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Assessment of air quality at the municipal waste dumping site in Aizawl, Mizoram

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Abstract

A study was done on the air quality of the Tuirial municipal dumping site in Aizawl, Mizoram, India. The air quality for suspended particulate matter (SPM), respirable suspended particulate matter (RSPM), NO_2 and SO_2 was analysed for a period of one year during 2011-2012. The study was undertaken under the aegis of MIPOGRASS (Mizo Post Graduate Science Society) and the Directorate of Science and Technology, Government of Mizoram. The SPM and RSPM concentrations were to a great extent above the permissible limit of the the National Ambient Air Quality Standard (NAAQS) by the Central Pollution Control Board (CPCB) throughout the study period. The highest SPM mean concentration was on April 2012 at 789.64 (SD ± 1172.73) μg/m³ and highest RSPM on November 2011 at 1345.99 (SD ±1 08.29) μg/m³. The mean concentration of NO_2 also showed above permissible limits for four months with highest on March 2012 at 43.62 (SD ± 8.19) μg/m³. The SO_2 showed highest concentration at 1.95 (SD ± 0.57) μg/m³ which was within the permissible limit throughout the study period.

Key words: Municipal solid wastes; pollutants; particulate matter; open burning.

Introduction

The increase in population growth, urbanization and rising standards of living have all contributed to an increase in both the amount and variety of wastes generated all over the world. There are potential risks to health and the environment from improper management of solid wastes. Open dumping of municipal solid wastes is the primitive stage of landfill development in developing countries and still remains the predominant waste disposal option owing to the low cost and lack of expertise and management effort with little consideration to the health and environmental effect. In India, it has been studied that open burning of wastes emit tons of pollutants into the air including particulate matter (PM), nitrogen oxides (NOx), sulphur dioxide

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(SO_2), as well as dioxins and furans.[1,2] During the last couple of decades, explosive growth in population and sustained drive for economic progress have also resulted in rapid urbanization and hence significant increase in the quantity of municipal solid waste (MSW) in Aizawl, Mizoram. The MSW generated in the state increased to 86 tonnes per day (TPD) in 2011 which was at 57 TPD in 200.[1] Presently, the wastes are disposed off openly and simply burned at Tuirial, which is known to have caused extensive environmental problems and also to human health.[3-7]

Aizawl, the capital city, lies in Aizawl district which is one of the 8 districts of Mizoram state in India. The district occupies an area of 3576.31 km² and a population of 404,054.[8] The population of the city is at 248,133 which constitute 76.19% of the total district population. Tonnes of garbage are dumped every day at the dumping site. There is no segregation, and the wastes are simply dumped and burned in the open emitting various air pollutants. The present study was carried out to determine the level of air pollutants like suspended particulate matter (SPM), respirable suspended particulate matter (RSPM), NO_2 and SO_2 at the dumping site.

Materials and Methods

Study site

The municipal solid waste dumpsite is located on the roadside of national highway 54 on the eastern part at a distance of 22 km from the heart of Aizawl city, locally called as 'Tuirial Airfield Veng' near Tuirial airfield. The dumping site falls within roughly within the geographical coordinates 23°44'27'' North and 92° 47'41'' East with elevation at approximately 450 m amsl.

Sampling method

The investigation for the air quality monitoring was set-up by placing a High Volume Air Sampler, Envirotech Model APM 460 BL at the station where constant burning of the wastes took place daily. Sampling was taken 4 times a month during the study period of August 2011 to May 2012. The air sample was taken from a monitoring period of 8 hours at each sampling and the absorbing reagents and filter papers were taken back to the laboratory for analysis. Whatmann microfibre filter papers EPM-2000 were used for the collection of PM_{10} particles.

Air Pollutant Analysis

The method used for determination of SPM was the high volume method and the cyclonic flow technique for RSPM, i.e. particulate matter of size below <10 µm (PM_{10}).[9] For the determination of nitrogen dioxide (NO_2), the Jacob & Hochheiser modified (sodium arsenite) method[10] was used and the modified West and Gaeke method[11] was used for determination of sulphur dioxide (SO_2).

Results and Discussion

The results of the analysis are presented below:

SPM

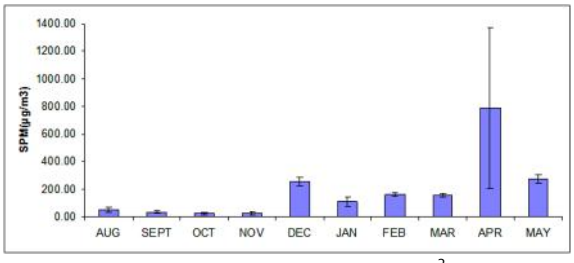

Figure 1. Monthly variation of SPM (µg/m^3)

Particles less than 100 µm in diameter that are suspended in the air are referred to as suspended particulates matter (SPM). The levels of SPM are presented in Table 1 and Figure 1. The average concentration of SPM varies greatly during the study period. It shows highest concentration during April 2012 with mean values at 789.64 (SD ±1172.73) µg/m^3 and lowest dur-

Table 1. Monthly readings of mean, standard deviation (SD) and standard error (SE ±) values of SPM, RSPM, NO_2 and SO_2 (µg/m^3) at Tuirial dumping site during the study period, August 2011 to May 2012.

