Nature Environment and Pollution Technology
An International Quarterly Scientific Journal

p-ISSN: 0972-6268 e-ISSN: 2395-3454	Vol. 17	No. 1	pp. 323-328	2018

Original Research Paper | Open Access

Air Quality Index (AQI) for Development of Environmental Impact Assessment (EIA) Reports of Urban Infrastructural Projects in Coimbatore City

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Nat. Env. & Poll. Tech.
Website: www.neptjournal.com

Received: 12-06-2017
Accepted: 13-07-2017

Key Words:
Air quality index (AQI)
Air pollution
Particulate matter
Climatic conditions

ABSTRACT

The principal objective of this work is to study the condition and quality of the air by measuring Air Quality Index (AQI) for the development of environmental impact assessment for building construction projects in Coimbatore city and to compare the measured values with standard values. This study also examines the variation of ambient air quality with different climatic conditions. The quality of air was resolute based on National Ambient Air Quality Standards (NAAQS). This study was carried out based on measuring four major air pollutants such as PM_{10}, $PM_{2.5}$, SO_2 and NO_2 with various ambiance conditions during November 2015 to October 2016. Respirable Dust Sampler (RDS) and Fine Particulate Sampler (FPS) were used to determine PM_{10} and $PM_{2.5}$ respectively. Foundry clusters, industrial units and automobile emissions are the key pollution sources which determine the ambient air quality of the city. Among the diverse climatic conditions, summer exhibits high pollution level in the air while monsoon exhibits low pollution level. The results also reveal that the industrial zones experience more pollutants followed by commercial and residential zones. As per the AQI classification, all locations are coming under the moderate category except industrial zones which require rigid control measures to reduce the particulate matters in the air.

INTRODUCTION

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 a person or with reasonable use or enjoyment of property". Many developmental activities will add air pollutants to the atmosphere or alter the weather and climate which may result in adverse effects on people, plants, animals, materials, buildings, etc. These effects can occur at local, regional or even global scale. The scientific and methodological approaches for evaluating the impacts of any new construction project activity on the air environment are discussed based on the air quality index calculations. With rapid urbanization, economic development, increase in commercial, construction and industrial activities during the last decades have increased the vehicular population by several folds in and around the city of Coimbatore. Vast quantities of dangerous waste products have been released into the atmosphere; whereas the rate of ejection is beyond the limits of natural cleansing ability and 'buffering capacity' of the atmosphere (Elsom 1992). The manmade activities have been responsible for these emissions. The rates of acid precipitation, global warming, the presence of a number of ozone holes, and in terms of human health, a rise in respiratory disorders continue to cause alarm. The air pollution level of Coimbatore city in Tamil Nadu is increasing year after year. The impacts of health hazards due to air pollution have been studied extensively. Many studies have been reported to explain the effect of different levels of air pollution, pollutants and potential parameters like temperature and humidity. Change of climate influences the air pollution and major air pollutants such as SO_2, NO_2, CO and particulate matter (Dockery et al. 1982). Various studies have reported a strong relationship among weather conditions that affect the concentrations of the particulates. 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 (Banerjee & Pandey 1989). NO_2, SO_2 and suspended particulate matter are major air pollutants in India, which are present in the air due to burning of fossil fuels and affect the living beings. Emissions from automotive vehicles are the main cause of air pollution in the highly populated areas and accounts for 60-70 % of the pollution in the urban environment (Samoli et al. 2005).
The effect of particulates is based on their geometry and concentration. The air quality index is used to assess the overall environmental condition and its trend with a spe-

Table 1: National ambient air quality standards.

Pollutants	Time Weighted Average	Concentration in ambient Air	
		Industrial, Residential & other	Ecologically Sensitive Area (Notified by GoI)
Particulate matter size less than 10 µm or PM_{10} (µg/m^3)	Annual*	60	60
	24 Hours**	100	100
Particulate matter size less than 2.5 µm or $PM_{2.5}$ (µg/m^3)	Annual*	40	40
	24 Hours**	60	60
Sulphur Dioxide (SO_2), (µg/m^3)	Annual*	50	20
	24 Hours**	80	80
Nitrogen Dioxide (NO_2), (µg/m^3)	Annual*	40	30
	24 Hours**	80	80

*Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals. **24 hourly or 8 hourly or 1 hourly monitored values as applicable shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits, but not on two consecutive days of monitoring.

