ANALYSIS OF NO2, RSPM & SPM: A GIS APPROACH

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ABSTRACT

Due to awareness of ill effects of pollution on human beings, number of studies have been done for Noise pollution, Air pollution, Soil pollution etc. The major pollutants like NO2, RSPM, SPM are playing a major role in deteriorating the human as well as soil health. Delhi, the capital of India, seen an unprecedented growth in population, vehicles, industries, which caused serious ecological imbalance and environmental degradation and causing deteriorating effects on health. The problem got further aggravated by increasing migration from neighbouring states for their livelihood. It has been observed in literature that the major polluting factors are NO2, RSPM and SPM, moreover apart from other factors, cracker burning during Diwali festival, pollution levels increases to approx. 5 times than the normal days. Thus, it motivates us to study temporal and spatial analysis of major pollutants i.e. NO2, RSPM and SPM places of Delhi and analyse the air quality pre Diwali and post-Diwali. The main objectives of the paper is (a) To determine variation of NO2, RSPM and SPM for the year 2008, 2009 and 2010 (b) Analysis of firecrackers burning during during Diwali for the year 2003, 2006 and 2009. In this study, inputs for the study has been procured from Central Pollution Control Board (CPCB) and Environmental Information System (ENVIS) for the required years. An attempt has been made to use Geographical Information System (GIS) and Geostatistical Technique like Kriging in this research. Results obtained are also compared with the National Ambient Air Quality Index (NAAQ) standards to study the actual position with reference to the pollution.

Keywords: NO2 (Nitrogen Dioxide), RSPM (Respiratory Suspended Particulate Matter), SPM (Suspended Particulate Matter).

1. Introduction

Air pollution in the Delhi is drawing major national and international concerns. The diseases like Cardiovascular, Hypertension, COPD, etc. related to air pollution are affecting residents of Delhi in an alarming rate. Various studies like Enrique Pulafito and his team (2004), Vibhor sood with his team (2014) and Report of WHO in 2013 points towards the impact on health due to pollution. Digital Mapping/ GIS and Kriging methods has been widely used in mapping, analysis and change detection. Various studies like Khaleed in 2010, Vibhor Sood and his team in 2014 also used kriging and found promising results. PM2.5 is one of the major causative agents of cancer and major components of pollutant during Diwali. As discussed Particulate Matters and oxides of nitrogen are responsible for various upper and lower (URS and LRS) Respiratory Symptoms. It has been estimated that globally 8,000 people die every day from diseases related to air pollution exposure.

Table 1: National Ambient Air Quality Standards

S.no	Pollutant	Time weighted average	Concentration In Ambient air		
			Industrial, Residential, Rural and other Area	Ecologically sensitive area	Methods of measurement
(1)	(2)	(3)	(4)	(5)	(6)
1	Nitrogen Dioxide (NO_2), µg/m^3	Annual* 24 Hours**	40 80	30 80	-Modifies Jacob & Hochheiser -Chemiluminescence
2	Particulate Matter, size less than 10 µm or PM10 µg/m3	Annual* 24 Hours**	60 100	60 100	-Gravimetric -TOEM -Beta Attenuation
3	Particulate Matter, size less than 2.5 µm or $PM_{2.5}$ µg/m^3	Annual* 24 Hours**	40 60	40 60	-Gravimetric -TOEM -Beta Attenuation

(Source: DPCC ENVIS Website)

*Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.
** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be compiled with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.
This paper aims to put light on Delhi pollution levels mainly, NO2, RSPM and SPM during the normal and Diwali days and measure its effects on health of Delhi dwellers. The
Diwali day's pollution level has been measured for major 42 residential areas of Delhi. The non-Diwali day pollution level has been analysed for major 9 places in Delhi.

2. Study Area:

Delhi and its urban region have been given the special status of National Capital Region (NCR) under the Constitution of India's 69th Amendment Act of 1991. It is the largest city in India in terms of geographical area—about 1,484 square kilometres. It has a population of about 16.3 million, making it the second most populous city, and 3rd largest urban area in the world. Delhi features an atypical version of the humid subtropical climate. Some major places were taken for study of non- Diwali period whereas 42 residential areas were taken for study for Diwali pollution.

3. Methodology

Researchers uses mainly two different types of data i.e. primary data (obtained from instruments) as well as secondary data (using already available data). During this study, secondary data were used and analysis was done using Geographical Information System (GIS). The brief methodology of this study has been shown in figure 3.1 and discussed in following paragraph.

