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AMBIENT AIR QUALITY MONITORING AND HEALTH IMPACT STUDY OF AIR POLLUTION NEAR JODA OF KEONJHAR, ODISHA, INDIA

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ABSTRACT
Monitoring of various ambient air quality parameters like PM10, PM2.5, SO2, NOX and NH3 were carried out at four sampling stations near Joda of Keonjhar district, Odisha for a period of six months i.e. from October, 2015 to March, 2016. Meteorological parameters like wind speed and wind direction data were also recorded during the sampling period. Out of the four sampling stations, highest concentrations of different air pollutants were recorded at Jaroli and the lowest was recorded at Jalahari. Further, the Air Quality Index (AQI) was also calculated for these sampling locations. The AQI of Village Jaroli indicates Moderate Air Pollution and for the rest villages I.e. Jalahari, Jadibahal and Bandhuabeda indicate light air pollution. Further, with respect to the health effect due to ambient air pollution in the area, it was noticed that, the village Jaroli is comparatively more affected and the Village Bandhuabeda is least affected.

KEYWORDS: PM_{10}, $PM_{2.5}$, SO_2, NO_x, NH_3, Air Quality Index.

INTRODUCTION
The atmosphere is a complex mixture of natural gaseous system that is essential to support life on the planet Earth. Air pollution is the introduction of particulates, biological molecules or other harmful materials on Earth's atmosphere causing diseases, death in humans and damage to other living organisms such as animals and food crops (Dahmann et al., 2008). A pollutant can be of natural origin or man-made. Primary pollutants are usually produced from a process, such as CO from the vehicles exhaust or the SO2 released from factories. Secondary pollutants are not emitted directly rather they form in the air when primary pollutants react or interact to form O3, PAN, acid rain etc. (Panda et al., 2010). In India ambient air quality have progressively derioted due to anthropogenic sources like rapid urbanization, industrialization, uncontrolled increase of vehicles, garbage burning, domestic cooking etc. It has become an important environmental risk factor for lung cancer and cardiopulmonary disturbances (Ghose and Majee., 2001). According to the World Health Organization (WHO), urban air pollution is responsible for approximately 800,000 deaths annually around the globe (Maji et al., 2010). Plants are also affected by various air pollutants. Excessive SO2 make the cell inactive and finally are killed. SO2 with water produces sulphuric acids that are extremely corrosive. Different metals such as iron, aluminium, copper are corroded when exposed to contaminated air. Air Act has been enacted in 1981 to take necessary step to reduce the air pollution and Central Pollution Control Board has enhanced its power and function under this act (Chaulya, 1999; Chen et.al., 2010; Analitis et al., 2006; Gawai et al., 2014; Mohapatra, 2006).

Mining is a vital industry for economic growth of any country. With increase in industrialization, urbanization and other developmental activities in the urban areas, there is a greater need of extraction of minerals. Air pollution in the opencast mining are caused by drilling, blasting, overburden loading and unloading, road transport, material handling plants, exposed pits and workshops. All these operations generates mostly particulate matter and is reported that by applying Heavy Earth Moving Machinery on haul roads of mechanized opencast mines could contribute 80% of the dust emitted (Chakraborty et al., 2002; Ghose & Majee, 2001; Panda et al., 2010; Barman et al., 2010).

Ambient air quality monitoring is the systematic, long term assessment of pollutants levels by measuring the quantity and types of certain pollutants in the surrounding (Alam et al., 1999) and comply with Indian Standards, evaluate the control technologies and prevent respirable diseases caused by pollutants (Stein & Corn, 1975). Air quality Index is the number used by the agencies to communicate to the public that how polluted the air is or how polluted it will become (Maji et al., 2010). For an effective ambient air quality monitoring, meteorological data of an area should also be recorded. Some of the similar study in the field of ambient air quality monitoring and AQI study are Sahu et.al., 2015, Dash and Dash, 2015 a and b; Parida et.al., 2015. Dash et.al., (2016) and Dash and Patra (2016) have also studied the soil quality and floristic composition respectively in the mining areas of the study district.

The present investigation was carried out to measure the concentration of five ambient air pollutants (PM10, PM2.5, SO2, NOX, NH3), air quality index and health impact of air pollution in all the four villages i.e. Jaroli, Jalahari, Jadibahal, Bandhuabeda of Joda, Keonjhar from October, 2015 to March, 2016.