Table 2: Name of the ambient air measuring locations.

Location	Zone Type	Code	Direction	Details
SIDCO Industrial Estate	Industrial	AQL1	S	It is an industrial area which has a number of small scale industrial units. Combustion activities, many industrial activities are the major source of air pollution in this area.
Lawley Road	Commercial	AQL2	W	Typical settlement which has a mix of residential, commercial and many other activities. Heavy traffic on narrow roads leads to jam and generation of air pollution.
Peelamedu	Mixed	AQL3	E	Type of settlement which has a mix of residential, institutional and commercial activities. Heavy traffic on roads leads to jam and generation of air Pollution during peak hours
Saravanampatti	Residential	AQL4	N	It is essentially a institutional area but due to expansion of city there is an increase in traffic density on the road of this area. Over the period of time the area has witnessed the increase in commercial activities as well.

cific standard. It is based on the lines of health index and measured by the degree. 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 November 2015 to October 2016 from four different areas for different climatic conditions.

Air pollution in environmental impact assessment: The human activities that have led to deterioration in air quality were mainly confined to the developmental projects, primarily to the operational stage and to aggregations of such projects that cause cumulative effects. Environmental impact assessment (EIA) has recently been acknowledged and used as an important planning and development tool (Wathern 1988). EIA allows the most likely consequences of a developmental project to be anticipated, prior to the approval, to commence any works on it (Afroz et al. 2003). Thus, it may be possible to mitigate the most polluting projects, to decide that they should not proceed, to approve their development at a more appropriate location, or to develop them in some modified way to reduce the impacts upon atmospheric quality.

MATERIALS AND METHODS

Study area: Coimbatore is known as Manchester of South India located in the western part of Tamil Nadu. An estimated average of 1,40,000 vehicles are moving and about 1.7 million people are living. The city has around 30,000 small and medium industries and large textile units. Coimbatore has also engrossed 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 favorable atmosphere for the expansion of new industries and growth pattern, this city has more potential for air pollution. Table 2 gives the various locations in Coimbatore city selected for the study, where the air samples were collected.

Sampling locations: Sampling locations were selected in

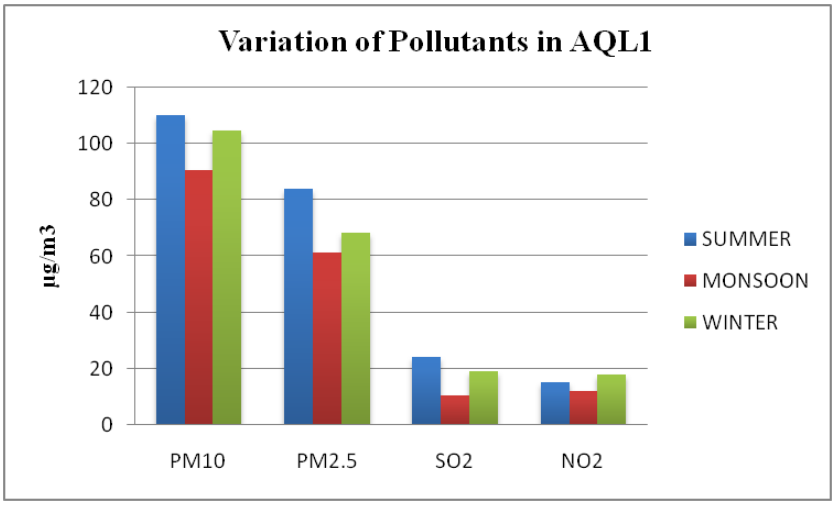

Fig. 1: Variation of pollutants in AQL1.

