AIR QUALITY ASSESMENT OVER YEARS ON DIWALI USING GIS APPROACH

Joginder Singh Yadav, Amul Patwal

Abstract— Activities like cracker burning during Diwali, the religious festival of India has now become the problem of noise and air pollution. The study area was taken Delhi, the capital of India and 40 monitoring station data is analysed by using of Geographical information system approach. The trends for Nitrogen oxides (NOx), Sulphur oxides (SOx), Suspended particulate matter (SPM), Respirable suspended particulate matter (RSPM) and Carbon monoxides (CO) on Diwali days for 2003 – 2009 are seen. The decreasing trend is seen from 2003 to 2009 on Diwali day on most of the monitoring station for each of the pollutant. One of the major reasons may be health awareness among people due to pollution. SPM and RSPM average concentration were investigated around 2.5 times and 3.5 times of permissible concentration respectively at all the monitoring stations in 2009. NOx, SOx and CO concentration was seen within the permissible limit in 2009 on Diwali day.

Index Terms — Geographcal Information system, Diwali, RSPM, SPM, NO_x. SO_x, ArcMap 9.3.

1 INTRODUCTION

Diwali, the religious festival of joy and happiness celebrated every year in India is now becoming the festival of noise and air pollution. In past it was celebrated with the lighting candles. But nowadays enjoyment is done with the fireworks such as crackers and sparkles. Festival comes in winter days during the month of October and November. Delhi is the capital of India which is most polluted city in the world (WHO 2014). The sources of pollution which makes it most polluted city is discussed in table 1.The episode event like Diwali contributes more pollution on existing one. Many researches have been done on the health impacts due to air pollution in Delhi and found problems related to respiratory system[1]. Table 2 gives some idea about the health impacts due to air pollution in Delhi. Chemicals which are used for making crackers are magnesium, zinc, nitrate, copper, lead, nitrite etc. which releases gases like Sulphur di oxide, carbon di oxide, carbon monoxide and suspended particles like PM10 and PM2.5, which can make the serious negative health impacts[2-4]. Many of the firework disasters happened in India during last years. Trace elements have been found in the blood and urine of victims of disasters. Burning of sparkles forms the ozone without participation of nitrogen oxides[5]. National cancer registry program has mentioned the Delhi to the most cancer prone area in India[6]. In Lucknow city, India concentration PM10, SO2, NOx became 5.7, 6.6 and 2.7 times higher than that of normal day on Diwali [7]. So the problem of air and noise pollution arises everywhere in the country at the time of Diwali. There is a formation of smog in the winter season due to trapping of pollutants because of the atmospheric inversion in cold conditions during Diwali. So it creates the problem for the people having diseases related with lung, heart and nervous system. Mainly children burn the crackers so they get high exposure of the bad air pollution. But the air pollution is decreasing with the years may be because of the awareness between the people. The awareness comes from the different advertisements as given before the Diwali for not burning the crackers. So now people are reducing the use of fireworks for celebrating Diwali. The geographical information system software gives the better visual communication to understand the spatial data information.

The objective of the study is to map the air quality parameters of 40 monitoring stations on Diwali such as SPM, RSPM, SO2, NOX, CO of seven years from 2003-2009 of Delhi using GIS and other major objective is to analyse how the air quality changing with the years.

TABLE 1
CONTRIBUTION OF AIR POLLUTION FROM DIFFERENT SOURCES IN DELHI

Source	1970 –1971 (%)	1980– 1981 (%)	1990– 1991 (%)	2000 –2001 (%)
Industrial	56	40	29	70
Vehicular	23	42	64	72
Domestic	21	18	7	8

TABLE 2
MEDICAL SYMPTOMS PREVALENT AMONG DELHI RESIDENTS CPCB (PARIVESH SEPTEMBER, 2001)

Name of disease	Male *N* = 788	Female *N* = 533	Total *N* = 1,321	(%)
Irritation of eye	354	233	587	44.4
Cough	224	157	381	28.8
Pharyngitis	138	81	219	16.5
Dyspnea	117	97	214	16.2
Headache	78	114	192	14.5
Nausea	50	82	132	10
Vomiting	44	79	123	9.3
Conjunctivitis	59	47	106	8
Abdominal pain	36	50	86	6.5

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Name of disease	Male *N* = 788	Female *N* = 533	Total *N* = 1,321	(%)
Respiratory problems	51	27	78	5.9
Rhinitis	23	21	44	3.3
Bronchitis	17	13	30	2.3
Burning of mouth and throat	8	3	11	0.8
Epistaxis	2	4	6	0.5
Depression	2	–	2	0.2
Non-smokers	–	–	–	87
Smokers	–	–	–	13

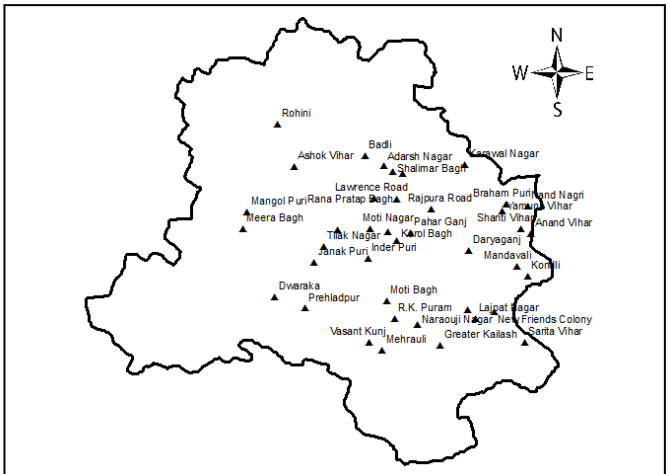

Fig. 1.Georeferenced Map of Delhi showing the monitoring stations

2 METHODOLOGY

2.1 Study area

The study area is Delhi; Capital of India which has coordinates of 28°36'36"N 77°13'48"E with the area of 1,484 Km2. The population of Delhi is around 16 million (census 2011) which is 2nd highest in India. Climate is mainly humid subtropical type with summer in May to July and winter in December to march. Total 40 monitoring stations were established by Delhi pollution control board to take data of Suspended particulate matter (SPM), Respirable suspended particulate matter (RSPM), Sulphur di oxides (SO_2), Nitrogen oxides (NO_x) and Carbon monoxides (CO) on Diwali day from 2003 to 2009. The monitoring stations are compromises of residential, commercial and industrial area.