MATERIALS AND METHODS

Study Area
Keonjhar district is covered with an geographical area of 8240 km^2. It is surrounded by the Singhbhum district of Jharkhand in the North, Jajpur in the South, Dhenkanal, Angul and Sundergarh in the West and Mayurbhanj and Bhadrak in the East. The study area is located near Joda which is about 80 km North-West of Keonjhar. The important minerals available in the area are Iron-ore, Manganese and Chromites. Mining and allied activities in the area generates different types of environmental pollutants.

Sampling Method
In the present study, sampling of PM_{10} was done by Respirable Dust Sampler (RDS) APM 460NL, sampling of $PM_{2.5}$ by RDS APM 550 and sampling of gaseous pollutants is done by APM 411 TE of Envirotech, Delhi. The sampler was placed at a height of 3-10m in the downwind direction. During sampling of PM_{10} air is drawn into the cyclonic chamber where the heavier particles size of 100μ-10μ are settled at the bottom and the lighter particles size less than 10μ are trapped on 8" X 10" Micro Glass Fiber (MGF) filter paper. Flow rate was maintained at 1.2 m^3/min. During sampling of $PM_{2.5}$, air was drawn into the Wein's impactor where the heavier particles size 10μ to 2.5μ are stick to the silica gel and the lighter particles size less than 2.5μ are trapped on the 46.7 mm Poly Tetra Fluro Ethylene(PTFE) filter paper with a flow rate of 1000m^3/hr. For the gaseous sampling, SO_2 was collected through 30ml of absorbing reagent of Potassium Tetra Chloro Mercurate (TCM), NO_X was collected through 30 ml of the absorbing reagent of Sodium Hydroxide (NaOH) and NH_3 was absorbed by Sulphuric acid (H_2SO_4) of 10 ml of solution at a flow rate of 1 liter/min.

Analysis procedure
Cyclonic flow technique and impactor based technique was followed for measurement of concentration of PM_{10} and $PM_{2.5}$ respectively. Improved West and Gaeke (1956) method was followed for laboratory estimation of SO_2. Modified Jacob and Hochheiser (1958) method was followed for laboratory estimation of NO_2. They are finally expressed as weight of particulates collected per cubic meter of air sampled (μg/m^3). Indophenol method was used for the analysis of NH_3.

Air Quality Index
Air quality index is an environmental index that describes the overall ambient air status and trends of a particular place based on specific standard. It is a measure of the ratio of the pollutants concentration to the status of ambient air in the places. The following computation was used to derive the air quality index values of the monitoring sites under consideration. The higher the AQI value, greater is the level of air pollution and greater the damage to health. The AQI scale was divided into five categories that describe the range of air quality and associated potential health.

AQI = ¼ (IPM_{10}/SPM_{10} + $IPM_{2.5}/SPM_{2.5}$ + ISO_2/SSO_2 + INO_2/SNO_2) X 100
Where;

IPM_{10}, $IPM_{2.5}$, ISO_2 and INO_2 are the individual values of PM_{10}, $PM_{2.5}$, SO_2 and NO_2 respectively obtained during sampling.SPM_{10}, $SPM_{2.5}$, SSO_2, SNO_2 are the standards of ambient air quality prescribed by Central Pollution Control Board.

RESULTS AND DISCUSSION

In village Jaroli the average concentration of PM_{10}, $PM_{2.5}$, SO_2, NO_X and NH_3 was 94 µg/m³, 50 µg/m³, 7 µg/m³, 16 µg/m³ and 26 µg/m³ respectively and AQI was 51. In village Jalahari the average concentration of PM_{10}, $PM_{2.5}$, SO_2, NO_X and NH_3 are 65 µg/m³, 26 µg/m³, 4 µg/m³, 11 µg/m³ and 20 µg/m³ respectively and AQI was 29. Near Jadibahal, the average concentration of PM_{10}, $PM_{2.5}$, SO_2, NO_X and NH_3 was 73 µg/m³, 32 µg/m³, 5 µg/m³, 13 µg/m³ and 22 µg/m³ respectively and AQI was 37. Similarly near Bandhuabeda the average concentration of PM_{10}, $PM_{2.5}$, SO_2, NO_X and NH_3 was 78 µg/m³, 34 µg/m³, 5 µg/m³, 14 µg/m³ and 29 µg/m³ respectively and the AQI was 39. Out of the four sampling stations, highest concentrations of different air pollutants was recorded at Jaroli and the lowest was recorded at Jalahari. Further, the Air Quality Index (AQI) was also calculated for these sampling locations. The AQI of Village Jaroli comes under moderate air pollution and for the rest villages i.e. Jalahari, Jadibahal and Bandhuabeda comes under light air pollution category. **Table 1** and **Figure 1** shows the average concentration of pollutants, air quality index and along with the standards prescribed by CPCB. Further, with respect to the health effect due to ambient air pollution in the area, it was noticed that, the village Jaroli is comparatively more affected and the Village Bandhuabeda is least affected. The particulate and gaseous pollutants affect the people lives in the study area from asthma, chronic obstructive pulmonary diseases (COPD) and cystic fibrosis. Asthma has been observed in many children.

