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Assessment of Air Quality Index of Coimbatore City in Tamil Nadu

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Abstract

Background/Objectives: The prime objective of this work is to study the condition and quality of the air in Coimbatore city by measuring Air Quality Index (AQI) and to compare the measured values with standard values. This work also examines the variation of ambient air quality with various climatic conditions. **Methods/Statistical Analysis:** The quality of air was determined based on National Ambient Air Quality Standards (NAAQS). This was carried out based on measuring four major air pollutants such as PM_{10}, $PM_{2.5}$, SO_2 and NO_2 at different climate conditions during January 2015 to December 2015. Respirable Dust Sampler (RDS) and Fine Particulate Sampler were used to determine PM_{10} and $PM_{2.5}$ respectively. **Findings:** The present work shows its significance because there is no such data available for researchers for reference. Industrial (foundry units) and automobile emissions are the major pollution source which determines the quality of ambient air in the city. Among the different climatic conditions, summer exhibits more pollution level in the air while monsoon exhibits less pollution level. Results also reveals that the Industrial area experiencing more pollutants followed by commercial and residential areas. As per the AQI category, all locations are coming under moderate category except industrial location which requires stringent control measures to reduce the particulate matters in the air. **Applications:** Since no data is available for the Air Quality Index study of the region, this can be taken as a reference for future study.

Keywords: Air Quality Index, Automobile Emission, Dust sampler, Pollution Level and Particulate Matter

1. Introduction

As per World Health Organization (WHO) definition the air pollution refers the presence of unwanted material in the ambient air which are harmful to mankind and their environment. According to Bureau of Indian Standards [BIS], air pollution refers "the presence in ambient atmosphere of substances, generally resulting from the activity of man, in sufficient concentration, present for a sufficient time and under circumstances such as to interfere with comfort health or welfare of persons or with reasonable use or enjoyment of property". Clean, pollution-free and hygienic living surroundings are essential as they are directly related to human health and better living standard of the country. The air pollution level of Coimbatore city in Tamil Nadu increases year after year due to its rapid industrial development and growth of automobile usages. The impacts of health hazards due to air pollution have been studied extensively[1-6]. Many studies have been reported to explain the effect of different levels of air pollutions, pollutants and potential parameters like temperature and humidity[7-9]. Change of climate influences the air pollution and major air pollutants such as SO_2, NO_2, CO and particulate matter. Previous study reported a strong relationship among weather conditions that affected the concentrations of particulates[10-13]. Table 1, shows the NAAQS recommended levels of pollutant concentration in the ambient air. Particulate matter refers a combination of solid and liquid particles such as carbon, ammonia, nitrates, sulphates, minerals, trace elements and water mixed in the air[14]. NO_2, SO_2 and suspended particulate matter are major air pollutants in India[15]

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which are presents in the air due to burning of fossil fuels and affect the living being[16]. Emissions from automotive vehicle are the main cause of air pollution in the highly populated area and accounts for 60-70 % of the pollution in the urban environment[17]. The effect of particulates[18,19] based on its geometry and concentration. Air Quality Index is used to assess the overall environmental condition and its trends with a specific standard. It is based on the lines of health index and measured by the degree[20,21]. In the present work, an attempt has been made to evaluate the concentrations of ambient air pollutants like PM_{10}, $PM_{2.5}$, SO_2 and NO_2 for one year during January to December, 2015 from four different areas for different seasons such as summer, monsoon and winter.

Table 1. Ambient Air Quality Standards

Pollutant	Concentration
PM_{10}	<100µg/m^3
$PM_{2.5}$	<60µg/m^3
SO_2	< 80µg/m^3
NO_2	< 80µg/m^3

2. Methods and Materials

2.1 Study Area

Coimbatore is known as industrial hub of South India, located in the western part of Tamil Nadu near Western Ghats. An estimated average of 1, 20,000 vehicles are moving and about 1.5 million peoples are living. The City has around 30,000 small and medium industries and large textile units. Coimbatore has also attracted investment from large software industries in the recent years. This city is also famous for the manufacturing of motor pumps and automotive components. Because of the conducive atmosphere for the expansion of new industries and growth pattern, this city has more potential for air pollution. Table 2, refers the various locations in Coimbatore city selected for study where the air samples were collected.