2.2 Construction of Maps

Geographical information system (GIS) aided mapping is done with the ArcGIS 9.3 software. The system used for the projection of Maps was world projection 1984. The map of Delhi is georeferenced using the georeferncing tools available in ArcMap and its R2 value came 0.001. Then the 40 monitoring sites were mapped on the georeferenced Delhi city map using their respectives longitude and latitude coordinates and represented by the circle symbols. The data for the air quality analysis is inserted in the ArcMap from excel sheet using the join tool by making their common FID number for each monitoring station. The determinands used for analysis were SPM, RSPM, SO2, NOx and CO because they are representatives of deciding the air quality. The 24hr average concentration for each of the parameter is calculated for the analysis of air quality. The concentration of each parameter for every year is normalized with their respective standard values by using the normalization tool in ArcMap. For analysing the change of air quality for every year on Diwali, the map for each parameter of each year from 2003-2009 is created using the proportional symbols in symbology tool of properties. The propotional symbols size makes easy to understand the situation of the air quality on that monitoring site. Each symbol size has some meaning that how much time it is from standard air quality value.

2.3 Characteristics of Air Quality Maps

The air quality maps for the Delhi city on Diwali day of following year 2003, 2004, 2005, 2006, 2007, 2008 and 2009 for 40 different locations are shown at end of this paper. Fig. 1 shows the 40 monitoring locations on Delhi map. The following characteristics are shown after mapping propotional symbols for every monitoring location for years from 2003 to 2009.

Suspended particulate matter

Concentration of SPM was seen very high in 2003, 2004 and 2005 after that it started falling down in next coming years 2006 to 2009. The standard for the SPM in India is 200µg/m3. The highest concentration was seen around 33 times of standard in 2004 at Meera bagh and then it decreased to 30 times in 2005, 16.5 times in 2006 and finally to 3.13 times in 2009. It might be people got aware of the health issues related to particulate matters through the various advertisements on social media. The same decreasing trend is seen for other monitoring stations from 2003 to 2009 on Diwali day like at Karol bagh and Janak puri. In year 2004, Karol bagh and Janak puri concentration was 22 times and 21 times, and it decreased to 3.31 times and 2.725 times in 2009 respectively. But it was investigated that the average concentration was still around 2.5 times at all the monitoring stations in 2009.

Respirable suspended particulate matter

RSPM is also seen very high as the SPM in years 2003 and 2004. RSPM standard according to CPCB is 100µg/m3. In Moti bagh and Meera bagh, RSPM is seen 25.5 times and 19.2 times of standard in 2005 and then it decreased up to 3.6 times and 4 times respectively in 2009 on the Diwali day. One more trend was also seen that RSPM concentration got decrease from 2003 to 2006, then suddenly risen in 2007 and again decreased in 2008 and 2009. The average concentration of RSPM was seen 3.5 times in 2009 Diwali day for whole Delhi as per all monitoring stations.

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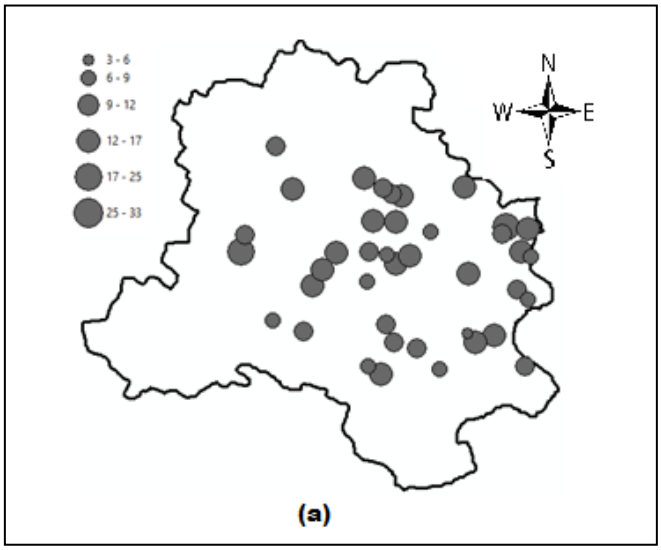

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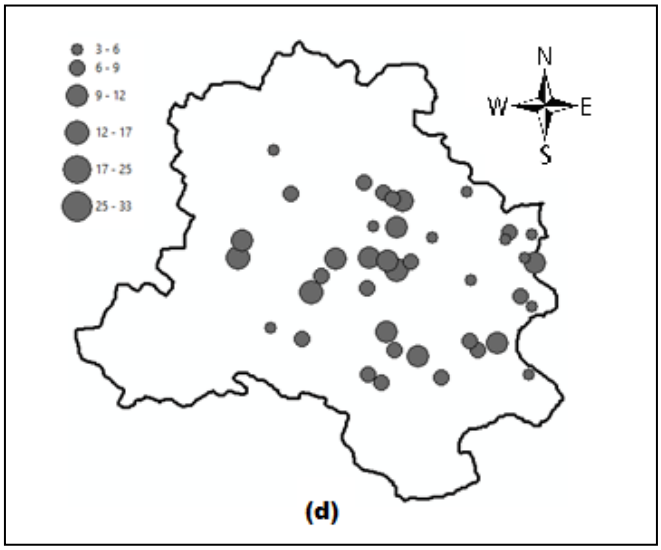

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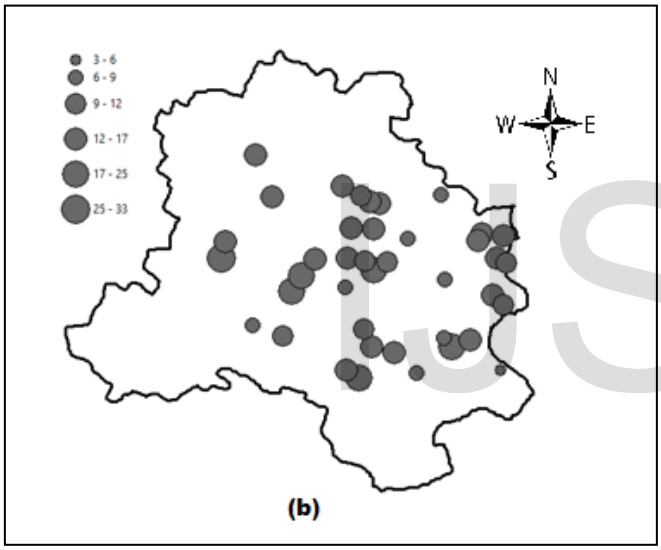

