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Assessment of Ozone Concentration by using Air Quality Index of Jabalpur, India

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ABSTRACT

Air pollution is a major concern of now days and AQI is a key tool which monitored the local air quality very well. The study has been conducted in Jabalpur, Madhya Pradesh, India to obtain the 8 h average AQI result of ozone during January 2012-December 2014. The result shows that in the year of 2013 the AQI of O_3 (34) was higher than 2012 (32) and 2014(23). All the years are coded green color which means, it comes under low health risk zone.

1. Introduction

Today the alarming issue which has been continuously looking towards earth is air pollution. The chemicals, particulates or biological materials which can be causes discomfort, disease, or death to humans, damage other living organisms such as food crops, or damage the natural persona is termed as air pollutants. Generally, air pollutants are categorizes in two types: primary and secondary. Usually, primary pollutants are directly emitted from a process, such as ash from a volcanic eruption, the carbon monoxide gas from a motor vehicle exhaust or sulfur dioxide released from factories. Secondary pollutants are not emitted directly, when chemical components react with primary pollutants in the presence of sunlight secondary pollutant is generate.

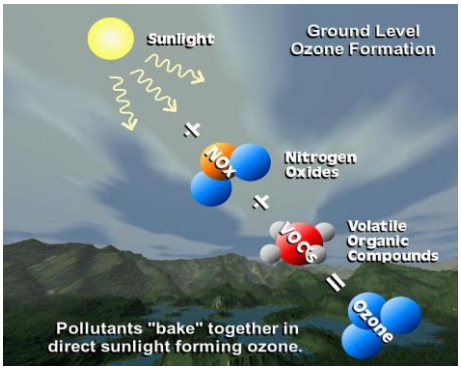

Fig. 1 Formation of tropospheric ozone

The developing countries continuously focused on their local air quality to find out how they live and breathe in present atmosphere. The U.S. Environmental Protection Agency (EPA) and our local air quality agencies have been working hard to gain more information about outdoor air quality similar to weather forecasting. Thus Air Quality Index (AQI) is a key tool which can be easy to get the air quality results [1-5]. EPA and other air quality agencies have been already given their AQI, to provide simple information about its air quality which directly influenced the health. Bishoi et al studied the comparative air quality index based on factor analysis and US-EPA methods for an urban environment for better result [6].

Generally, an AQI value corresponds to the National Air Quality Standards (NAQS), which has already being set a level by EPA [7], to protect public health. To better understand the AQI is divided into six levels of health concerns (Table 1).

Table 1 Air quality index by EPA [8]

AQI ranges	Levels of health concern	Symbolized colors
0-50	Good	Green
51-100	Moderate	Yellow
101-150	Unhealthy for sensitive groups	Orange
151-200	Unhealthy	Red
201-300	Very unhealthy	Purple
300-500	Hazardous	Maroon

Each group has corresponds to a different level of health concerns:

1) *Good*: The AQI ranges in between 0-50. Air quality is satisfactory and possess little or no health issues.
2) *Moderate*: The AQI ranges in between 51-100. Pollution in this range may pose a moderate health concern for a very small number of individuals.
3) *Unhealthy for Sensitive Groups*: When the ranges of AQI are in between 101-150, the members of sensitive groups may be experience health effects, but the general public is unlikely to be affected.
4) *Unhealthy*: Everyone may experiences some health effects under the range of AQI in between 151-200. Members of sensitive groups may be suffering from more serious health effects.
5) *Very Unhealthy*: The AQI values in between 201-300, which trigger a health alert. It means, everyone in this group may experience more serious health effects.
6) *Hazardous*: When AQI ranges going over 300, it triggers health warning of emergency conditions. The entire population is even more likely to be affected by serious health effects.