Parameters / Months	SPM (µg/m^3)			RSPM (µg/m^3)			NO_2 (µg/m^3)			SO_2 (µg/m^3)		
	Mean	SD±	SE ±	Mean	SD±	SE ±	Mean	SD±	SE ±	Mean	SD±	SE ±
AUG	50.74	38.32	19.16	896.42	60.77	30.38	23.47	1.80	0.90	1.50	0.25	0.12
SEPT	33.33	19.61	9.80	1068.33	105.30	52.65	36.81	3.79	1.90	1.65	0.17	0.09
OCT	23.95	20.57	10.28	931.46	759.51	379.76	25.47	6.45	3.23	1.80	0.69	0.35
NOV	25.02	20.50	10.25	1346.00	108.29	54.15	25.22	8.99	4.49	1.95	0.57	0.29
DEC	256.24	61.51	30.76	1279.27	227.92	113.96	29.95	8.41	4.21	1.50	0.25	0.12
JAN	107.29	60.45	30.22	1027.08	191.19	95.60	22.06	5.24	2.62	1.58	0.29	0.14
FEB	158.33	28.34	14.17	1028.43	157.40	78.70	32.59	5.05	2.53	1.58	0.29	0.14
MAR	153.12	23.80	11.90	971.66	94.41	47.20	43.63	8.19	4.10	1.43	0.75	0.38
APR	789.64	1172.73	586.37	1245.83	103.38	51.69	25.25	5.25	2.63	0.83	0.29	0.14
MAY	273.36	68.90	34.45	939.30	166.61	83.31	31.06	5.39	2.70	0.90	0.35	0.17

ing October 2011 which is 23.95 μg/m^3. The SPM was mainly found to be higher than those in the National Ambient Air Quality Standard (NAAQS) by the Central Pollution Control Board (CPCB). It exceeded the permissible level of 500 μg/m^3 for Industrial area, 200 μg/m^3 for residential, rural and other areas for three months December 2011, April and May 2012 as well as the permissible level of 100 μg/m^3 for sensitive areas for six months from December 2011 to May 2012 during the study period.

Table 1 also shows high values of SD and SE especially during the month of April 2012 with an SD of ± 1172.734 which reveal the variable nature of the sample reading at the dumping site when burning take place. SPM shows more concentration during the dry season from December 2011 and extending up to May 2012. The peak monsoon period from August to October 2011 including November show lesser concentration than the drier months of winter which may be due to precipitation by wet deposition during rainfall as observed by others.[12,13]

Respirable suspended particulate matter (RSPM/PM$_{10}$)

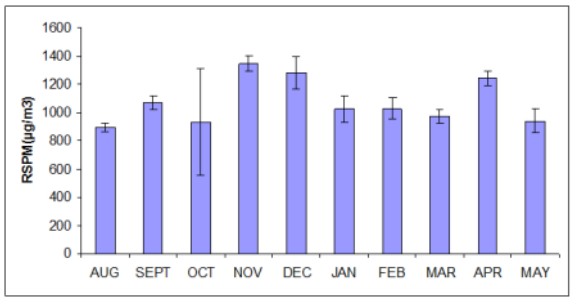

Figure 2. Monthly variation of RSPM (μg/m^3)

Air-borne particles less than 10 micrometers in diameter that are suspended in the air are referred to as respirable suspended particulate matter (RSPM) or PM$_{10}$. The result for the RSPM are presented in Table 1 and Figure 2. The mean monthly concentration of RSPM varies to a lesser extent than SPM. The average concentration of RSPM was higher than the prescribed NAAQS for all the months during the entire study. It exceeded the permissible level of 150 μg/m^3 for industrial area, 100 μg/m^3 for residential, rural and other areas and the permissible level of 75 μg/m^3 for sensitive areas. The highest recorded mean value was during November 2011 which was 1345.99 (SD ± 108.29) μg/m^3. The great variability in the sample record was most noticeable during October 2011 with an SD of ±759.51. The variation may be mainly attributed to the quantity of wastes burned during sampling as well as local weather.[12,13]

The common sources of RSPM are plastic, synthetic fibres and domestic items which can release ions. A number of health problems have been reported in the adjoining locality as well as the daily rag-pickers at the site. RSPM can enter the nasal tract and as a result it will enter into the lungs and can cause various diseases and discomfort including irritation of the skin, nose and eyes, gastrointestinal problems, fatigue, headaches, psychological problems and allergies, asthma, cancer and heart attack.[15,16]

