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Air Quality Index of an Industrial District of Jharkhand, India

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Abstract

This paper deals with the assessment of air quality status of the study area by means of NAAQS Dependant air quality index (AQI). It was performed by combining various pollutant concentrations in a specific mathematical equation to get a single number for air quality. Air quality was monitored at thirty one monitoring locations which are covering entire Jharia Coalfield. Monitoring was done to assess the concentration of various particulate (suspended particulate matter, respirable particulate matter and fine particulate matter) and gaseous pollutants (oxides of sulphur, nitrogen and carbon).

As per AQI based on prevailing air quality standard, location A7 (Kusunda) registered high AQI followed by Bastacola (A17), Lodna (A30), Bank More (A6) and Sijua (A10). These locations were close to opencast mining area as well as receiving vehicular dust resuspension. Only one location i.e., A23 (BIT-Sindri) comes under moderate pollution status.

Keywords: SPM, PM10, PM2.5, Air Quality Index.

Introduction

Jharia Coalfield **(**JCF) is declared as critically polluted area by Central Pollution Control Board (CPCB). It is quite necessary to develop a database on systematic monitoring and analysis. However, this database may not convey relevant information to the local community policy makers, government regulators and other stakeholders. These database need to be presented in a convenient form which can facilitates easy understanding of the situations. This can be done by putting in the form of indexing the data on health scale. Thus an index can be created for a given area which is based on air quality of the desired area. This is called as Air Quality Index (AQI). The AQI is an index dealing with the air quality. It tells about the clean and healthy air and the associated health effects this is also known as Air Pollution Index (API) (Shenfeld, 1970; Ott and Thom, 1976; Thom and Ott, 1976; Murena, 2004) or Pollutant Standards Index (PSI) (Ott and Hunt, 1976; EPA, 1994).

An “Air Quality Index” may be defined as a single number for reporting the air quality with respect to its effects on the human health (Thom and Ott, 1976; Bortnick et al., 2002; Murena, 2004). In most elaborate form, it combines many pollutants concentrations in some mathematical expression to arrive at a single number for air quality. This approach for the evaluation of air quality is entirely based on National Ambient Air Quality Standards (NAAQS). In Indian context, the studies on AQIs have been carried out for the city of Mumbai (Sharma, 1999), Delhi (Sengupta et al., 2000) and Kanpur (Sharma et al., 2003). The mathematical functions for calculating these indexes are based on health criteria of the EPA and Indian air quality standards.

Keeping this in view AQI for the study area was calculated by using NAAQS dependent air quality index.

Methodology

In this method, equal importance was given to all the pollutants. Using observed and standards value, the quality rating for each pollutant was calculated. The geometric mean of these quality ratings gives the Air Quality Index. Based on this assumption, the air quality index was derived in the manner outlined as under:

The existing concentrations of pollutants were compared with ambient air quality standards (with the standard being assumed as reference base line for each pollutant) and accordingly the quality rating for a particular pollutant was derived as shown below:

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$Q_i = 10(C_i/S_i)$ ……….. (1.0)
where

Q_i = Quality rating for a i^{th} pollutant,
C_i = Concentration of i^{th} pollutant
S_i = Air quality standard for i^{th} pollutant

Air Quality Index (AQI) = $(Q_1 \times Q_2 \times \text{--------} \times Q_n)^{1/n}$ ……… (1.1)

Where

n = Number of pollutants considered.

The categorization of air quality index has been assigned as per guidelines provided by Environment Canada shown in Table 1.0. It measures the air quality in relation to the health on a scale from 1 to 10. The higher the number, the greater the health risk associated with the air quality. When the amount of air pollution is very high, the number will be reported as 10+. Following the above criteria, Air Quality Index (AQI) was calculated for all the monitoring station on an annual basis and categorizations were assigned as shown in Table 2.0

Table 1.0: Air Quality Health Index

Level of risk	**Index reading**	**At risk population**	**At general population**
Low	1– 3	• Enjoy your usual outdoor activities. • Follow your doctor's advice for exercise.	Ideal conditions for outdoor activities: sports, biking or walking.
Moderate	4 – 6	• If you have heart or breathing problems and experience. Symptoms, consider reducing physical exertion outdoors or rescheduling activities to times when the index is lower. • Follow your doctor's usual advice about managing your condition.	No need to modify your usual outdoor activities.
High	7-10	• Children, the elderly and people with heart or breathing problems should reduce or reschedule physical exertion outdoors to periods when the index is lower, especially if you experience symptoms. • Follow your doctor's usual advice about managing your condition.	Anyone experiencing discomfort such as coughing or throat irritation should consider reducing or rescheduling strenuous outdoor activities to periods when the index is lower.
Very High	Above 10	• Children, the elderly and people with heart or breathing problems should avoid physical exertion outdoors. • Follow your doctor's usual advice about managing your condition.	Everyone should consider reducing or rescheduling strenuous outdoor activities to periods when the index is lower, especially if you experience symptoms.