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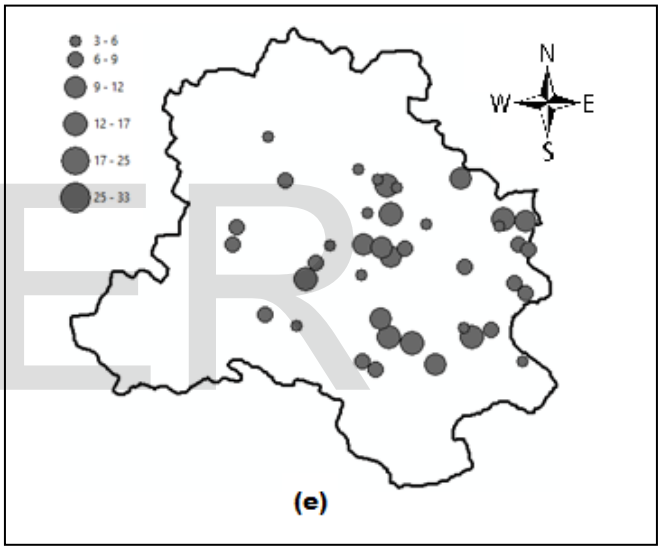

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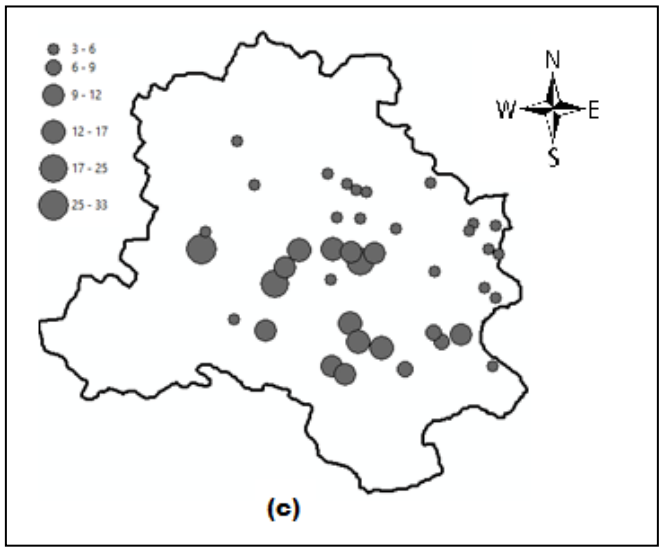

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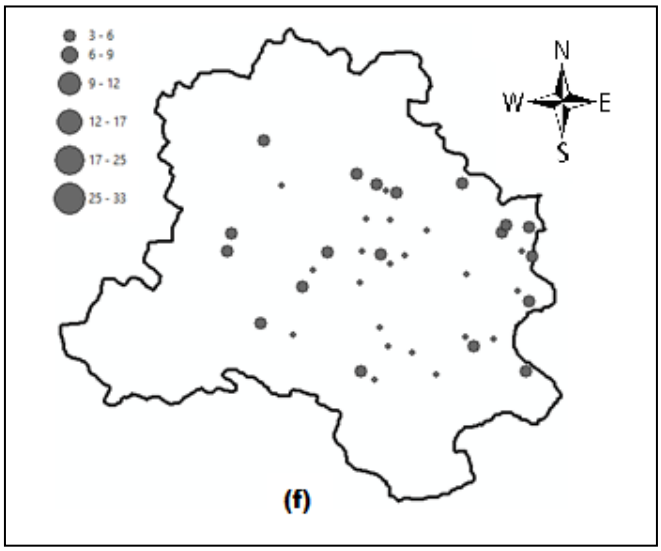

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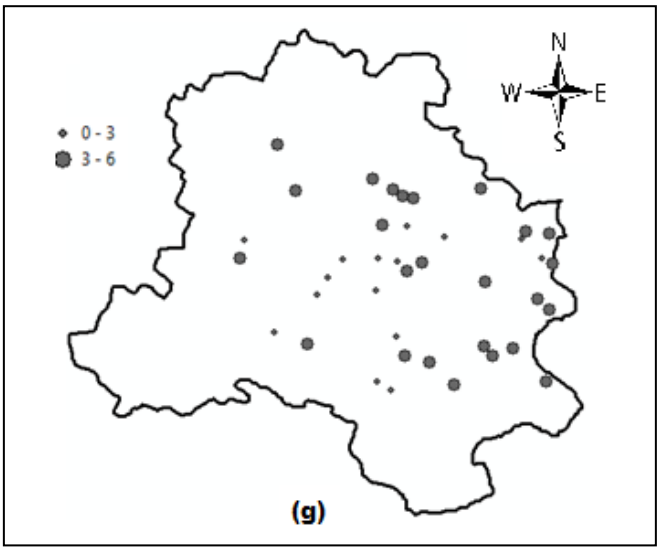