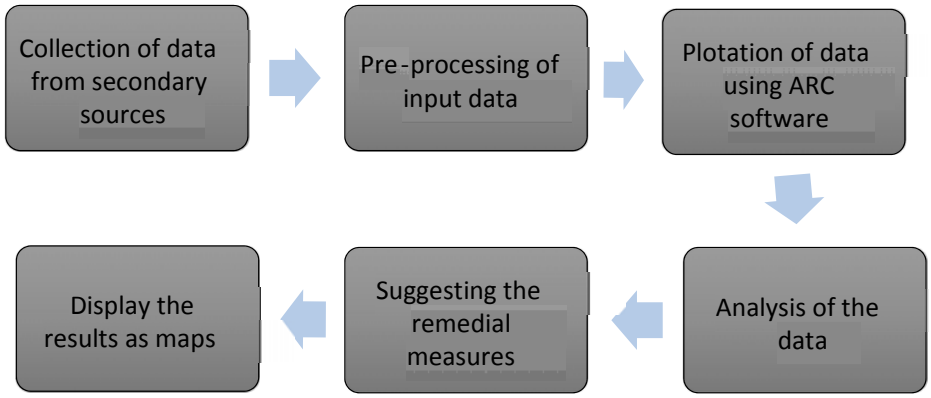

Fig 3.1: Flowchart for methodology

a) Collection of secondary data:
Secondary data for NO2, RSPM and SPM has been procured from Delhi Pollution Control Board (DPCC) Environmental information System (ENVIS). The data for Diwali period was available from year 2004 to 2009, while data for non-Diwali period was available from year 2007 to 2010 for 9 major places only for the concerned area.

b) Sampling Locations:
Major 9 places for non-Diwali and 42 places for Diwali was selected as sampling locations to be studied.

Fig. 3.2: Locations for Diwali period

Fig 3.3 Locations for 9 non-Diwali period

c) Kriging
During this study, Kriging which is an advanced geostatistical method, used to generate probable surface from a scattered set of points with z-values. This method works on the assumption that the distance or direction between sample points reflects a spatial relation which can be used to explain variation in the surface. In ArcGIS, Geostatistical analyst was used for kriging. The kriging/Co-kriging tool was used and the option of ordinary kriging and prediction map was selected. This method results in creating a surface using the input parameters. After which, semivariogram/covariance model was used to examine spatial relations between the measured points. In next stage, locations with no measured values were predicted which is used for displaying a map of air pollution concentration. The examination of distribution of data was done using the histogram function of geostatistical analyst.
The normal quantile-quantile (QQ) plot was created to compare the distribution of the data to a standard normal distribution.

Similarly the trend study was done using the trend analysis function of the geostatistical analyst.

4) Results and Discussions

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During this study, spatial and temporal variation of NO2,RSPM and SPM are estimated by Grpahs as well as maps. In following paragraphs, these results are discussed

