Post-Monsoon Ambient Air Quality Assessment in Korba Industrial Area Chattisgarh

Sridhar. P. Gadwal[1] Dr. S. R Mise[2]
[1]M. Tech. Student [2]Professor
[1,2]Department of Civil Engineering
[1,2]PDA College of Engineering Kalaburagi India

Abstract— Agricultural, Industrial and urban waste discharges along with natural factors such as drought conditions are the main cause of decline in environmental quality. The present study report shows analysis of ambient air quality in korba Town Chattisgarh. The 24 hourly average concentrations of five major criteria pollutants viz., PM_{10}, $PM_{2.5}$, SO_2, NO_2 and NH_3 at five different locations in korba town have been considered for this analysis. The air quality variation shows that pollutant concentration for PM_{10} samples were exceeding the discharge standard prescribed by NAAQS (National Ambient Air Quality Standards) except sampling point A1 & A2 while in $PM_{2.5}$the sampling point A1 exceeding the discharge standard prescribed by NAAQS were as for NO_2, SO_2, NH_3 concentration are not exceeding the discharge standard prescribed by NAAQS.

Key words: Post-Monsoon Ambient Air, Post-Monsoon Ambient Air Quality Assessment, Coarse

I. Introduction

A. *General*

The beauties of nature are being lost one after another and environmental destruction is spreading today, Environmental pollution has emerged as a global public health problem. Rapid Industrialization and urbanisation are one of the most prominent reasons for environmental problems. Due to increase in industries emission many cities in India are experiencing deterioration of ambient air quality. Air pollution has adverse effect on human and especially for children and old people. The urban population is exposed to higher levels of SO_2 and NO_2 due to urbanization and industrialization, which lead to formation of SO_4^{2-} and NO^{3-} aerosols. Concentrations of ambient air particulates have been found to be associated with a wide range of effects on human health. Monitoring of air pollutants is a prerequisite to air quality control. Their impact on the chemical composition of plants is often used as an indicator and a tool for monitoring environmental pollution (V Prathipa et.al.)

Air pollution is a well –known environmental problem associated with urban areas around the world. Various monitoring programme have been under taken to know the quality of air by generating vast amount of data on concentration of each air pollutant such as PM_{10}, $PM_{2.5}$, SO_2, NO_2 and NH_3 in different parts of the world .The large data often do not convey the air quality status to the scientific community, government officials, policy makers and in particular to the general public in a simple and straight forward manner. The study has been made to monitor the ambient air quality of the korba town to assess the pollution load of the area for planning the environmental management to abate and control the air pollution apart from a discussion of the various air pollutants and their implications.

B. *Background*

Chhattisgarh is one of the 29 states of India, located in the centre-east of the country. It is the 10th largest state in India, with an area of 135,194 km^2 (52,199 sq mi). With a population of 28 million, Chhattisgarh is the 17th most-populated state in the country. A resource-rich state, it is a source of electricity and steel for the country, accounting for 15% of the total steel produced. Chhattisgarh is one of the fastest-developing states in India. The state was formed on 1 November 2000 by partitioning 16 Chhattisgarhi-speaking south eastern districts of Madhya Pradesh. The capital city is Raipur. Chhattisgarh borders has the states of Madhya Pradesh in the northwest, Maharashtra in the southwest, Telangana in the south, Andhra Pradesh (East Godavari district) in the south, Odisha in the southeast, Jharkhand in the northeast and Uttar Pradesh in the north. Currently the state comprises 27 districts. Korba is a big city and an industrial area in the Indian state of Chhattisgarh. Korba is headquarter of Korba district situated about 200 km from the capital city Raipur. Korba is known for its coal mines such as Gevra area which is one of the biggest coal mines of Asia as well as Kusmunda Area and Dipka Area, all located in Korba Coalfield. It also has power plants such as NTPC, CSEB and Bharat Aluminum Company (BALCO). Korba is situated on Maikal ranges of the Satpura Hills and Chota Nagpur Plateau is high and low and open. The rivers Hasdeo and Ahiran flow through the city, with Hasdeo boasting two hydroelectric dams. Korba is located at 82° 42' 30" E longitude and 22° 21' N latitude in the eastern part of Chhattisgarh State. It is about 238 kilometres by road from capital city Raipur. As of 2011 India census Korba city had a population of 365,073. The climate is tropical in Korba. The summers here have a good deal of rainfall, while the winters have very little. The climate here is classified as Aw by the Köppen-Geiger system. The temperature here averages of 35.2 °C, May is the warmest month. January is the coldest month, with temperatures averaging 19.8 °C. In a year, the average rainfall is 1420 mm. The average relative humidity for year is around 33%-38%. The average wind speed has been around 5.92kmph - 13.92 kmph

C. *Scope of the Study*

Due to lot of industries in korba district which cause air pollution due to discharge of air pollutants in the atmosphere. Hence this district is selected for study.

