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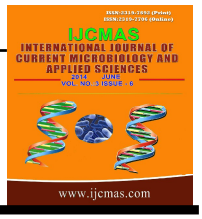

Original Research Article

An Estimation of Air Quality Index of a Coastal Station – A case study

Vennapu. Lakshmana Rao*

Department of Meteorology and Oceanography, Andhra University, Visakhapatnam, India

****Corresponding author***

A B S T R A C T

Visakhapatnam is situated in the North Eastern Coast of Andhra Pradesh with topography like a spoon shaped basin surrounded by hill ranges on three sides and the sea on the other side. The hill ranges cause inversion conditions, particularly in the winter season. In this article the analysis of the ambient air in the Visakhapatnam air quality index (AQI).The 24-hourly average concentrations of major conventional pollutants, viz. Suspended particulate matter(SPM), Respirable particulate matter(RPM),Lead for the year 2013 (winter) at fifteen different locations have been considered for this analysis. It has been observed that the calculated AQIs values. The observed SPM concentrations had a minimum concentration of 60 µg/m3, which was recorded in INS Veerabahu. The observed SPM concentrations had a maximum concentration of 163 µg/m3, which were recorded in Police barracks area. The observed RPM concentrations had a minimum concentration of 132 µg/m3, which are recorded in Mindi area, the observed RPM concentrations, had a maximum concentration of 317 µg/m3, which are an also recorded in Police barracks area. The air quality index values are maximum in I- Town (193.56) and Gnanapuram (191.66) areas; whereas the minimum values are observed in INS Veerabahu (52.15) and Seetammadhara (59.67) areas.

Keywords

Topography, air quality index, conventional pollutants.

Introduction

In India the ambient atmospheric conditions have progressively deteriorated due to urbanization, industrial development, lack of awareness, poor maintenance of motor vehicles and poor road conditions. Transport vehicles and industrial emissions are the major sources of pollutants in the Visakhapatnam city. The initial iteration of the air quality index used standardized ambient pollutant concentrations to yield individual pollutant indices. This indicates were then weighted and summed to form a single total air quality index. The AQI is an index determined by calculating the degree of pollution in the city or at the monitoring point and includes five main pollutants –

particulate matter ground- level Ozone, Sulfur dioxide, Carbon monoxide and nitrogen dioxide. Each of these pollutants has an air quality standard, which is used to calculate the overall AQI for the city.

Rapid industrialization followed by consequential population and economic growth surrounding industrial nuclei have often a serious concern for the environmental deterioration of surrounding areas. Industrial development in Visakhapatnam (17°42'N; 82°18'E) is conspicuous to urban agglomeration and the whole city is within a distance of 10 km from the shore of the Bay of Bengal. It is located in a topographic bowl formed by two hill ranges with peak heights ranging from 1170 to 1603 ft and the area covered is approximately 50 km2. An air quality index (AQI) may be defined as a numerical rating that reflects the composite influences on overall quality of a number of air quality parameters, when will be helpful not only for advising the public, but also for urban planning (Srivastava et al., 1975; Kassomenos et al., 1999).T.N. Tiwari and Manzoor Ali have suggested a method for calculating the AQI from the data on various air quality parameters, which is useful to implement the air quality improvement programs effectively.

Materials and Methods

Calculation of AQI

Let there be n air quality parameters Pi (i= 1, 2, 3... n), which are to be taken into account for calculating the AQI. Let Vi be the observed value of the ith parameter Pi in the ambient air and let Vsi be the standard value recommended for this parameter. Then the quality rating Qi for this parameter is given by

$$Qi = 100 (Vi/Vsi) \quad \ldots\ldots\ldots\ldots\ldots (1)$$

If Qi < 100, it is to be noted that the given parameter is within the prescribed limit. On the other hand, if Qi > 100, it implies that the ith parameter exceeds the prescribed standard and the ambient air is harmful for breathing by human beings. It is assumed here that all the parameters have the equal importance and so only the unweighted air quality indices are calculated. The geometric unweighted AQI may be calculated from the quality ratings Qi by taking their geometric mean.

$$AQI = (\Pi Qi)^{1/n} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where Π runs from $i = 1$ to N.

This relation is simplified and hence

$$AQI = \text{Antilog} \left(\sum \log Qi\right)/n \quad \ldots\ldots\ldots\ldots (3)$$

where the sum runs from $i = 1$ to n.

The ambient AQI can be calculated using equations 1 and 3 (Tiwari and Manzoor Ali, 1987).

National ambient air quality standards prescribed by CPCB, which are the concentration levels of air quality necessary with an adequate margin of safety, to protect the public health, vegetation and property, are presented in Table 1. The estimated concentrations of the pollutants and the air quality standards are used in the present calculation and the air quality indices are calculated. In this article the analysis of the air quality index of Visakhapatnam for the year 2013 winter season have been considered for this analysis. Here we consider major conventional pollutants like SPM, RPM and Pb.

Categorization of AQI

The ambient air quality can be categories like good, moderate, poor, very poor and critical based on the values of air quality index (Avinash Kumar, 2005).The status of air quality in the area of interest can be

found with the help of this rating scale, which are listed in table 2.

The calculated air quality indices and the categorization on the basis of rating scale are presented for the sampling sites of the present study in Table 3.