4. 1.) NO2, SPM & RSPM Analysis during 2008/9/10

a) NO2 Analysis

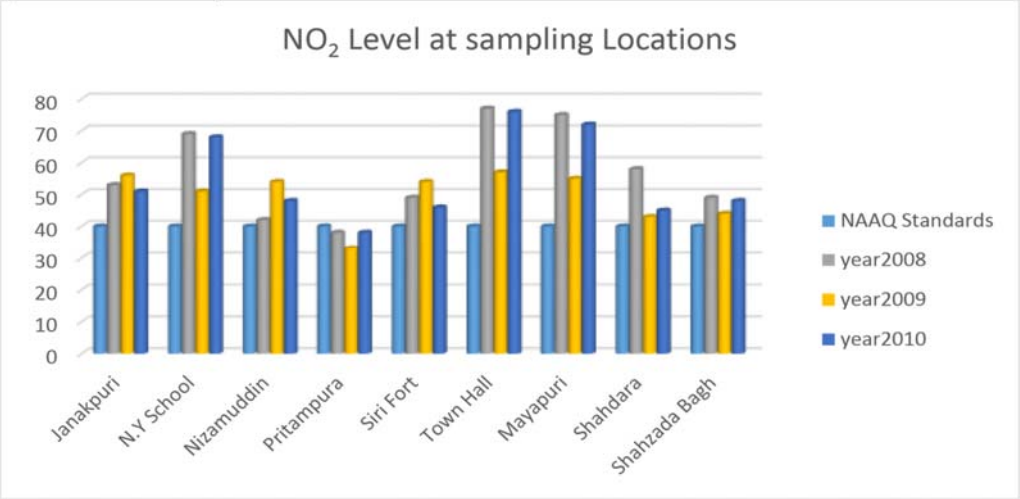

Figure 4.1: Nitrogen Dioxide levels at different sampling locations

Figure 4.1 shows the NO2 levels were, in general higher than permissible values for Industrial areas. For residential areas, the values were below the NAAQS throughout only for Pitampura, while Sarojni Nagar (N.Y. School) showed highest NO2 levels in the years 2008 and 2010. Results also shows that Mayapuri industrial are and town hall (chandni chowk) had constantly high NO2 levels throughout these 3 years

these 3 years.

b) SPM Analysis

Figure 4.2 shows a gradual rise in SPM level was seen all the places. Nizamuddin, Shazadabagh and Siri fort observed a decline in SPM levels in 2010. The maps for SPM levels indicate that Shahazadabagh, Town hall and Mayapuri have always been in great risk in cases of SPM levels. A severe rise from 445µg/m3 to 550 µg/m3 was seen in these 3 years.

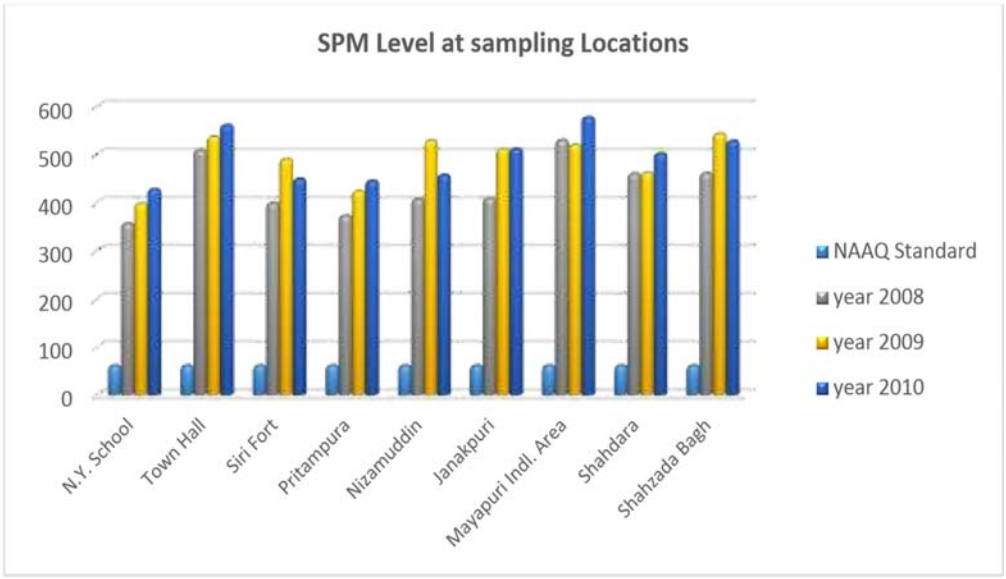

Figure 1.2 : SPM Levels at different sampling Locations

d) RSPM Analysis

Figure 4.3 shows a gradual rise in SPM level was seen all the places. Nizamuddin, Shazadabagh and Siri fort observed a decline in SPM levels in 2010. The maps for SPM levels indicate that Shahazadabagh, Town hall and mayapuri have always been in great risk in cases of SPM levels. A severe rise from 445µg/m3 to 550 µg/m3 was seen in these 3 years.