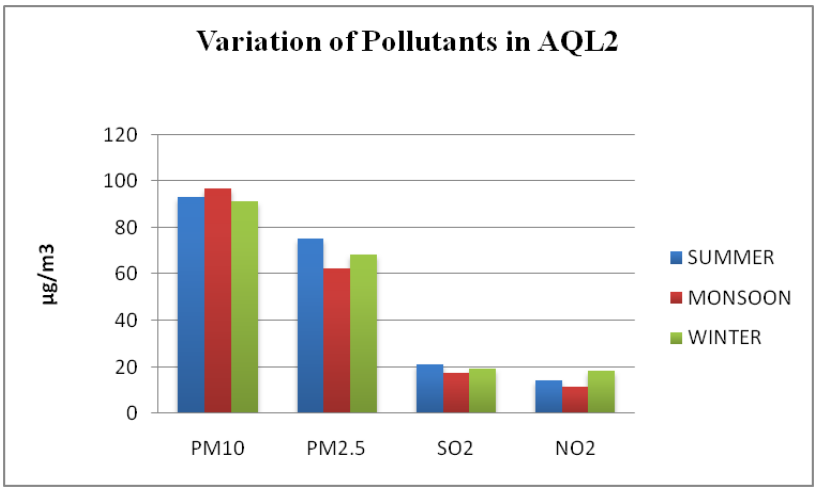

Fig. 2: Variation of pollutants in AQL2.

accordance with the population density, commercial cum traffic and other industrial activities. Heavy traffic volume on roads, commercial belts and industrial activities contribute to the generation of highly toxic particulate matter in the surrounding air (Bhuyan & Samantray 2010). Four air quality sampling locations representing different activity areas, i.e., one each in industrial, residential and other area (commercial) were selected for the study as summarized.

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 were also noted.

Method of sampling for particulate matter: Suspended particulate matter (SPM) of size above 10 µ present in ambient air was 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 (Horaginamani & Ravichandran 2010). The mass concentration of SPM was calculated by measuring the weight of collected matter in known volume of air sampled. The final results are expressed in terms of µg/m^3.

Sulphur dioxide: The determination of SO_2 was done by modified West and Gaeke method (Kavuri & Paul 2013). In this method, SO_2 is absorbed from a known quantity of air in a solution of sodium tetra chloromercurate to form stable dichlorosulphito- mercurate mixture. Formaldehyde is then used for reaction and the color intensity is estimated photometrically.

Nitrogen dioxide: Jacob Hochheiser method was used to

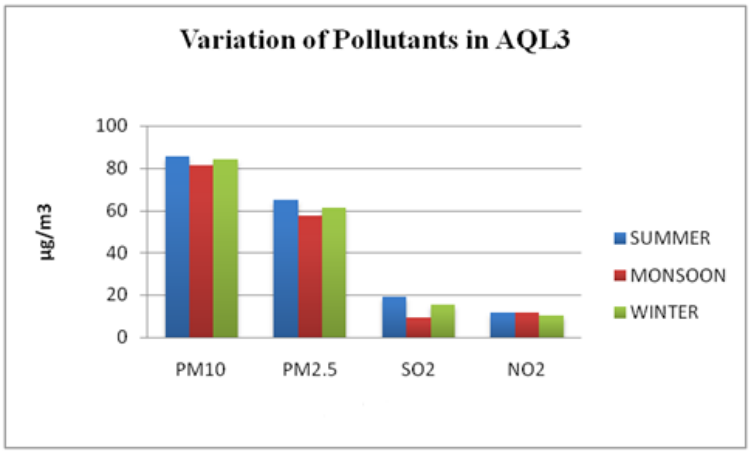

Fig. 3: Variation of pollutants in AQL3.

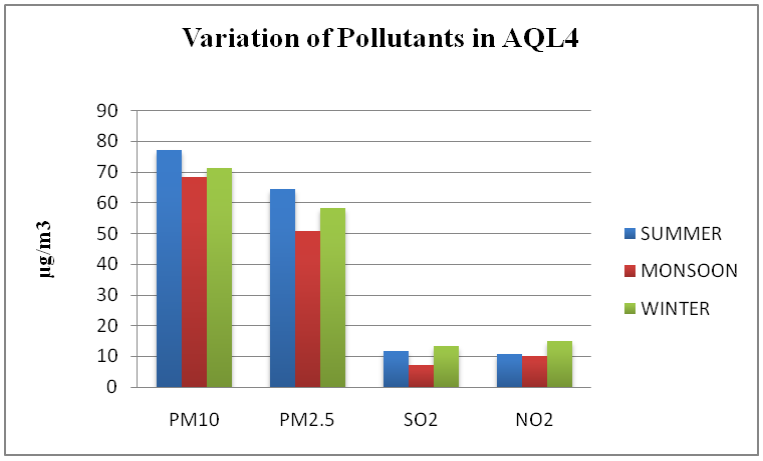

Fig. 4: Variation of pollutants in AQL4.