Table 2. Name of the ambient air measuring locations

Location	Zone type	Code	Direction
Kurichi	Industrial	L1	S
RS Puram	Commercial	L2	W
Peelamedu	Residential	L3	E
Ganapathi	Residential	L4	N

2.2 Sampling Method and Analysis Procedure

In the present study, 25 air samples were collected from each location for a period of 8 hours duration and the various parameters like wind speed, direction, relative humidity and temperature are also noted.

2.2.1 Method of Sampling for Particulate Matter

Suspended Particulate Matter (SPM) of size above 10 µ present in ambient air is measured by using a Respirable Dust Sampler with a cyclone attachment for a period of one day by sucking a known quantity of air through glass filters. The mass concentration of SPM is calculated by measuring the weight of collected matter in known volume of air sampled. The final results are expressed in terms µg/m^3.

2.2.2 Sulphur dioxide

The determination of SO_2 is done by modified West and Gaeke method. In this method, SO_2 is absorbed from a known quantity of air in a solution of sodium tetra chloromercurate to form stable dichlorosulphitomercurate[21] mixture. Formaldehyde is then used for reaction and the color intensity during reaction is estimated photometrically.

2.2.3 Nitrogen dioxide

Jacob Hochheiser method is used to estimate concentration of NO_2 in the air. Nitrogen Oxides are collected from sodium hydroxide solution to form stable sodium nitrite. The ion of nitrite produced is calculated by photometrically.

2.2.4 Air Quality Index

An AQI is an environmental index which describes the overall atmospheric air status. It is the measure of ratio of the concentration of pollutants to the condition of atmospheric air in the area. Table 3, gives the levels of health concern based on AQI values. The following computation[22-27] was used to arrive the AQI values of the selected locations under study. Higher the AQI value refers higher the status of air pollution and greater the affect to 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.

$S_{PM_{10}}$, $S_{PM_{2.5}}$, S_{SO_2}, S_{NO_2} are the atmospheric air quality standards prescribed by CPCB (Central Pollution Control Board).

Table 3. Air quality categories based on Air Quality Index

Air Quality Index	Levels of Health Concern
0 to 50	Good
51 to 100	Moderate
101 to 150	Unhealthy for sensitive groups
151 to 200	Unhealthy
200 and above	Hazardous

3. Results and Discussions

In this present work, the air pollutants concentration like PM_{10}, $PM_{2.5}$, SO_2 and NO_2 were measured in selected four locations in Coimbatore city. Tables 4-6, provides the climate wise air quality status for various parameters.

The variation of pollutants in location 1 (L1) which represents industrial area shown in Figure 1. PM_{10} exceeds the recommended limits in all the climate conditions and other parameters are within the standard limits.

Figure 2 shows the variation of pollutants in location 2 (L2) which represents commercial area. Result revealed that all parameters are within the standard limit except PM_{10} which is slightly above the standard level.

Figures 3 and 4 shows the variation of air pollutants in the residential areas (L3, L4) and they revealed that all the parameters are well within the range of standard levels. It was revealed that pollutant concentrations vary widely for various zones.

Table 7, shows the average values of AQI comprising of various climatic conditions. It reports that the residential zones are in low air pollution status, the commercial zone is under moderate level and the industrial zone is under high level.

Table 4. Average ambient air quality data for different parameters during summer

Location Code	Summer			
	PM_{10}	$PM_{2.5}$	SO_2	NO_2
L1	112.2	82.3	24.3	15.2
L2	97.2	78.6	20.4	14.2
L3	90.9	67.2	19.2	12.3
L4	75.3	63.6	12.9	10.5

Table 5. Average ambient air quality data for different parameters during monsoon

Location Code	Monsoon			
	PM_{10}	$PM_{2.5}$	SO_2	NO_2
L1	90.2	62.2	10.5	12.1
L2	97	62.3	18.1	11.9
L3	81.3	57.5	9.6	11.6
L4	69	51.1	7.6	10.5

Table 6. Average ambient air quality data for different parameters during winter

Location Code	Winter			
	PM_{10}	$PM_{2.5}$	SO_2	NO_2
L1	102.8	68.3	19.2	18.2
L2	90.8	68.3	19.2	18.2
L3	84.3	60.9	15.6	10.4
L4	71.3	58.2	13.5	15.5