Table 1 Average concentrations of air pollutants (µg/m³) and AQI in the study area

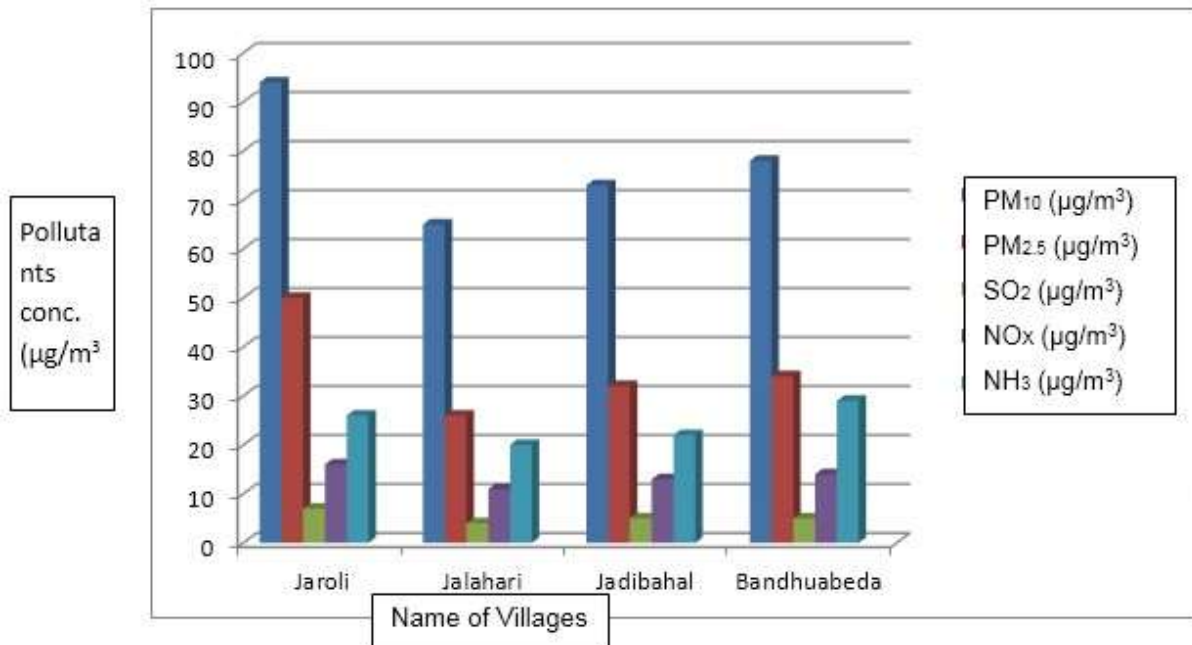| Location	PM_{10}	$PM_{2.5}$	SO_2	NO_x	NH_3	AQI
Jaroli	94	50	7	16	26	51
Jalahari	65	26	4	11	20	29
Jadibahal	73	32	5	13	22	37
Bandhuabeda	78	34	5	14	29	39
Standard	**100**	**60**	**80**	**80**	**400**	