Basically AQI has been calculating to enhance a global air quality. To investigate level of AQI of various air pollutants over the cities has today's need. Many air quality standards are present which is helping to get accurate AQI [9]. Such as, AQI of Ozone with its concern impact is present here under:

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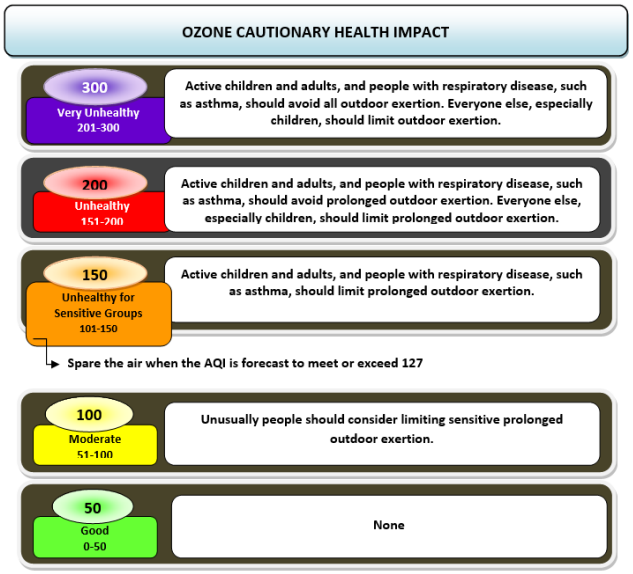

Fig. 2 Ambient Air Quality Index of Ozone with its health impact.

The study is significant to gain information about the ambient air quality of the city Jabalpur [11]. The observation has continuously monitored by AAQMS (Ambient Air Quality Monitoring System). In the upcoming years, AAQMS is going to enforce in each city to aware the population about its importance and necessity.

2. Experimental Methods

2.1 The Study Area

Madhya Pradesh (Fig. 3) is generally known as the heart of India. The site Jabalpur is one of the major centers of Madhya Pradesh in India and is famous for its green belt. Geographically it is located at 23.17°N 79.95°E. It has an average elevation of 411 meter (1348 feet). Topographically Jabalpur is rich with forests, hills and mountains which contain lots of minerals in it. On the other hand, quality of air is getting deteriorated slowly by increasing industrialization and due to tremendous increase in number of vehicles plying on the roads [10].

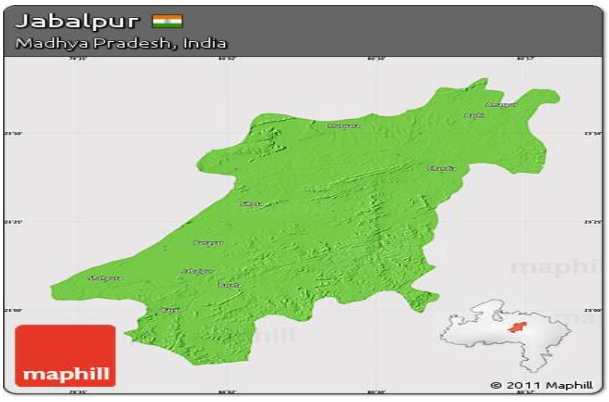

Fig. 3 Satellite view of Jabalpur, India

2.2 Sampling and Investigative Method

The instrument Ambient Air Quality Monitoring System (AAQMS) was manufactured by Ecotech Australia. It is systematic, assessment of long term pollutants in the surroundings. Ecotech established the instrument for environmental monitoring that is Win AQMS (Air Quality Monitoring Station). This Win AQMS has two parts: the client as client and the server. The monitoring system consists of the assembly of many transducers and analyzers employing various instrumentation techniques. The instrument has provided all the yearly observation of the O_3 concentration by EC9810 Ozone Analyzer (O_3) [10].

2.3 Observational Study

The site for the study is quite dense related to residential area but the place of Jabalpur is also very near to green belt. While on monitoring the ambient air by AAQMS (Ambient Air Quality Monitoring System) of the city, the gaseous pollutants are ozone (O_3) is the prime focus. The 8 hours average of O_3 concentration has been taken up to the three years of the study (January 01, 2012 - December 31, 2015).