Table 7. Location wise average AQI

Location Code	AQI
L1	58.4
L2	49.7
L3	34.6
L4	32.1

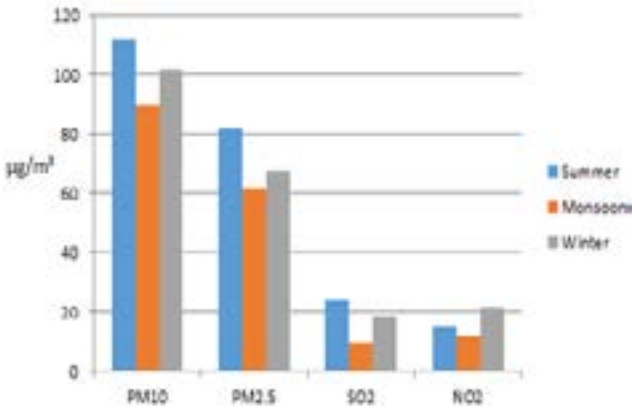

Figure 1. Variation of Pollutants in L1.

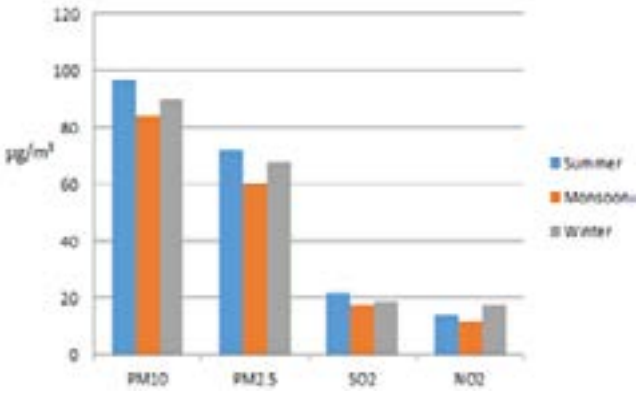

Figure 2. Variation of Pollutants in L2.

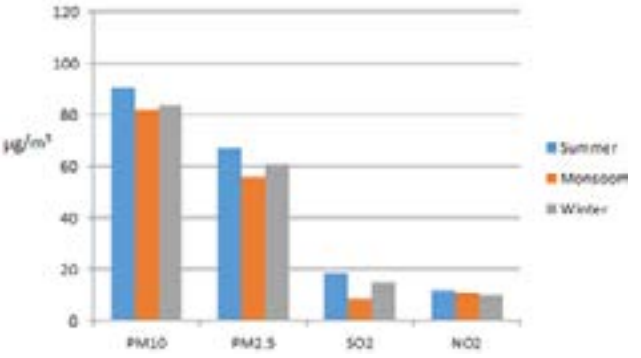

Figure 3. Variation of Pollutants in L3.

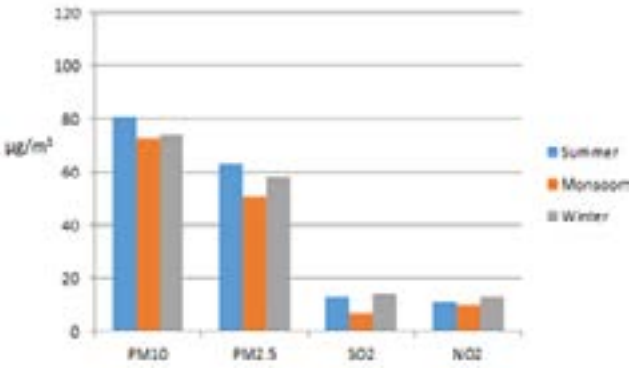

Figure 4. Variation of Pollutants in L4.

4. Conclusion

The current work was carried out to estimate the climatic variation in AQI at four different areas of Coimbatore, Tamil Nadu. Industrial emissions (foundry units) and automobile emissions are the major sources of pollution which determine the ambient air pollution condition of the zone. It is observed that the AQI is lower during monsoon, followed by summer and higher in winter. Results also revealed that, the pollution level is low for residential zones and moderate for commercial zone and is high for industrial zone.

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