(Source :www.ec.gc.ca)

Table 2.0: Location-wise Air Quality Index of the Study Area

Locations	***Sub index of various pollutants***						***AQI***	***Category***
	QSPM*	***QPM_{10}***	***$QPM_{2.5}$***	***QSO_2***	***QNO_x***	**QCO**		
A1	11	22	16	4	24	9	20	VeryHigh
A2	12	21	18	3	30	10	21	VeryHigh
A3	11	22	22	5	30	10	24	VeryHigh
A4	12	21	20	5	27	9	22	VeryHigh
A5	12	23	20	3	28	11	22	VeryHigh
A6	14	27	23	7	34	10	29	Very High

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A7	19	51	23	11	34	6	35	VeryHigh
A8	18	49	12	4	7	9	19	VeryHigh
A9	17	35	26	6	9	10	24	VeryHigh
A10	20	57	31	7	8	7	27	VeryHigh
A11	10	21	25	6	5	6	16	VeryHigh
A12	19	31	11	3	5	3	12	VeryHigh
A13	18	50	11	4	15	3	18	VeryHigh
A14	18	28	16	2	5	7	15	VeryHigh
A15	15	29	13	4	10	8	18	VeryHigh
A16	17	29	10	2	4	10	13	VeryHigh
A17	20	56	38	8	10	7	30	VeryHigh
A18	12	22	15	3	4	9	13	VeryHigh
A19	18	48	17	8	10	7	24	VeryHigh
A20	7	14	11	9	3	4	10	High
A21	21	53	12	7	9	9	23	VeryHigh
A22	13	23	30	3	6	2	12	VeryHigh
A23	5	10	10	2	4	1	5	Moderate
A24	10	20	12	2	5	0	7	High
A25	18	35	12	3	9	5	16	VeryHigh
A26	16	35	12	2	7	5	14	VeryHigh
A27	13	27	14	3	7	1	11	VeryHigh
A28	11	26	9	4	5	1	9	High
A29	11	27	13	2	5	2	9	High
A30	20	54	31	7	10	3	24	VeryHigh
A31	11	34	30	7	13	7	24	VeryHigh

(Source: www.ec.gc.ca)

Q_{SPM},Q_{PM10}, $Q_{PM2.5}$, Q_{SO2} , Q_{NOx} and Q_{CO} - Quality ratings for SPM,PM_{10}, $PM_{2.5}$, SO_2 , NOx and CO respectively and AQI indicate the Air Quality Index.

Table 2.0 indicates that almost all locations are falling under high to very high pollution status. Kusunda (A7) had very high pollution status followed by A17 (Bastacola), A30 (Lodna), A6 (Bank More) and A10 (Sijua) with index value >10 due to intensive traffic situation and associated mining activities. Locations A20 (Barari), A24 (ISM Campus), A28 (Singra) and A29 (Jarma) are falling under high pollution status due to mining and related activities and vehicular movement with index value within 7 to 10. Location A23 (BIT-Sindri) registered moderate pollution status due to plantation in this location, which helps in suppression of pollutants. In this connection, location wise air quality index map was prepared and shown in Figure 9.1 which depicts the pollution status of all the monitoring stations.

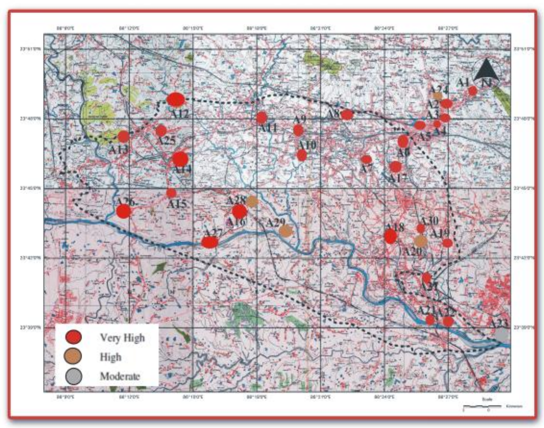

Figure 1.0: Air Quality Index Map of the Study Area

The use of this approach to some extent helps to maintain a 'desired' environmental quality, but this does not explain the periodic degradation in air quality, particularly if the measured values remain below NAAQS. The reason behind this drawback arises from the fact that by providing an upper threshold concentration value in the form of a standard, air quality tends to get categorized either as 'good' or 'bad' depending on whether the standards have been exceeded or not. In reality, however, there

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are instances where concentration of pollutants become sufficiently high to pose environmental and health problems, but owing to the fact that may not be high enough to cross the threshold value, they are falsely interpreted to represent 'acceptable' air quality.

As such, it was felt to evaluate air quality status through depreciation indexing. Air quality depreciation index is a method that measures deterioration in air quality (with due weightage to the potential capacity of pollutants to affect bio-physical, health and aesthetic attributes) on an 'absolute' environmental quality scale independent of NAAQS. The index makes use of value function curves to determine air quality.

Conclusion

The AQI was calculated and a map for the same was formulated for major air pollutants (gaseous and particulate matter) having a great concern in the study area. For each of these pollutants, MOEF has established national ambient air quality standards to protect public health. The concentration values were compared with NAAQS values to develop AQI map for the study area. Which helps in dealing with the probable sources and the mitigation measures to be taken in the same area .The Higher AQI was calculated for location A7 (Kusunda) followed by Bastacola (A17), Lodna (A30), Bank More (A6) and Sijua (A10).This was due to noxious gases and particulate emissions from coal mines, Bokaro thermal power plants, coal washery, coke oven plants, coupled with heavy vehicular traffic activities and frequent (on the substandard road network within mining areas), etc.

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