D. *Objectives*

- Ambient air quality sampling at different sampling points.
- Analysis for particulates ($P.M_{2.5}$ and $P.M_{10}$) and major gaseous pollutants (NH_3, SO_2, NO_2.).

II. MATERIAL AND METHODOLOGY

A. *General*

In this chapter the study area is discussed, air quality monitoring at different location is shown.

B. *Description of Study AreA*

Korba has few of the largest capacity power plants and primary industries such as NTPC, CSEB and Bharat Aluminum Company (BALCO) and coalfields.

When it comes to air pollution, a World Health Organisation (WHO) report concluded that Korba has gained the dubious distinction of being the worst city in India and has found its way on the list of top twenty polluted cities in India. (WHO, 2012) Particulate matter smaller than about 10 micrometres also referred as PM_{10}that can settle in the bronchi and lungs and cause health problems, PM_{10} is the one of the biggest sources of asthmatic problem. Coal is the major natural resource available in this region. Korba is known as power capital or power hub of the Chhattisgarh because it is the home to more than 10 thermal power plants with 6,000 megawatts capacity. Many coal-based thermal power plants like the National Thermal Power Corporation and Chhattisgarh State Electricity Board among others are located in Chattisgarh. The Korba district is shown in Figure 1.

Fig. 1: Map showing korba District (Source: http://www.gadm.org/country)

C. *Air Quality Monitoring*

In order to determine the contribution of different air pollution sources, the whole study area has been divided into 3 different grids with city as epic-centre and grid size increasing radially. The rationale for using this pattern of gridding system is that the impacts are expected to reduce as we gradually move away from epic-centre of industrial development. A schematic representation of grid pattern is shown Figure 2.

1) *Sampling Locations*

The sampling locations are selected based on major industries which are located in korba district. A schematic representation of grid pattern and sampling locations for October month are shown in Figure 2.

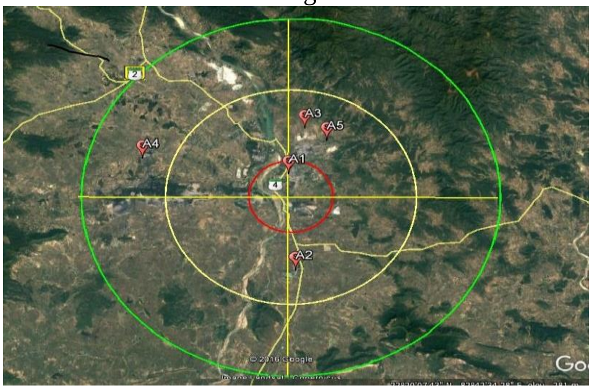

Fig. 2: Radial gridding of study area (Source: Google Earth)

In study area for Korba region, inner red circle has radius of 5km from the epic-centre of the city. Sampling locations in this circle denoted by A1. And the middle circle has radius of 10km from the epic-centre of the city and sampling locations in this circle denoted by A2, A3, A5. Same as the most outer circle has radius of 25km from the epic-centre of the city and sampling locations in this circle denoted by A4.

Sampling Location, Sampling Category and Latitude Longitude of the locations in korba region are shown in Table 1.

Sampling Location	Sampling Category	Latitude Longitude of the location
A1	Industrial	22°21'53.11"N, 82°43'40.26"E
A2	Industrial	22°14'35.50"N, 82°43'31.89"E
A3	Industrial	22°25'22.66"N, 82°39'44.47"E
A4	Industrial	22°23'20.76"N, 82°32'51.24"E
A5	Industrial	22°24'25.46"N, 82°45'42.11"E

Table 1: Sample Locations in study area

Ambient air quality monitoring performed at different locations in the study region. Depending upon the land use pattern and locations of point sources, at the selected monitoring locations.

Following are the details of the monitoring methodology and specification to be adopted for different pollutant types are shown in Table 2.