estimate concentration of NO_2 in the air (Mamta & Bassin 2010). Nitrogen oxides are collected from sodium hydroxide solution to form stable sodium nitrite. The ion of nitrite produced is measured photometrically.

Air quality index: An air quality index (AQI) is an environmental index which describes the overall atmospheric air status (Mamta & Bassin 2010). 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 was used to arrive at the AQI values of the selected locations under study. Higher AQI value refers higher status of air pollution and greater effect on the health.

$$AQI = ¼ (IPM_{10}/SPM_{10} + IPM_{2.5}/SPM_{2.5} + ISO_2/SSO_2 + INO_2/SNO_2) \times 100$$

Where; IPM_{10}, $IPM_{2.5}$, ISO_2, INO_2 are the individual values of PM_{10}, $PM_{2.5}$, SO_2 and NO_2 respectively obtained during sampling. SPM_{10}, $SPM_{2.5}$, SSO_2, SNO_2 are the atmospheric air quality standards prescribed by CPCB (Central Pollution Control Board).

RESULTS AND DISCUSSION

In the present study, the concentrations of PM_{10}, $PM_{2.5}$, SO_2 and NO_2 were measured in selected four locations in Coimbatore city. Tables 4-6, provide the climatewise air quality status for various parameters.

The variation of pollutants in location 1 (AQL1), which represents industrial area, are shown in Fig. 1. PM_{10} exceeds the recommended limits in all the climate conditions and other parameters are within the standard limits.

Fig. 2 shows the variation of pollutants in location 2 (AQL2) which represents commercial area. The results revealed that all parameters are within the standard limit, except PM_{10} which is slightly above the standard level.

Table 3: Air quality categories based on air quality index.

Air Quality Index	Levels of Health Concern	Colour Code
0 to 50	Good (Minimal Impact)	
51 to 100	Moderate (Minor Breathing Discomfort to sensitive people)	
101 to 150	Unhealthy (Breathing Discomfort to the People with Lungs and heart Diseases	
151 to 200	Unhealthy (Respiratory Illness)	
200 and above	Hazardous (Affects healthy people and seriously impacts those with existing diseases)	

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

Location Code	Summer			
	PM_{10}	$PM_{2.5}$	SO_2	NO_2
AQL1	110.2	84.1	24.3	15.4
AQL2	93.2	75.3	21.2	14.1
AQL3	85.6	65.2	19.1	11.9
AQL4	77.3	64.6	11.8	10.9

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

Location Code	Monsoon			
	PM_{10}	$PM_{2.5}$	SO_2	NO_2
AQL1	90.5	61.5	10.6	12.1
AQL2	96.8	62.3	17.2	11.5
AQL3	81.2	57.5	9.4	11.6
AQL4	68.3	50.9	7.3	10.2

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

Location Code	Winter			
	PM_{10}	$PM_{2.5}$	SO_2	NO_2
AQL1	104.6	68.2	19.1	18.1
AQL2	91.3	68.6	19.4	18.3
AQL3	84.2	61.2	15.3	10.2
AQL4	71.2	58.3	13.2	15.1

Table 7: Locationwise average AQI.

Location Code	AQI
AQL1	65.51
AQL2	62.67
AQL3	54.53
AQL4	49.34

Figs. 3 and 4 show the variation of air pollutants in the residential areas (AQL3, AQL4) 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 gives 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.

CONCLUSION

The present research work was carried out to estimate the condition and quality of the air by measuring the air quality index (AQI) at four different zones of Coimbatore, Tamil Nadu for the development of environmental impact assessment (EIA) reports for the new infrastructural projects in Coimbatore city. The emissions from foundry clusters and automobiles 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 the monsoon, followed by winter and higher in summer. The 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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