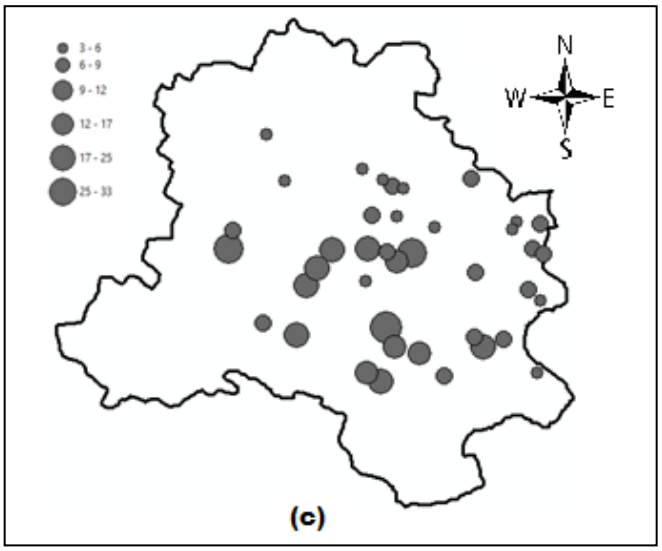
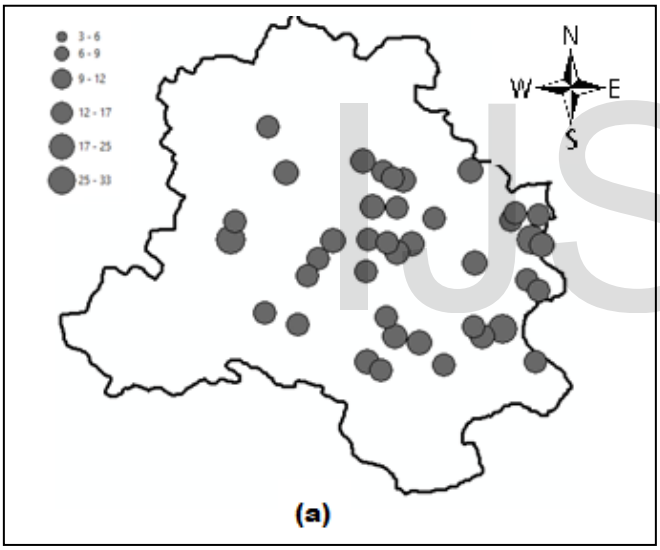
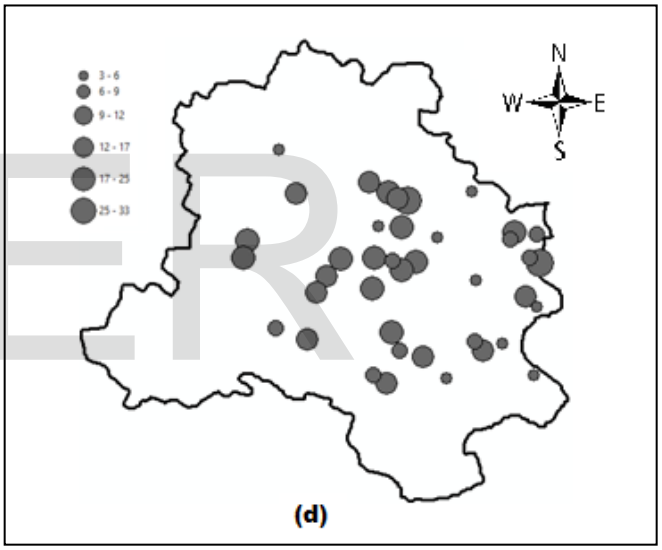
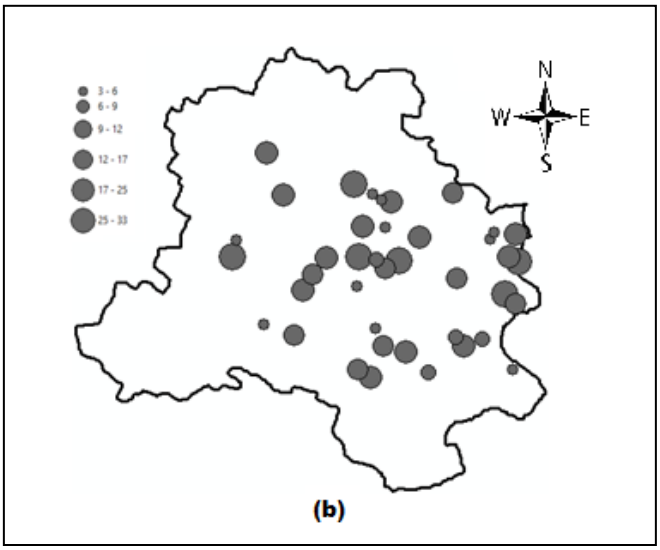
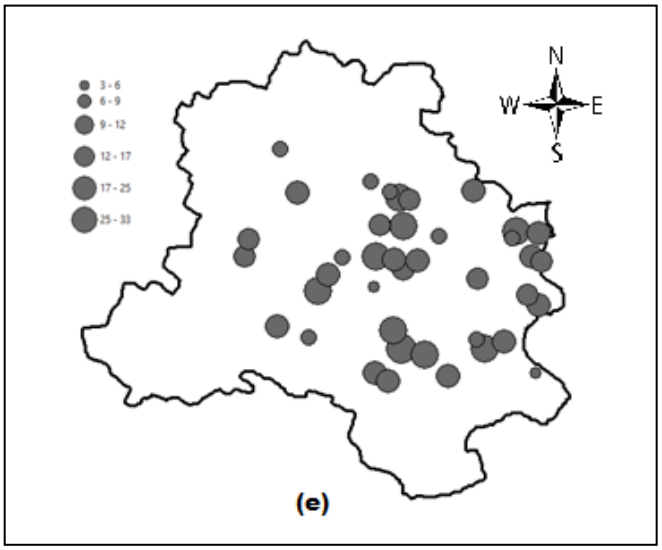


Fig. 2. Map of SPM concentration times over permissible limit of 40 monitoring station for year (a) 2003,(b) 2004, (c) 2005, (d) 2006, (e) 2007,(f) 2008, (g) 2009.









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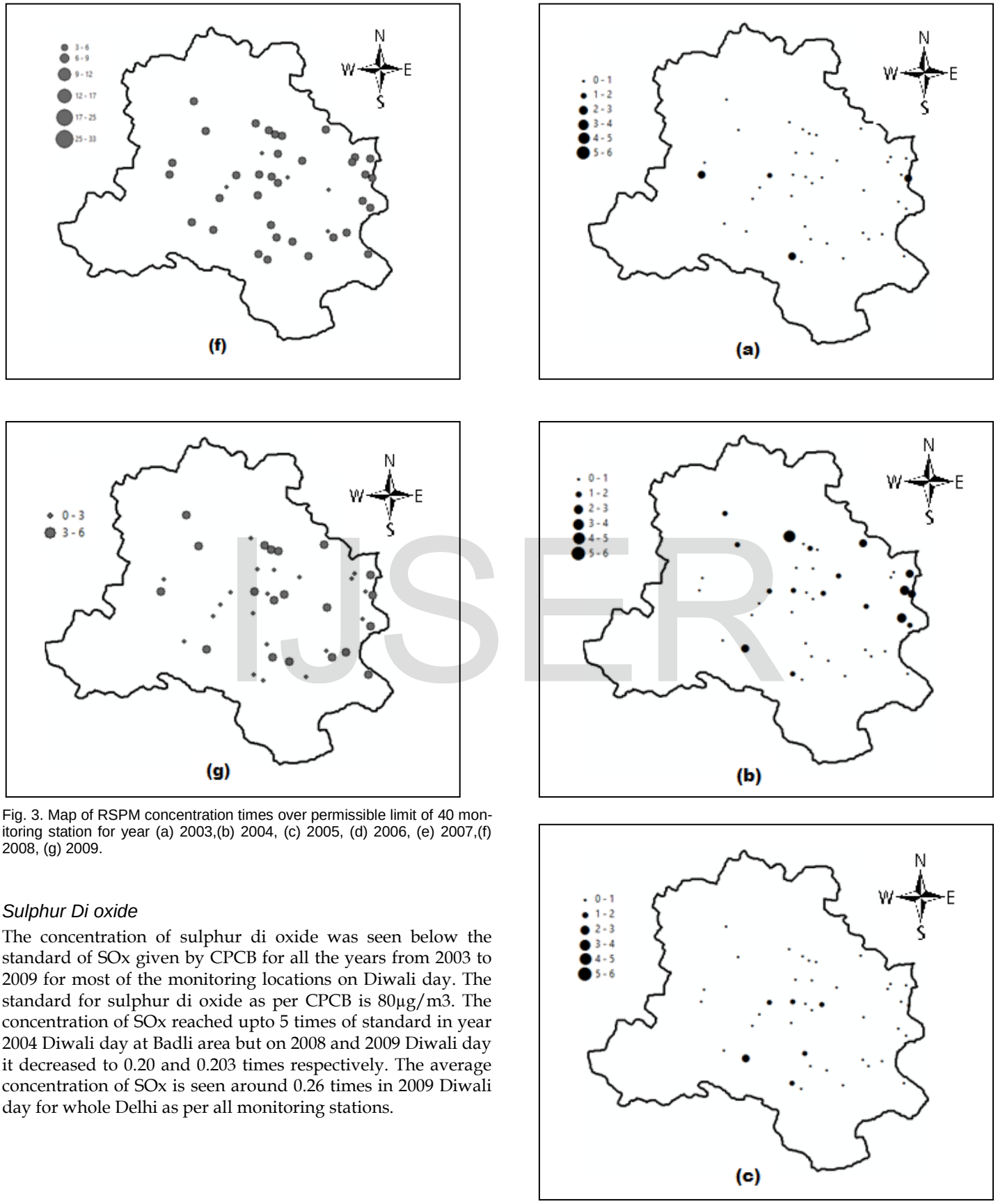