Pollutant	Sampling Duration	Flow rate	Instrument/ equipment	Sample collection	Analysis	Method
Sulphur Dioxide, $\mu g/m^3$	4 hours	1 LPM	Gaseous Sampler	0.1N Sodium Tetra-Choloromercurate	UV Spec (560 nm)	Improved West and Gaeke Method
Nitrogen Dioxide, $\mu g/m^3$	4 hours	1 LPM	Gaseous Sampler	Solution of NaOH & Sodium Arsenate	UV Spec (540 nm)	Jacob &Hochheiser modified Method
PM10, $\mu g/m^3$	8 hours	16.7 LPM	Combo Sampler	Micro fibre glass filter	Gravimetric	Gravimetric
PM2.5, $\mu g/m^3$	8 hours	16.7 LPM	Combo Sampler	47 mm PTFE paper	Gravimetric	Gravimetric
Ammonia, $\mu g/m^3$	1 hour	1 -2 LPM	Gaseous Sampler	Impinger solution	UV Spec (630 nm)	Indophenol blue method

Table 2: Sampling methodology for air pollutants (Source: (CPCB, 2009))

III. RESULTS AND DISCUSSION

A. General

In this chapter the results of seasonal variation of air pollution concentration are discussed.

B. Variation of Air Pollutant Concentration

The results of various pollutant concentrations are tabulated in Table 3. Meteorological factors which influence the dispersion and dilution of pollutants include wind speed, atmospheric temperature and relative humidity. These explained the differences in concentration of pollutants. This corroborates the postulation by Jacobson, that low wind speed, high temperature and low humidity reduce the rate of dispersion of air pollutants, thus increasing ground concentration of same pollutants and vice versa. If temperature of pollutant gases is higher than the surrounding air, the plumes will tend to rise. On the other hand, if temperature of ambient air is higher, pollutant gases become concentrated at ground level (Jacobson.M.Z, et.al, 2005). Therefore, atmospheric temperature is thus an important factor for the dispersion of pollutant gases, as the larger the difference between cool ambient air and plumes, the higher the plume rises, so also the rate of dispersion or spread of pollutants from its source before it reaches ground level. Relative humidity is also another meteorological factor that explains the concentration of pollutants at a point. Rene revealed that relative humidity is generally higher during the wet season. High relative humidity results to lower atmospheric temperature, and consequently high rate of plume ascent, and vice versa (V.S.Balogun, et.al. 2015).

Pollutants (µg/m^3)	Sampling Points				
	A1	A2	A3	A4	A5
PM_{10}	142.3	122.2	64	54.23	61.23
$PM_{2.5}$	74.98	37.24	37.84	42.12	37.25
SO_2	17.66	18.24	20.14	18.2	17.24
NO_2	19.23	23.24	22.31	40.21	24.35
NH_3	153.56	179.89	237.20	226.34	216.00

Table 3: Variation of Air Pollutant Concentration in Korba Town

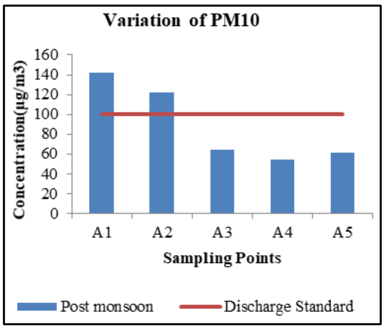

Fig. 3: Variation of PM_{10}

The concentration of PM_{10} is analyzed as 142.3, 122.2, 64, 54.23 and 61.23µg/m^3 at different sampling points respectively. A1 and A2 sampling points are exceeding the discharge standard (100µg/m^3) prescribed by NAAQS (National Ambient Air Quality Standards) except sampling point A3, A4 and A5. The variation of PM_{10} is shown in Fig 3.

The concentration of $PM_{2.5}$ is analyzed as 74.98, 37.24, 37.84, 42.12 and 37.25µg/m^3 respectively. All sampling points except A1 were not exceeding the discharge standard (60 µg/m^3) prescribed by NAAQS (National Ambient Air Quality Standards). The Variation of $PM_{2.5}$ is shown in Figure 4

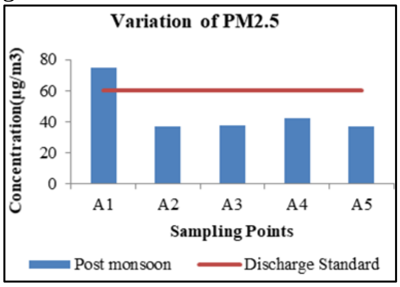

Fig. 4: Variation of $PM_{2.5}$

The concentration of SO_2 is analyzed as 17.66, 18.24, 20.14, 18.2 and 17.24µg/m^3 respectively. All sampling points were not exceeding the discharge standard (80 µg/m^3) prescribed by NAAQS (National Ambient Air Quality Standards). The Variation of SO_2 is shown in Figure 5.