Nitrogen dioxide (NO$_2$)

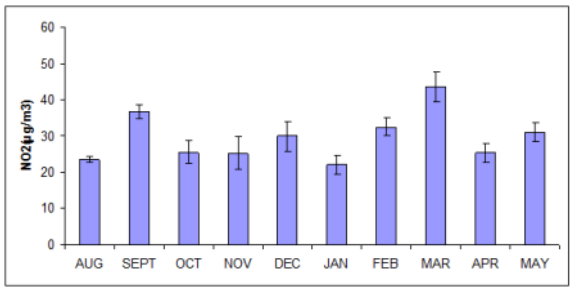

Figure 3. Monthly variation of NO$_2$ (μg/m^3)

The levels of NO$_2$ are presented in Table 1 and Figure 3. The maximum concentration of NO$_2$ was in March 2012, which was 43.62 (SD ± 8.19) μg/m^3. The average mean concentration of NO$_2$ was lower than the NAAQS prescribed level of 80 μg/m^3 for residential, rural and other areas for all the monthly reading by of the CPCB. However it was found to be higher than the prescribed level of 30 μg/m^3 for sensitive

areas in September 2011, and during February, March and May of 2012 with values of 36.81 (SD ± 3.79) µg/m^3, 32.59 (SD ± 5.05) µg/m^3, 43.63 (SD ± 8.19) µg/m^3 and 31.06 (SD ± 5.39) µg/m^3 respectively.

Nitrogen content of Municipal Solid Wastes is rather low, especially in Asian countries, the main sources being plastic materials (polyamides, polyurethane, etc.), textile (acrylonitrile, wool, etc.), and proteins from waste food[14] which may be the main reason for the low concentration of NO_2 at the site. In general, automobiles produce nearly 40% of the total NO_X discharged in the atmosphere.

Sulphur dioxide (SO_2)

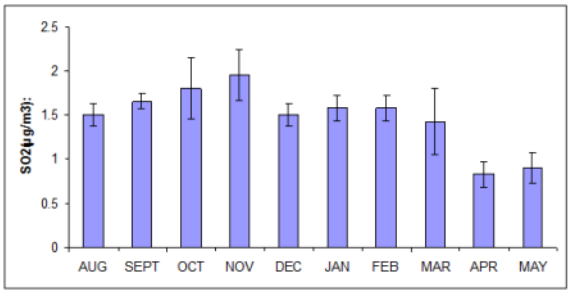

Figure 4. Monthly variation of SO_2 (µg/m^3)

Table 1 and Figure 4 show the concentration or levels of SO_2. The average concentration of SO_2 during does not exceed the NAAQS permissible limit of 30 µg/m^3 for sensitive areas during the entire study period. The highest value being observed on November 2011 with a mean value of 1.95 (SD ± 0.57) µg/m^3. Sulphur dioxide (SO_2) is formed when sulphur contained in the waste is oxidized during burning of sulphur-containing items such as textiles, rubber, gypsum and plastics. The main source of SO_2 is from fossil fuel burning, industrial emissions and diesel vehicles. The low level of SO_2 may be due to the nature of wastes burned at the dumping site and also because of the smaller frequency of vehicle plying and distance of station from the highway. The values are in uniformity to the values as recorded in the busier street lying in National Highway-54 at Bawngkawn, Aizawl[15, 16]. It may also be noted here that daily rag-pickers numbering quite a fair amount are very active at the site and a number of them have turned to it as an occupation. The removal of waste by these may be also the reason for the lower concentration of NO_2 and SO_2.

CONCLUSION

The Tuirial dumping site being situated on the road-side of NH-54 creates problem to people living in the area as well as those in vehicles plying through the area. The pungent smell and smoke generated from the burning of the wastes creates irritation to eyes and nausea amongst passengers and drivers traveling in the area. The adverse health effects of the various air pollutants on human health have been widely reported by many.[17-23] At Tuirial dumping site, health problem, especially those associated with breathing are noted amongst the locals and nearby areas especially among children. Rag-picking being a common occupation at the site, a number of the rag-pickers who are constantly exposed to the smoke also have complaints of breathing and other respiratory problems.

From the study, it is evident that there is enormous amount of air pollution especially with reference to particulate matters by the practice of open dumping and burning of municipal solid waste at the site. The amount of SPM and RSPM shows concentrations above the permissible limits in the NAAQS of the CPCB for industrial area, residential-rural-and-other areas, and sensitive areas which may be considered as alarming. The NO_2 concentration was lower than the permissible limits except for a few months where it was higher than the permissible level for sensitive areas. The SO_2 concentration was found to be lower than the permissible limits during the entire sampling period. The low level of NO_2 and SO_2 concentration was mainly attributed to the nature of the domestic waste and activity of rag-pickers at the site.

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