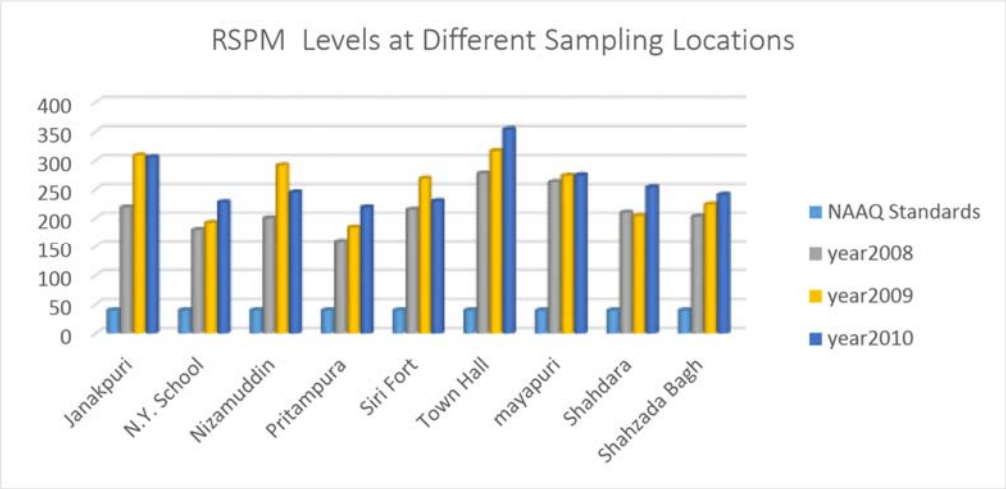

Figure 4.3: RSPM Levels at different sampling locations

Results of NO2, SPM & RSPM were also analyzed in spatial context, which assists researched to understand the variations better. Kriging which is a geostatistical technique is used for the same and following spatial maps are generated.