Results and Discussion

In this article the SPM, RPM and Pb concentrations were measured at fifteen sampling stations within the urban limit of the city Visakhapatnam. The sampling was carried out during the winter period of the year 2013. The observed SPM concentrations had a minimum concentration of 60 µg/m3, which was recorded in INS Veerabahu. The observed SPM concentrations had a maximum concentration of 163 µg/m3, which were recorded in Police barracks area. The observed RPM concentrations had a minimum concentration of 132 µg/m3, which are recorded in Mindi area, the observed RPM concentrations, had a maximum concentration of 317 µg/m3, which are also recorded in Police barracks area. The sources of these pollutants might be transportation, small scale industries, and higher rate of combustion of fuels for domestic/ commercial purposes in the city. The sand, along the sides of the roads, which was dusty in nature, was not removed periodically. This also might have elevated the SPM and RPM concentration due to the existing favorable meteorological conditions, besides the mentioned sources.

The estimated Pb concentration ranged in between 0.40 and 1.52 µg/m3. The highest concentration was recorded in Police barracks areas; whereas the minimum concentration was recorded in INS Veerabahu. The ambient Pb concentrations were about to exceed the permissible limits in some of the sampling sites. The major urban source of Pb pollution might be gasoline-powered vehicles. This gasoline – powered vehicles emit lead particles of 0.2 microns to 2 microns. In fact, the light tonnage vehicles, which are mostly gasoline-powered, have lion share in the total number of vehicles plying on the road in Visakhapatnam city. In addition to the medium tonnage vehicles, these two wheelers also might have caused these increased levels.

This preliminary investigation was executed in winter season. The meteorological information of all seasons of Visakhapatnam city was compared with the noted meteorological conditions during sampling. It was studied that the air temperature was relatively lower and the relative humidity is relatively higher than all the other seasons due to low daytime solar insulation and cold cover. The wind speeds were also relatively lower than some other seasons. These all form the st ability conditions that were favorable to the accumulation of particulate pollutants and hence elevated concentrations were recorded during the study period. The period of study was the season, which had the maximum rainfall. So, the influence of rain in washing down the SPM and RPM from the ambient air might also be the cause for the present estimated concentrations.

Some of the sampling sites partially had the resemblance to nature of canyon by having narrow streets in between elevated buildings, which lined up continue along both sides. So, this might lead to accumulation of all these particulate pollutants.

As Visakhapatnam city is a developing city, the nature of activities in many parts of the city is heterogeneous and mixed. So, for the preliminary investigation, three sensitive sites, two residential sites, three industrial

Table.1 National Ambient Air Quality Standards

Area	Category	Concentrations (µg/m3)		
		SPM	RPM	LEAD
A	Industrial and Mixed Usage	500	150	1.5
B	Residential and rural	200	100	1.0
C	Sensitive	100	75	0.75

Table.2 A Q Categories Based on Air quality index

Category	AQI	Descriptions of ambient air quality
I	0-50	Good
II	51-100	Marginally Polluted
III	101-200	Unhealthy
IV	201-300	Very Unhealthy
V	>300	Critical

Table.3 Air Quality indices and categories in Visakhapatnam city

Site No	Date of Samples	Sampling Stations	AQI	Air Quality Category
01	09.10.2013	Police Barracks	163.67	Unhealthy
02	14.102013	Gnanapuram	191.66	Unhealthy
03	19.10.2013	Seethammadhara	59.67	Marginally Polluted
04	24.10.2013	Gajuwaka	152.27	Unhealthy
05	29.10.2013	ESI Hospital	149.88	Unhealthy
06	04.11.2013	Agannampudi	67.12	Marginally Polluted
07	09.11.2013	I E Marripalem	134.25	Unhealthy
08	14.11.2013	Arilova	72.15	Marginally Polluted
09	19.11.2013	Allipuram	149.88	Unhealthy
10	24.11.2013	K G H	129.62	Unhealthy
11	29.11.2013	Mindi	111.21	Unhealthy
12	04.12.2013	I Town	193.66	Unhealthy
13	09.12.2013	Gopalapatnam	122.92	Unhealthy
14	14.12.2013	Simhachalam	87.81	Marginally Polluted
15	19.12.2013	INS Veerabahu	52.15	Marginally Polluted

sites, one traffic, eight commercial cum traffic sites, three traffic cum sensitive sites were chosen before having an in-depth study in the city. The result of the preliminary investigation showed that some air pollutants were within the permissible limits at many sampling sites and some exceeded the sixteen sites were unhealthy condition that meant that the air quality concentrations were higher. It is important to note that the highest values of AQI were calculated in sensitive areas,

traffic areas and commercial area, which have low levels of permissible limits. The air quality index values are maximum in I-Town (193.56) and Gnanapuram (191.66) areas; whereas the minimum values are observed in INS Veerabahu (52.15) and Seetammadhara (59.67) areas.

From the above results, it is amply clear that the particulate pollutants are a emerging as critical pollutants for the priority attention. On the basis of rating scale, it is found that the atmospheric environment of Visakhapatnam city is mostly polluted. The atmospheric pollutants from anthropogenic sources, especially the pollutants of present interest need systematic control, which will not only safeguard the population.

Many parts of the city fall in the marginally polluted and unhealthy categories based on air the quality index. These places may become heavily polluted category in the upcoming years, if the emissions from the sources are continue in the same trend. The residential as well as the floating population in the central parts is higher than most other parts of the city. The central parts also have some social assets like temples and monuments. The central parts endure more pollution than the reminder parts of the city. So, there is urgency in instituting preventive and control measure in this area. The city has many heavy plants; pollution from industries is found very high in Visakhapatnam. It is concluded that overall air quality status in winter season is most polluted or unhealthy season. It is also concluded that further industrial growth in Visakhapatnam should not be encouraged and meticulous post, air quality management plan should be implemented to avoid further deterioration of air quality.

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