Fig. 3. Map of RSPM concentration times over permissible limit of 40 monitoring station for year (a) 2003,(b) 2004, (c) 2005, (d) 2006, (e) 2007,(f) 2008, (g) 2009.

Sulphur Di oxide

The concentration of sulphur di oxide was seen below the standard of SOx given by CPCB for all the years from 2003 to 2009 for most of the monitoring locations on Diwali day. The standard for sulphur di oxide as per CPCB is 80µg/m3. The concentration of SOx reached upto 5 times of standard in year 2004 Diwali day at Badli area but on 2008 and 2009 Diwali day it decreased to 0.20 and 0.203 times respectively. The average concentration of SOx is seen around 0.26 times in 2009 Diwali day for whole Delhi as per all monitoring stations.

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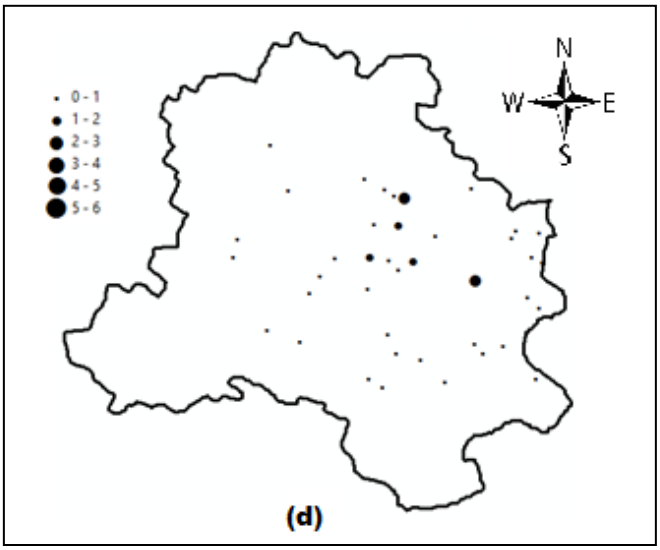


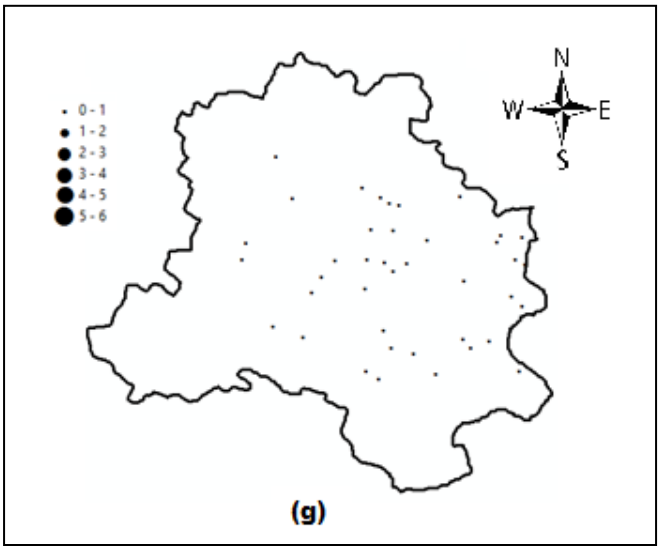
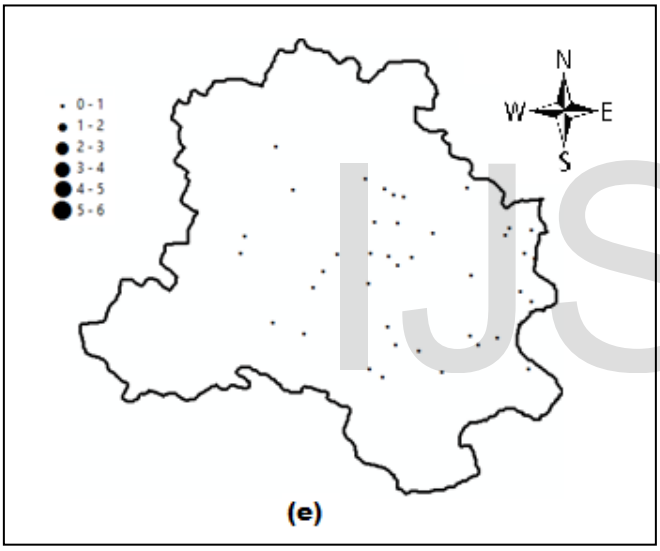
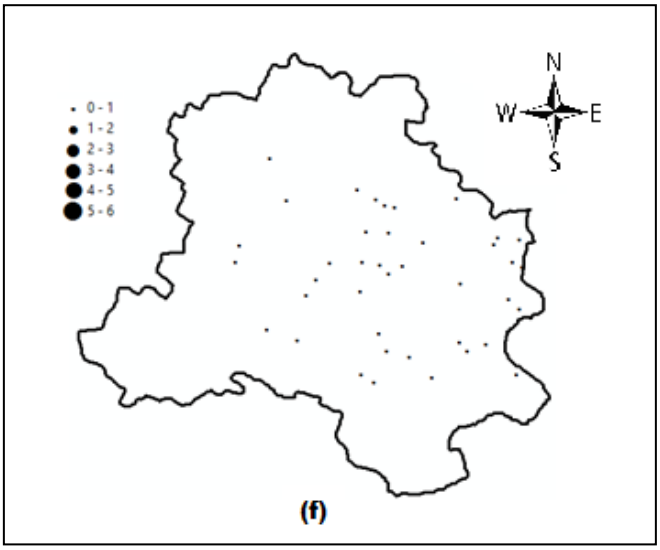