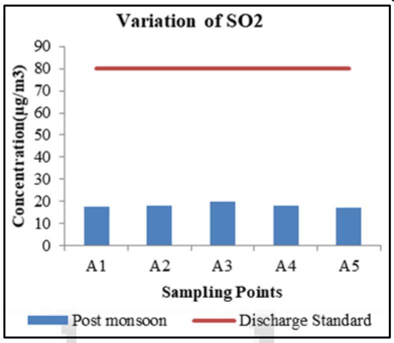

Fig. 5: Variation of SO_2

The average concentration of NO_2 is analyzed as 19.23, 23.24, 22.31, 40.21 and 24.35µg/m^3 respectively. The samples were not exceeding the discharge standard (80 µg/m^3) prescribed by NAAQS (National Ambient Air Quality Standards). The Variation of NO_2 is shown in Figure 6.

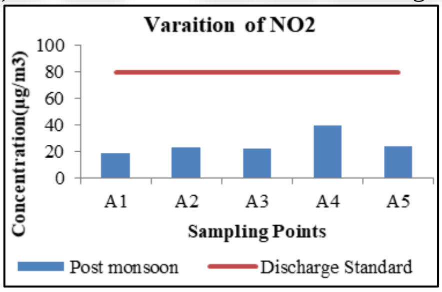

Fig. 6: Variation of NO_2

The average concentration of NH_3 is analyzed as 153.56, 179.89, 237.2, 226.34 and 216µg/m^3 respectively. The samples were not exceeding the discharge standard (400 µg/m^3) prescribed by NAAQS (National Ambient Air Quality Standards). The Variation of NH_3 is shown in Figure 7.

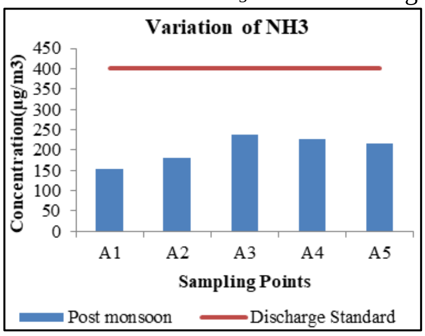

Fig. 7: Variation of NH_3

IV. CONCLUSIONS

1) The concentration of PM_{10} is analyzed as 142.3, 122.2, 64, 54.23 and 61.23µg/m^3 at different sampling points respectively. A1 and A2 sampling points are exceeding the discharge standard (100 µg/m^3) prescribed by NAAQS except sampling point A3, A4 and A5.
2) The concentration of $PM_{2.5}$ is analyzed as 74.98, 37.24, 37.84, 42.12 and 37.25µg/m^3 respectively. All sampling points except A1 were not exceeding the discharge standard (60 µg/m^3) prescribed by NAAQS.
3) The gaseous pollutants like SO_2, NO_2 and NH_3 showed that the samples were not exceeding the discharge standard prescribed by NAAQS.

REFERENCES

[1] Jacobson, M.Z. Fundamentals of Atmospheric Modelling.2nd Edition, Cambridge University Press, New York (2005).
[2] Verere Sido Balogun, Oluwagbenga Oluwapamileri Isaac Orimoogunje. “An Assessment of Seasonal Variation of Air Pollution in Benin City, Southern Nigeria”.Atmospheric and Climate Science, Vol.5, 2015, pp 201-218.
[3] Prakash Mamta and Bassin J.K. “Analysis of Ambient Air Quality Using Air Quality Index-A Case Study. International Journal of Advanced Engineering Technology, Vol. 1, 2010, pp 106-114.
[4] Rohit Kumar Gupta and Dr. A.K Mishra. “Analysis of Ambient Air Quality of Gida (Gorakhpur) using Air Quality Index –A Case Study. International Conference on Engineering Innovations and Solutions (ICEIS – 2016).
[5] V. Prathipa and A.Sahaya Raja. “Air Quality Assessment and Air Quality Index of DindigulTown (TamilNadu), India– A Case Study.International Journal of PharmTech Research, Vol.8, 2015, pp 45-55.
[6] CPCB, 2014 National Ambient Air Quality Standards. Central Pollution Control Board Notification, New Delhi.
[7] URL 1: CentralPollution Control Board (CPCB) (2009)<http://cpcb.nic.in/National_Ambient_Air_Quality_Standards.php> (accessed on14.09.2016)
[8] United States Environmental Protection Agency(USEPA)(1999)<https://www3.epa.gov> (accessed on 25.08.2016)
[9] Googleimage<https://www.google/image/air pollution/.co.in>(accessed on 30.08.2016)
[10] URL4:Googleearth<https://www.google/maps/place/Raipur/korba/Chhattisgarh.co.in>(accessed on 30.08.2016)