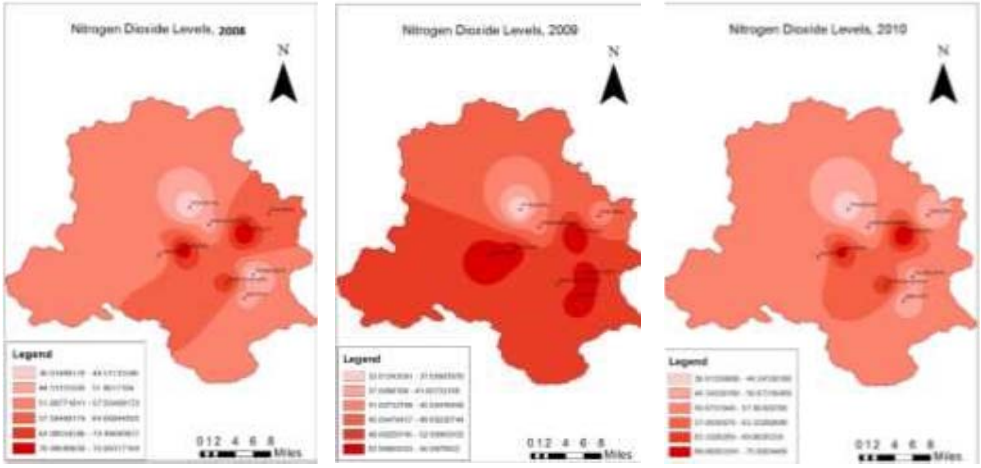

Figure 4.4: Spatial variation of NO_2 for Year 2008/9/10

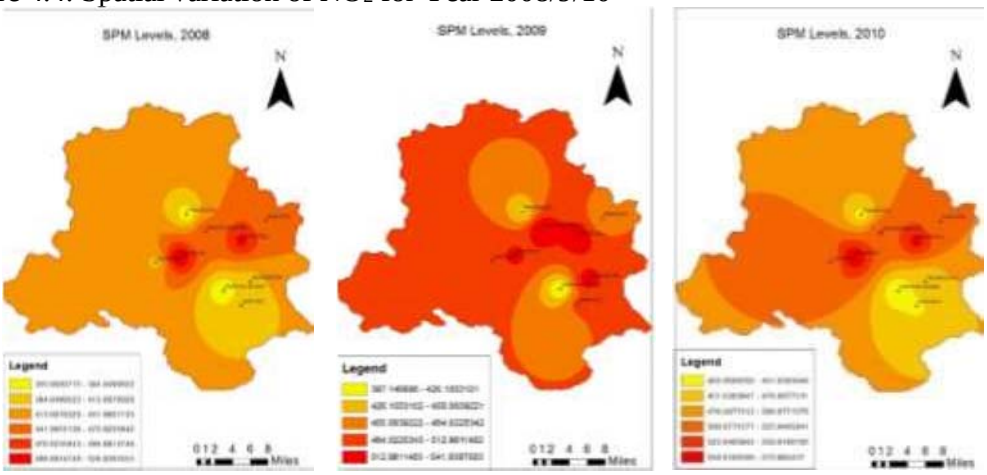

Figure 4.5**:** Spatial variation of SPM for Year 2008/9/10

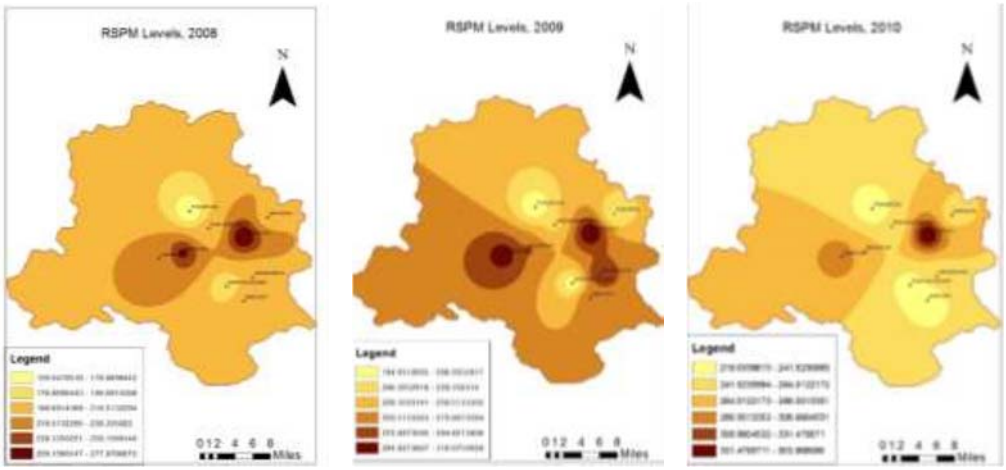

Figure 4.6**:** Spatial variation of RSPM for Year 2008/9/ 10

4.2) NO2, SPM & RSPM Analysis during Diwali for the year 2003/6/9

During Diwali period major amount of pollution accounts for bursting firecrackers. There was no major change observed in the NO2 levels. Firecrackers mostly contain potassium, Sulphur, charcoal and nitrates. When the pollution levels are examined NO2 shows its presence in a minimal amount. The rate of NO2 emission shows a decrease from 450 µg/m3 in 2006 to 70 µg/m3 in 2009

