Allocation of Major Air Pollutants in Rural Environment near Municipal Solid Waste Dumping Site Mathuradaspura- Jaipur, Rajasthan

Anirudh Sahni* and Abhishek Gautam**

Department of Environmental Science
Birla Institute of Technology, Mesra (Ranchi), Jaipur Campus
* Senior Scientific Officer, ** Project Fellow
email: anirudhsahni@yahoo.com, dranirudhsahni@gmail.com

Abstract: The municipal solid waste (MSW) generated in the cities has resulted in severe problems. The unplanned dumping of MSW of Jaipur city is done in open land near the village Mathuradaspura. The present study was carried out to understand the impact of MSW on air environment. The air sampling was done for the analysis of suspended particulate matter (SPM), sulphur dioxide (SO_2) and nitrogen oxides (NO_X) at Meena ki Dhani, Badi ka Baas, Langriyabas and Rupa ki Nangal. The study for the four seasons namely summer, monsoon, winters and autumn revealed the highest range of SPM (614-624 $\mu g/m^3$), SO_2 (35.5-37.5 $\mu g/m^3$) and NO_X (26.5-27.0 $\mu g/m^3$) at Meena ki Dhani during Autumn season. The air pollution caused may harm the people residing in core and nearby study area and flora and fauna. A statistical study showed that pollution levels at Meena ki Dhani has direct correlation (r = 0.86, 0.97, 0.97) with the other three villages. The dumping site is slowly being polluted due to frequent dumping of municipal solid waste.

Key Words: Air pollutants, Municipal Solid Waste, Impact, Correlation, Environment, Human Health.

Introduction

The solid waste management is a very serious problem all over the world. Growing population and unplanned urbanisation has resulted high amount of municipal solid waste. The MSW consists of biodegradable and non-biodegradable components. The non-biodegradability of the waste causes a serious concern to the human health and environment. There has been a significant increase in municipal solid waste (MSW) generation in India during the last few decades. In India, per capita generation of MSW varies from 100 grams in small towns to 500 grams in big cities (Kaur, 2005). Unplanned dumping of municipal solid waste generates unwanted heat, gases and leachate and create nuisance for the surrounding environment and also tells upon the human health for the people living around. Leaching of toxic compounds from MSW causes degradation of water and soil in and around dumping areas (Sahni and Gautam, 2011). Urban air pollution has worsened the health in the cities of both developed and developing countries (Shankar and RamaRao, 2002). In developing countries, it is common for municipalities to spend 20-50 percent of their available recurrent budget on solid waste management (Reddy ,2011).

Jaipur the capital of Rajasthan whose population was 14.58 lakhs in year 1991 has increased 23.24 lakhs in the year 2001 which may rise up to 37.00 lakhs in the year 2011. During the last two decades, the city of Jaipur has emerged out with an exponential increase in MSW. The present MSW dumping site Mathuradaspura receives tones of garbage every day collected from different parts of the city. This unplanned dumping of garbage pollutes the air and emits pollutants like SPM, NO_X and SO_2. The study was carried out to determine the level of air pollutants mentioned above at core and buffer locations of the study area. There is a significant association between the concentration of air pollutants and adverse health impacts (Ostro, *et al.*, 1995).

Materials and Methods

The present study site is near the village Mathuradaspura in the north-east of Jaipur about 20 to 22 Km. from the main city and falls under the toposheet No. 45 N/13. The land is used for dumping the municipal solid waste. The villages nearby are thickly populated and extensive agriculture is carried out in the area under study. The climate is semi arid and average temperature is around 30°C in summers while average temperature in winters range from 15 to18 degree celsius. The annual rainfall in the area is approximately 650 mm annually (wikipedia).

In the year 2009-10 the air sampling was done for all the four seasons viz. summers, monsoon, winter and autumn. The air samples were collected for SPM (suspended particulate matter) on 24 hourly basis, SO_2 (sulphur dioxide) and NO_X (nitrogen oxides) for every 8 hourly basis. The study was done for two consecutive days and 2 weeks at a particular site. The four places under observation were Meena ki Dhani, Badi ka Baas, Langriyabas and Rupa ki Nangal. The air sampling was done with the help of Respirable Dust Sampler (RDS, Envirotech).

SPM Analysis

High volume sampling method (Table-4) using glass microfibre filter (GF/A Whatman) was employed. The estimation was done gravimetrically in laboratory to obtain SPM.

Sulphur dioxide analysis

The sampling and analysis for SO_2 was done according to standard West and Gaeke Methodology.

Nitrogen oxides analysis

The Nitrogen oxides in the air are estimated by Jacobs and Hochheiser method.

The absorbing mediums were later analysed for both NO_X and SO_2 spectrophotometrically (Systronics UV-300) and estimated by comparing the standards.

Results and Discussion

The air samples collected for different seasons were computed for SPM, NO_X and SO_2. The results are as $\mu g/m^3$ (Table 1 – 3).