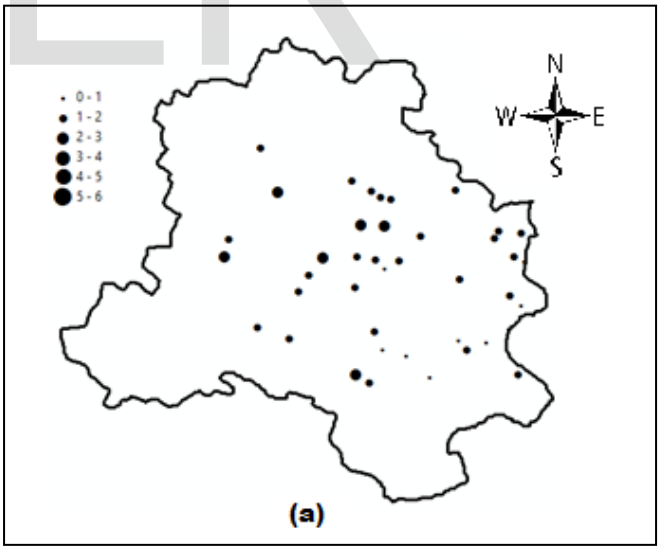
Fig. 4. Map of SO_x concentration times over permissible limit of 40 monitoring station for year (a) 2003,(b) 2004, (c) 2005, (d) 2006, (e) 2007,(f) 2008, (g) 2009.





Nitrogen Di oxide

The standard for the NOx is 80µg/m3 as given by CPCB. The average concentration is seen around 1.8 times in 2003 and 2004 Diwali day on all 40 monitoring stations. The concentration seen in 2009 Diwali day for all the monitoring station was below the standard of NOx.



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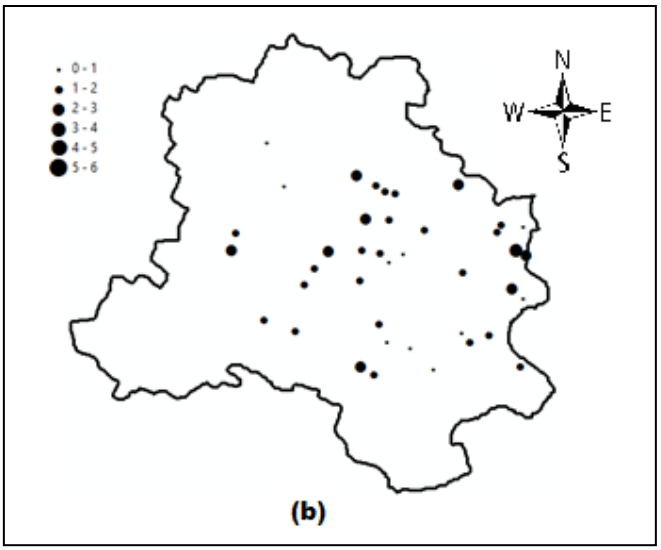

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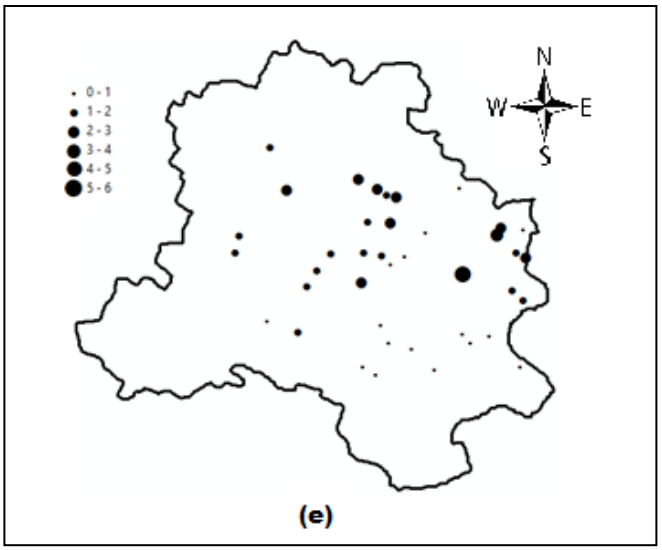

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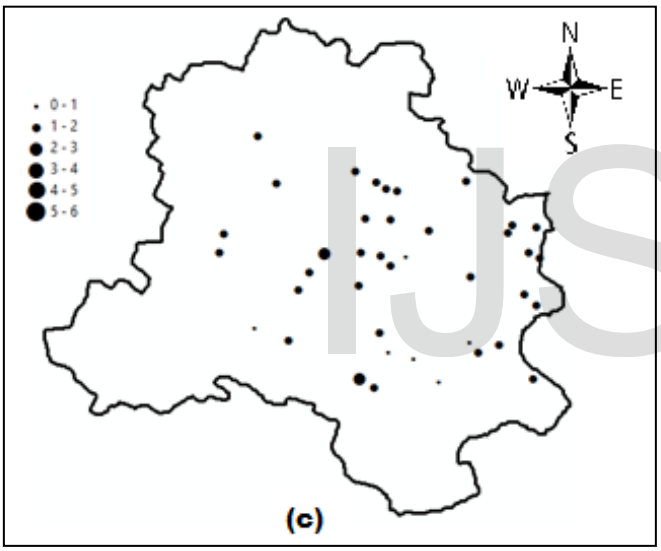