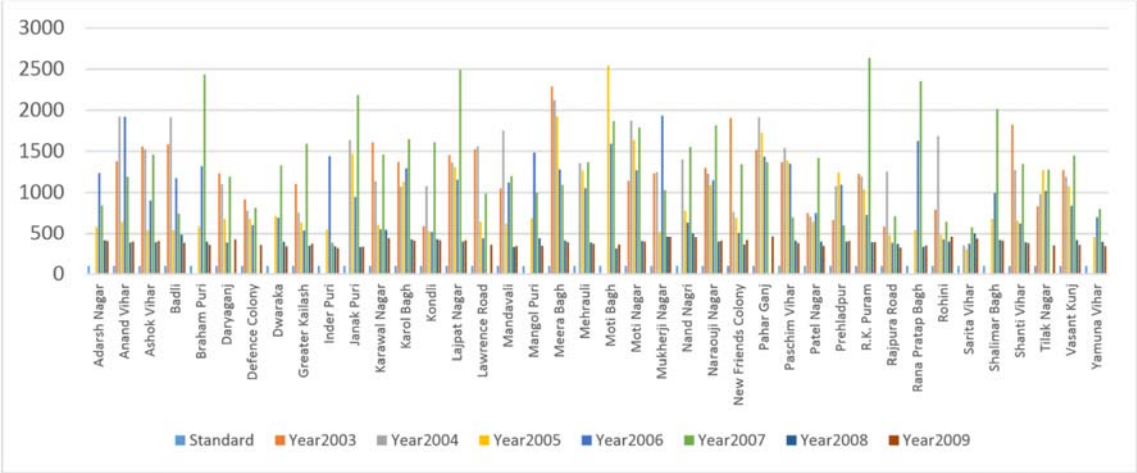

Figure 4.7: Temporal Variation of RSPM during 2003-2009

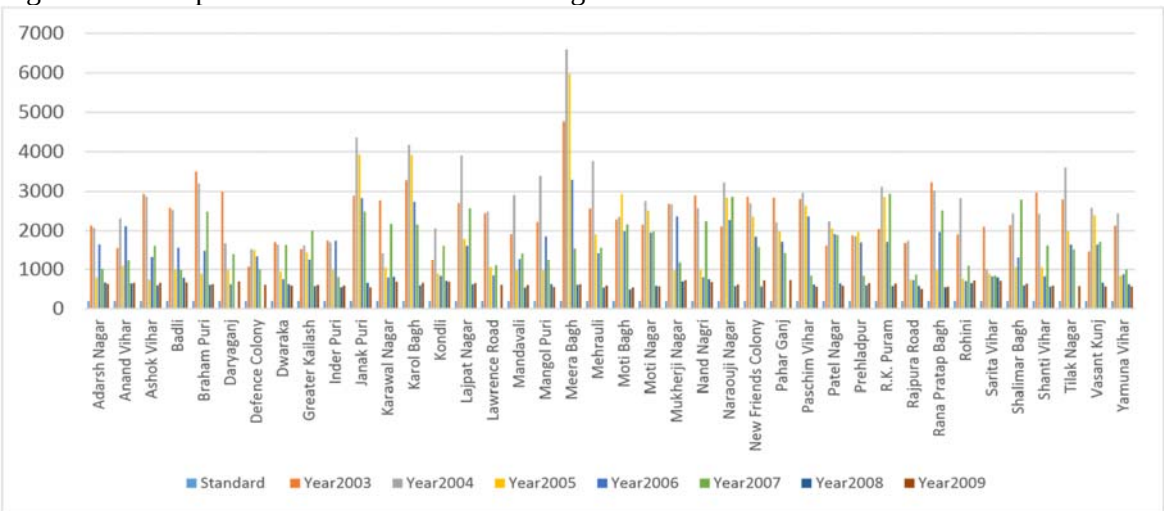

Figure 4.8: Temporal Variation of SPM during 2003-2009

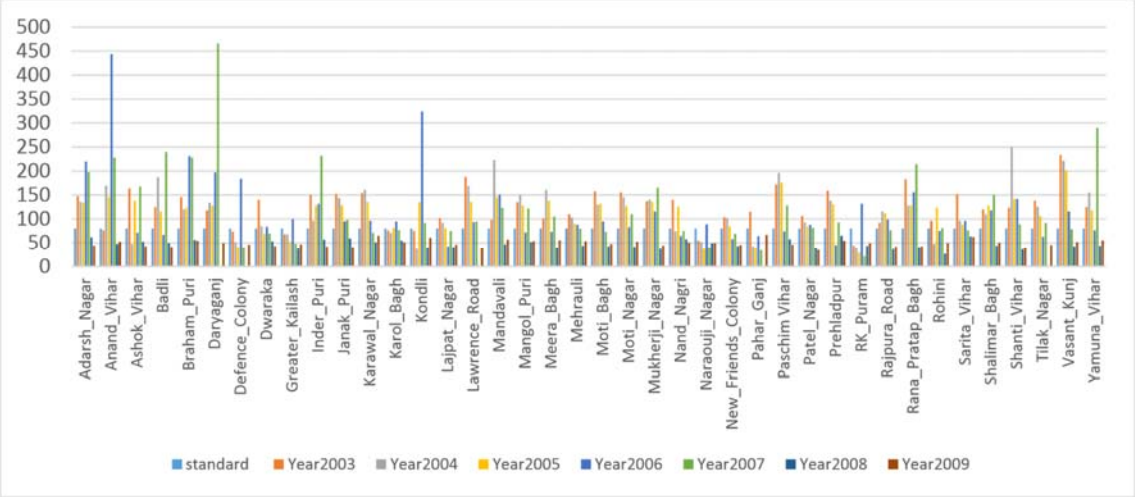

Figure 4.9: Temporal Variation of NO2 during 2003-2009

Figure 4.10: Temporal Variation of NO_2 during Diwali

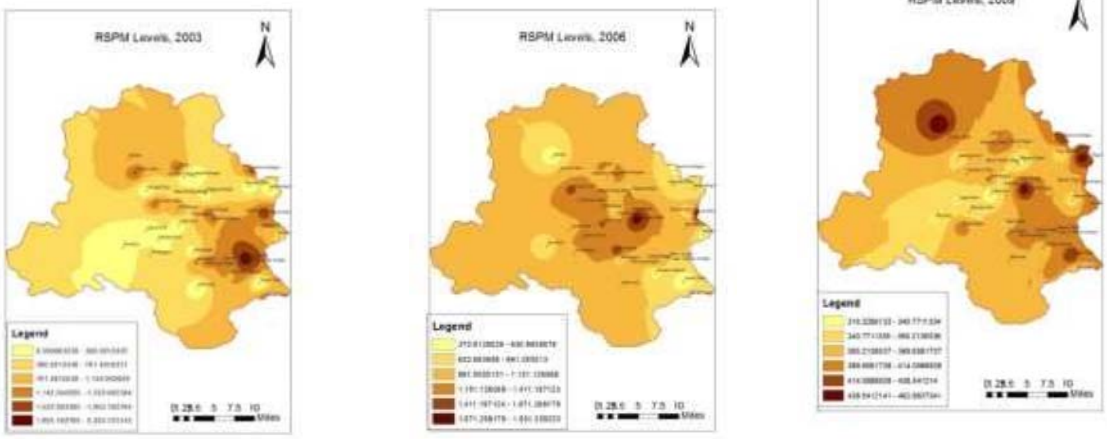

Figure 4.11: Temporal Variation of RSPM during Diwali period

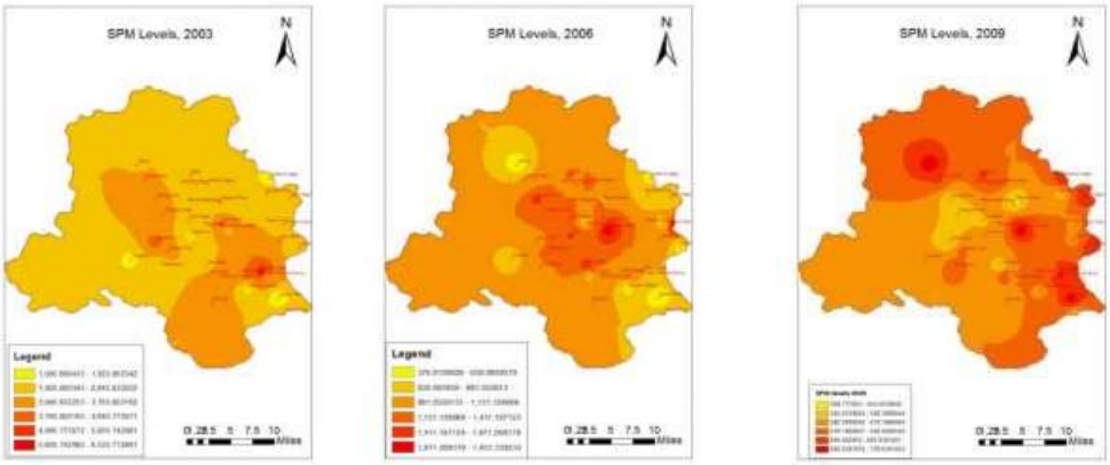

Figure 4.12: Temporal Variation of SPM during Diwali period

Continuous and excessive inhaling of PM2.5 could cause dire problems such as premature deaths, lung cancer, heart attacks and development of chronic lung diseases and other problems. This level can cause URS (upper Respiratory Symptom) to the Delhi dwellers. Chronic obstructive pulmonary disease (COPD) can be detected in higher percentage of residents of Delhi against those of controls, indicating lung obstruction. Hypertension, alteration of kidney and liver function, lungs function disorder is major problems that the Delhi air can cause.

5) Conclusion

The level of SPM and RSPM were seen to be much higher than the permissible limits. This pollution level is slowly going to cause several respiratory, livers, kidney problems to the Delhi dwellers. It doesn't only affect the adults but also in harmful to small kids or pregnant mothers. Various measure have been taken by the Delhi Government to tackle this issue. But the alone effort of government is not sufficient. The common people of Delhi also need to tackle this problem in their individual level. Rather than phasing out diesel vehicles in Delhi/NCR, Diesel Particulate Filter (DPF) could be fitted into older vehicles, including heavy duty commercial vehicles to reduce emissions. Power availability in Delhi/NCR has to be improved by providing grid supply, new commercial DG sets in Noida and Delhi should be based on CNG and existing DG sets should be retrofitted with requisite pollution control system to reduce Nitrogen Oxides and soot particles. Every individual should keep a proper check on the pollution level of their vehicles. One of the best ways to control pollution is to manage wastes of all types in a proper manner.

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