Table1: SPM analysis for four different seasons. All units in $\mu g/m^3$

Sl.No.	Places	Seasons			
		Summer	Monsoon	Winter	Autumn
1	Badi Ka Baas	250-279	258-265	260-332	243-251
2	Meena Ki Dhani	366-421	317-350	422-490	614-624
3	Langriyabas	590-597	479-550	479-495	551-578
4	Rupa Ki Nangal	278-315	311-313	301-349	283-309

Table 2: Range of SO_2 for four different seasons. All units in $\mu g/m^3$

Sl.No.	Places	Seasons			
		Summer	Monsoon	Winter	Autumn
1	Badi Ka Baas	22.6-23.3	27.1-27.3	28.0-28.8	27.3-28.7
2	Meena Ki Dhani	15-35.3	30.6-35.8	32.5-36.7	35.5-37.5
3	Langriyabas	31.6-33	29.6-30.1	30.9-32.1	33-33.5

Table 3: Range of NO_X for four different seasons. All units in $\mu g/m^3$

Sl.No.	Places	Seasons			
		Summer	Monsoon	Winter	Autumn
1	Badi Ka Baas	15.7-18.3	21.2-23.4	23.0-24.5	23.5-24.0
2	Meena Ki Dhani	20.4-21.0	21.6-22.5	23.7-25	26.5-27.0
3	Langriyabas	17.2-28.4	22.1-24.2	23.5-24.0	24.5-25
4	Rupa Ki Nangal	16.5-23.5	21.0-22.7	23.0-24.0	24.3-24.5

The SPM values in decreasing order are Meena ki Dhani > Langriyabas > Rupa ki Nangal > Badi ka Baas. The high amount of SPM may be attributed to the municipal solid waste dumped in the area. Meena ki Dhani is the nearest village to the MSW dumping site. Langriyabas village has also high SPM because of numerous brick kilns in the nearby area. As such there is cumulative effect of MSW dumping and fly ash from the kilns.

The SO_2 and NO_X values in decreasing order are Meena ki Dhani > Langriyabas > Rupa ki Nangal > Badi ka Baas. The same order is seen in the case of SPM values. The sulphur dioxide and nitrogen oxide pollution is an outcome of occasional burning of the MSW in the area. The SPM values are higher than the Central Pollution Control Board (CPCB) guidelines given for rural and residential areas while the SO_2 and NO_X values are within the limits. All the three values are above the limits given for sensitive areas (Table – 4).

Table 4 : CPCB standards for ambient air quality (NAAQS). All units in $\mu g/m^3$

Pollutants	**Time weighted average**	**Industrial area**	**Residential, rural and other area**	**Sensitive area**	**Method**
Sulphur Dioxide(SO_2)	Average 24 hours	120	80	30	Improved West and Geake Method
Nitrogen Oxides (NO_X)	Average 24 hours	120	80	30	Jacobs and Hochheiser method
Suspended Particulate Matter (SPM)	Average 24 hours	500	200	100	High Volume sampling (average flow rate not less than 1.1 m^3/minute)

A correlation study on the surrounding environment between the core site of Meena ki Dhani and other three villages was done to understand the impact of MSW dumping (Table 5 to 7). The mean average values of the SPM, SO_2 and NO_X values were used to calculate the Karl Pearson coefficient (r).

Table 5 : Correlation of mean average values of SPM analysis

Places	**Meena Ki Dhani**	**Badi Ka Baas**	**Langriyabas**	**Rupa Ki Nangal**
Meena Ki Dhani	1			
Badi Ka Baas	-0.319	1		
Langriyabas	0.213	-0.679	1	
Rupa Ki Nangal	-0.340	0.860	-0.955	1

Table 6 : Correlation of mean average values of SO_2 analysis

Places	Meena Ki	Badi Ka Baas	Langriyabas	Rupa Ki Nangal
Meena Ki Dhani	1			
Badi Ka Baas	0.975	1		
Langriyabas	0.004	-0.138	1	
Rupa Ki Nangal	0.971	0.951	0.176	1

Table 7 : Correlation of mean average values of NO_X analysis

Places	Meena Ki Dhani	Badi Ka Baas	Langriyabas	Rupa Ki Nangal
Meena Ki Dhani	1			
Badi Ka Baas	0.844	1		
Langriyabas	0.852	0.679	1	
Rupa Ki Nangal	0.954	0.936	0.703	1

Correlation coefficient (r) was calculated with Karl Pearson method as given in the Table 5 – 7. The tables show the correlation of SPM, SO_2 and NO_X among different sampling stations for the four seasons. Statistical analysis show that in case of suspended particulate matter, Meena ki Dhani has positive correlation with Langriyabas (r = 0.213) while Badi ka Baas has positive correlation with Rupa ki Nangal (r = 0.86). The reason may be attributed to the similar levels of SPM pollution at these places. As regards of SO_2 values, a positive correlation is observed between villages Meena ki Dhani, Badi ka Baas, Langriyabas and Rupa ki Nangal (r = 0.975, r = 0.004, r = 0.971 respectively). It shows that SO_2 levels of Badi ka Baas, Langriyabas and Rupa ki Nangal depend upon Meena ki Dhani. The NO_X values of Meena ki Dhani show positive correlation with all the other three places similar to SO_2 (r = 0.844, r = 0.852, r = 0.954 respectively). The nitrogen oxide values of the other three villages are influenced by the NO_X levels at the core site, Meena ki Dhani. Langriyabas has also positive correlation with Rupa ki Nangal and Badi ka Baas for NO_X values (r = 0.703, r = 0.679). Thus, it is revealed that the high air pollution in the nearby areas of MSW dumping site at Meena ki Dhani, a negative correlation is noticed for SPM and SO_2 values between Langriyabas and Badi Ka Baas (r = -0.679 and r = -0.138 respectively).