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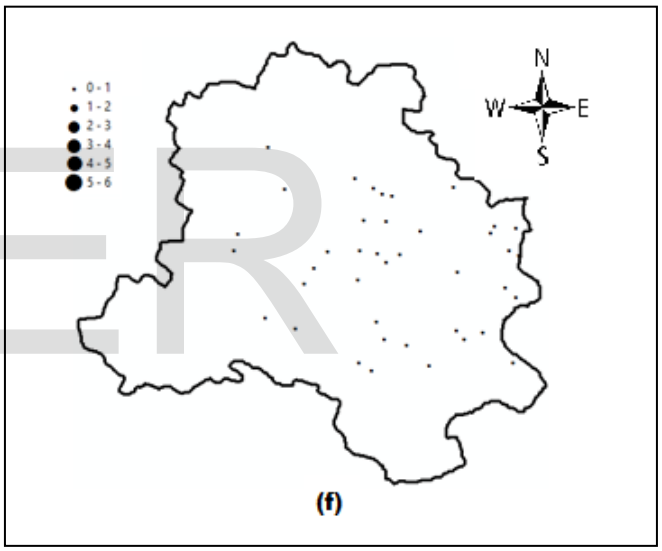

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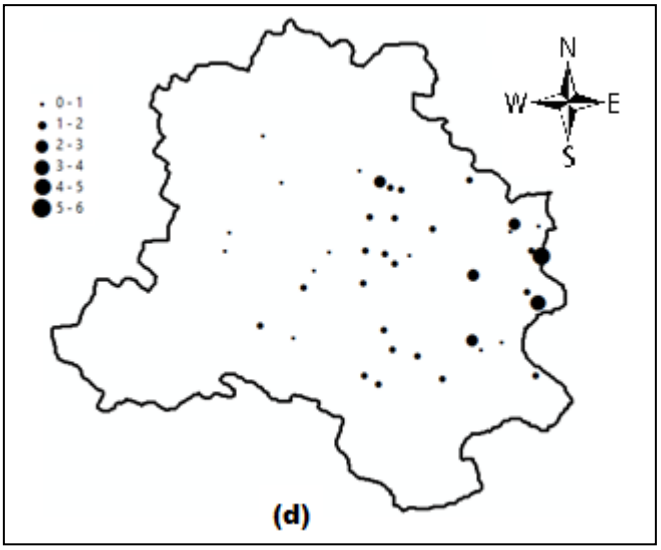

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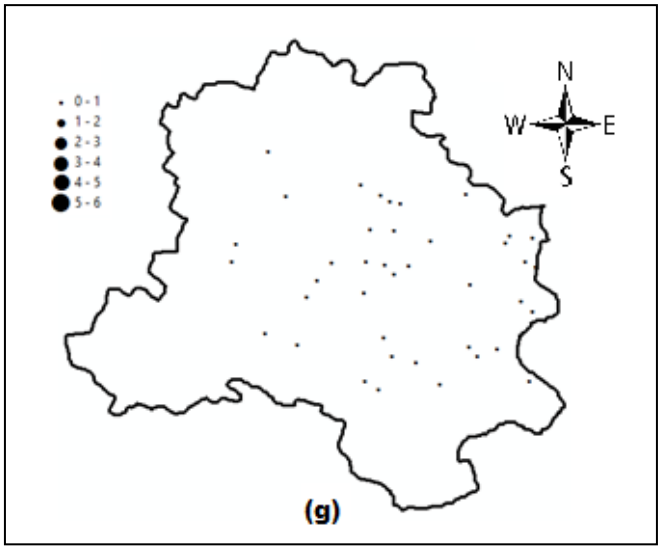

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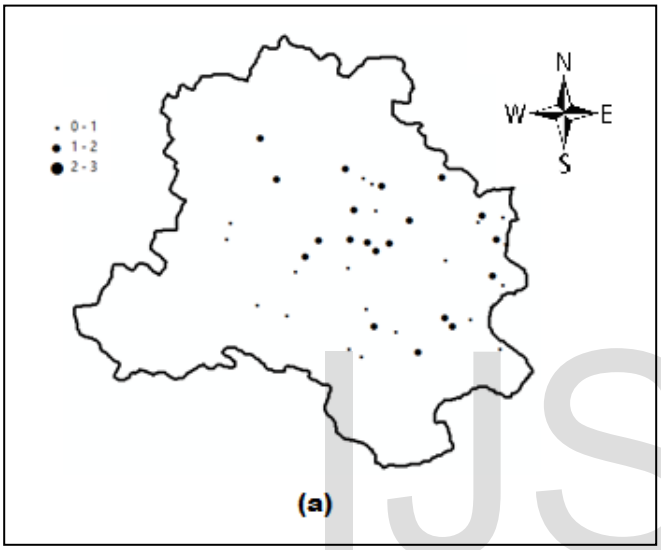
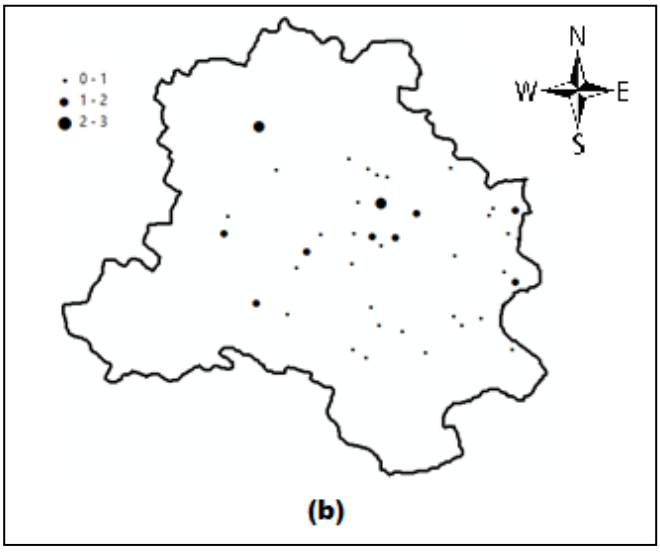
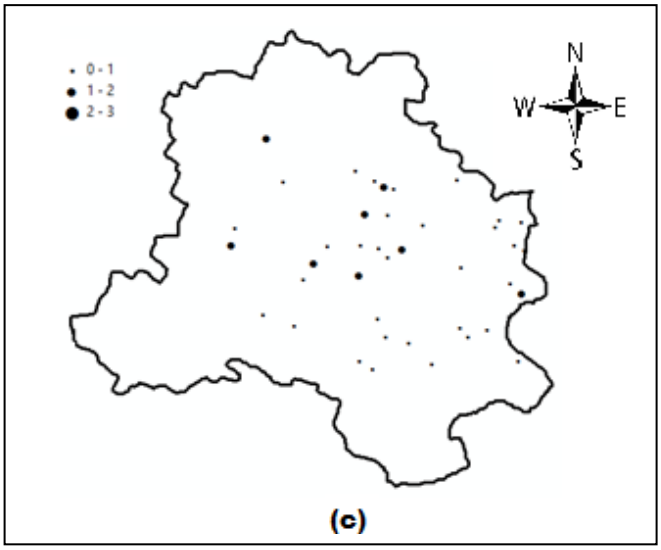
Fig. 5. Map of NO_x concentration times over permissible limit of 40 monitoring station for year (a) 2003,(b) 2004, (c) 2005, (d) 2006, (e) 2007,(f) 2008, (g) 2009.