Figure-1 Concentration of air pollutants at different stations

Figure 2, 3, 4, 5, 6, 7 shows the wind rose diagrams for the month of October, November, December, January, February and March respectively. Table 2 shows the affected people in study area due to Air Pollution between the age group of 0-6 years and above 6 years with their percentage value.
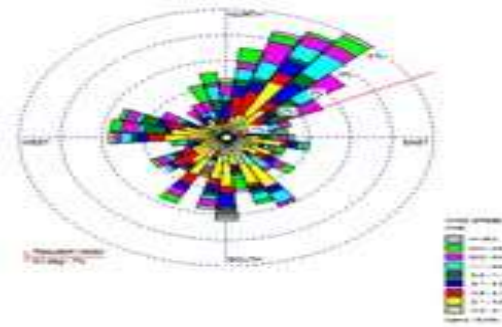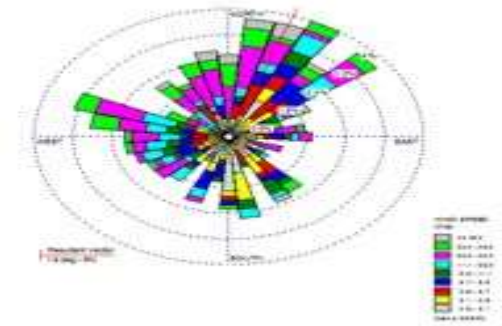
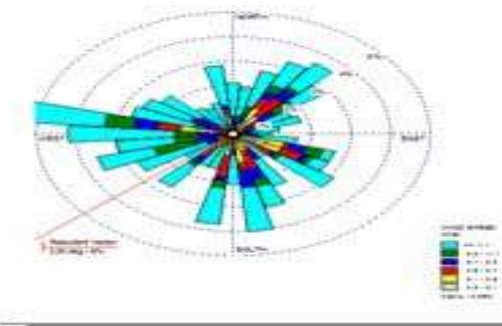*Figure-2: Wind rose of October*

Figure-3: Wind rose of November
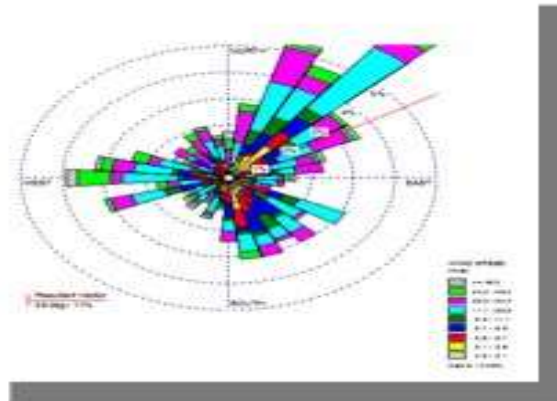

Figure -4: Wind rose of December
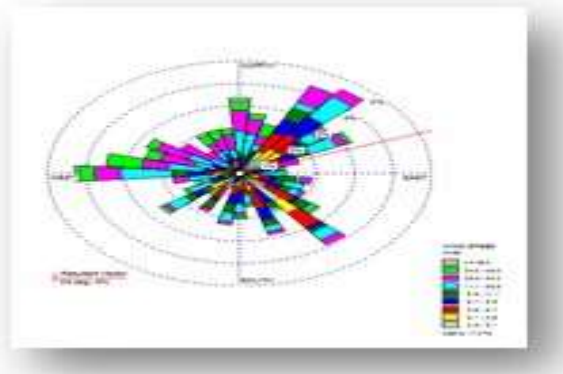
Figure -5: Wind rose of January
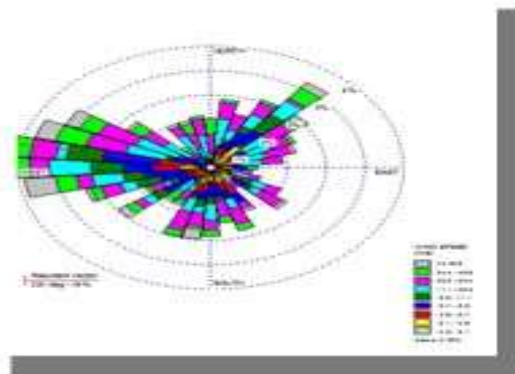

Figure-6: Wind rose of February

Figure-7: Wind rose of March

Table 2: Affected people in study area due to Air Pollution

Sl. No.	Village name	Population	Affected population			Percentage (%)		
			Above 6 yrs		0-6 yrs	Above 6 yrs		0-6 yrs
			male	female		male	female	
1	JAROLI	4017	747	368	109	18.59	9.16	2.71
2	JALAHARI	3986	414	289	78	10.38	7.25	1.95
3	JADIBAHAL	1228	256	144	51	20.84	11.72	4.15
4	BANDHUABEDA	573	98	62	37	17.10	10.82	6.45

Source: Local Health Care Center

CONCLUSION

India and other developing countries have experienced a progressive degradation of air quality due to urbanization, industrialization, number of motor vehicles, lack of awareness among the people, use of fuels with poor environmental performance and ineffective environmental regulations. In this present study, the particulate and gaseous pollutants are below the standards as prescribed by CPCB. Care should be taken to avoid the health hazards caused due to the air pollution in the study area.

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