The burning of waste causes release of SO_2 and NO_X which was confirmed by the study of Allen *et.al.* (1999) and Bhaguwant *et.al.*(2002). The generation of sulphur dioxide and nitrogen oxides may harm the local population and flora and fauna. Anthropogenic SO_2 and NO_X emissions are chemically converted to sulphuric and nitric acids and are responsible for acid rain, stone leprosy and decrease in the soil alkalinity (Hewit, 2000, Wright andSchindler,1995, Munn *et.al.*, 2000). The high suspended particulate matter in the area may be cause of concern to the population residing in the area and lead to harmful effects such as bronchial asthma and other respiratory problems. Particulate matter in air causes acute and chronic respiratory disorders and lung damage in humans. It is also a suspected carcinogen (Pulikesi *et.al.*, 2005). Population residing in areas polluted by high suspended particulate matter has high risk of cardiovascular diseases (Nautiyal *et.al.,* 2007).

Conclusions

The research carried out has shown a clear trend where the site Meena ki Dhani is most affected by the air pollutants followed by Langriyabas, Badi ka Baas and Rupa ki Nangal. The statistical analysis of the data also confirms the presence of SPM, SO_2 and NO_X in higher levels due to MSW dumping at the core site and its effect on the other three sites. The SPM levels are higher than the standard limits given by CPCB for residential and rural area. The SO_2 and NO_X levels are although in limits of residential area but above the limits given for sensitive areas. The dumping of MSW if continued in same manner will slowly result in exceeding of pollution (SO_2 and NO_X) levels above the standard limits of residential area.

The dumping of municipal solid waste should be confined to areas which are away from dwelling locality as such that the negative impact is minimised. Burning of waste must be prohibited to control the addition of pollutant gases like sulphur dioxides and nitrogen oxides to the environment. A methodological disposal of municipal solid waste is the need of the hour to stop such kind of air pollution.

Acknowledgements

The authors are thankful to University Grants Commission, New Delhi, for the financial assistance. We are also thankful to Dr. Abhinav Dinesh, Director, Birla Institute of Technology (Mesra, Ranchi) Jaipur campus, for providing guidance and necessary help.

References

Allen G., Lawrence J., Koutrakis P. (1999) : Field validation of a semicontinuous method for aerosol black carbon (aethalometer) and temporal patterns of summertime hourly black carbon measurements in southern western PA, Atmos. Environ. **33**, 817– 823.

Bhugwant C., Cachier H., Bessa M., Leveau J. (2000) : Impact of traffic on black carbon aerosol concentration at La Reunion Island (Southern Indian Ocean), Atmos. Environ. **34**, 3463 –3473.

Hewitt C.N. (2000) : The atmospheric chemistry of sulphur and nitrogen in power station plumes, Atmos. Environ. **35**, 1155–1170. Wikipedia:http:// en.wikipedia.org/wiki/Jaipur

Kaur H., *Environmental Chemistry* (2008) Pragati Publications.

Munn T., Timmerman P., Whyte A. (2000) : Emerging Environmental Issues, Bull. Am. Met. Soc. **81**, 1603–1609.

Nautiyal Jyoti., Garg M.L., Sharma Manoj Kumar, Khan Asif Ali, Thakur Jarnail S. and Kumar Rajesh (2007) : Air Pollution and Cardiovascular Health in Mandi-Gobindgarh, Punjab,India - A Pilot Study. *Int. J. Environ. Res. Public Health*. **4(4)**, 268-282

Ostro, B. *et al*., (1995) : Air Pollution and Mortality: Results from Santiago, Chile.

Pulikesia M., Baskaralingama P., Elangob D., Rayuduc V.N., Ramamurthia V., Sivanesana S. (2006) : Air quality monitoring in Chennai, India, in the summer of 2005.

Reddy P.J. (2011) : Municipal Solid Waste Mangement: Processing Energy Recovery-Global Example CRC Press, B.S.Publication).

Sahni Anirudh, Gautam Abhishek (2011) : Heavy Metal Assessment in Leachates of Municipal Solid Waste Dumping Site – Jaipur., 98th Indian Science Congress, Chennai – January, 2011.

Shankar P.R., RamaRao G. (2002) : Impact of Air Quality on Human Health: A Case of Mumbai City, India. IUSSP Regional Conference on Southeast Asia's Population in a Changing Asian Context, 10-13 June 2002.

Wright R.F., Schindler D.W. (1995) : Interaction of acid rain and global changes: effects on terrestrial and aquatic ecosystems. Water Air Soil Pollution. **85**, 89–99.