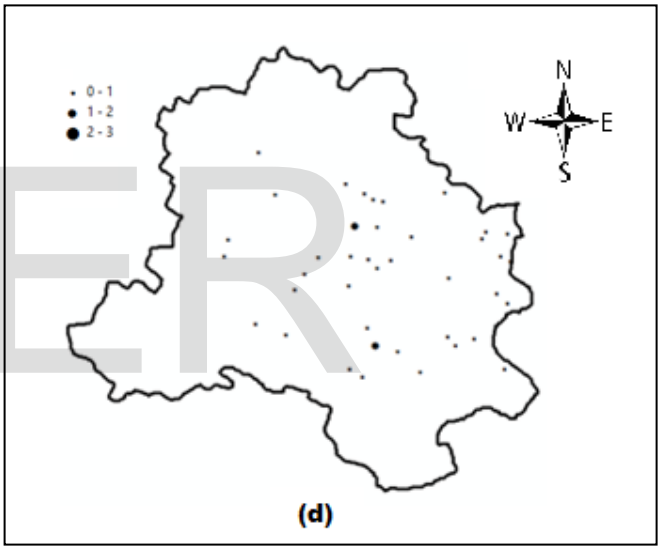
Carbon mono oxide

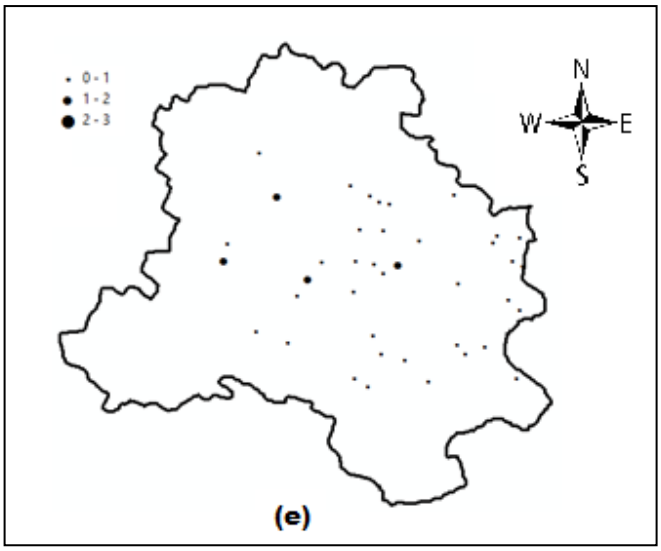
Most of the monitoring station shown CO concentration more than standard on Diwali day of 2003. It was around 1.2 times of standard. The standard for the CO as per CPCB is 4000µg/m3. It also followed same trend of decrease in concentration along with the years as other pollutants. The concentration was seen half of the standard at all the monitoring stations in the year 2009.











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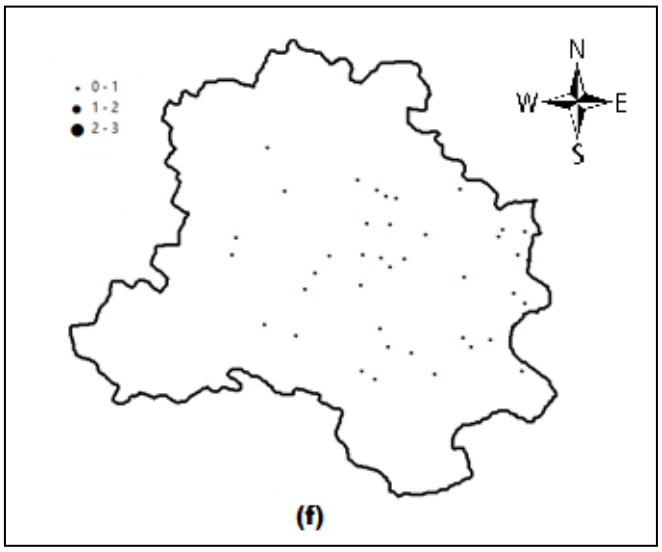

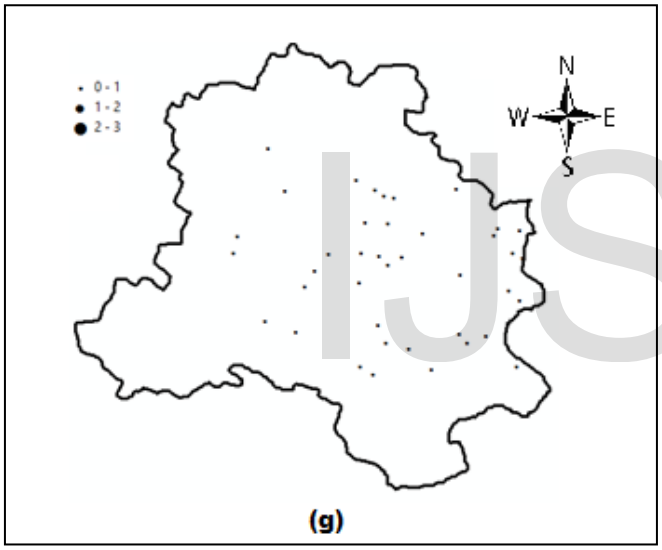

Fig. 6. Map of CO concentration times over permissible limit of 40 monitoring station for year (a) 2003,(b) 2004, (c) 2005, (d) 2006, (e) 2007,(f) 2008, (g) 2009.

CONCLUSION

The map of Delhi is georeferenced using the georeferncing tools available in ArcMap and its R2 value came 0.001. There is strict decreasing trend from year 2007 to 2009 seen at each monitoring station on Diwali day for all the pollutants through GIS approach. Concentration of SPM was seen very high in 2003, 2004 and 2005 after that it started falling down in next coming years 2006 to 2009. SPM and RSPM were seen very high in 2003 but it decreased along the years. But then also it does not reached up to the standard in 2009 Diwali day. The average concentration of NOx is seen around 1.8 times in 2003 and 2004 Diwali day on all 40 monitoring stations. NOx, SOx and CO concentration was seen within the permissible limit in 2009 on Diwali day..

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