To calculate the AQI of concentration [11], a common formula has to be applied on the concentration level:

$$I_p = \frac{I_{Hi}-I_{Lo}}{BP_{Hi}-BP_{Lo}}(C_p - BP_{Lo}) + I_{Lo} \quad (1)$$

Where, the initials of the formulae symbolizes the term as, I_P (the index for pollutant p), C_P (the rounded concentration of pollutant p), BP_{Hi} (the breakpoint that is greater than or equal to C_P), BP_{Lo} (the breakpoint that is less than or equal to C_P), I_{Hi} (the AQI value corresponding to BP_{Hi}), I_{Lo} (the AQI value corresponding to BP_{Lo}). The breakpoint of O_3 for the AQI is shown in Table 2.

Table 2 Breakpoint of O_3 for the AQI

O_3 (ppm) 8 hours	O_3 (ppm) 1 hour	Equal to AQI	Category
0.000-0.064	-	0-50	Good
0.065-0.084	-	51-100	Moderate
0.085-0.104	0.125-0.164	101-150	Unhealthy for sensitive groups
0.105-0.124	0.165-0.204	151-200	Unhealthy
0.125-0.374	0.205-0.404	201-300	Very Unhealthy
([3])	0.405-0.504	301-400	Hazardous
([3])	0.505-0.604	401-500	Hazardous

Source: Control of Urban Pollution Series, 2014-15 [12] and Gao et al [13].

3. Results and Discussion

AQI provides all the beneficial aspects which cover the health of atmosphere as well as human beings. The standard AQI has already fixed which has been updated in all the years (Table 3 and 4). While seen area wise, the AQI of Jabalpur demonstrate the quality of ambient air and the 8 h average during the studied period.

Table 3 Annual 8 h average AQI of ozone at Jabalpur

Year	Avg. O_3 conc. 8 h (ppb)	O_3 conc. (ppm)	Result of AQI
2012	41	0.041	32
2013	43	0.043	34
2014	29	0.029	23

The resultant table of annual AQI shows green color in all the years. Thus, all the values in between the range of 0 - 50 and there is very less or no health issues were found related to ozone. In 2014, an AQI value was very low, which has been given the assurance that, in the upcoming years the awareness toward ozone and air quality will be spread everywhere.

Table 4 Monthly AQI of 8 h O_3 concentration in between 08:00 AM to 03:00 PM

Year	2012		2013		2014	
Month	8 h O_3 (ppb)	AQI	8 h O_3 (ppb)	AQI	8 h O_3 (ppb)	AQI
Jan	55	47	70	84	63	61
Feb	68	77	63	61	58	49
Mar	66	71	69	80	58	49
Apr	68	77	69	80	63	61
May	69	80	47	40	55	47
Jun	57	48	50	42	42	36
Jul	42	36	35	30	32	27
Aug	36	31	36	47	15	13
Sep	43	36	56	54	12	10
Oct	59	50	61	50	20	17
Nov	68	77	59	97	30	25
Dec	68	72	74	90	25	21

To obtain a better result of AQI, the calculation has been predicted throughout the monthly average of each year. This represents the accuracy in the AQI which gives precious information regarding current status of the quality of ambient air. For this, annually 8 hours average of each year has been calculated. Later on, the higher average should be taken up for the further calculation of basic AQI. Through which it is easier to find out the good, moderate, healthy and unhealthy observation by the help of color coding.

On applying the AQI formulae on the monthly averages of 8 hours average of O_3, it found that, the observed value of AQI shows good as well as moderate color coding. AQI value which is less than 50, coded 'green'

which means good air quality; whereas, AQI ranges more than 50 up to 100, coded 'yellow' which means air quality is moderate, needs to control on air pollution.

4. Conclusion

The AQI gives the clear layout about ambient air and its critical pollutant, which is mainly responsible for destroying the quality of ambient air and human health. Though the three year result has shown quite good green color mainly in Jabalpur. But, while observing the monthly average, the yellow moderate color is a primary warning. It was not a ignoring observation. The devloping city Jabalpur, wants to do many air quality related task which will gives ideal monitoring observations.

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