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Air Quality Assessment and Air Quality Index of Dindigul Town (Tamil Nadu), India– A Case Study

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Abstract: The present study report the analysis of ambient air quality in Dindigul Town Tamil Nadu employing the Air Quality Index (AQI) .The 24 hourly average concentrations of four major criteria pollutants viz., suspended particulate matter (SPM),Respirable Suspended particulate matter(RSPM),Sulphur dioxide(SO_2)and Nitrogen dioxide (NO_2) at three different locations in Dindigul town (Tannery-Thomaiyarpuram-by pass),(Commercial cum traffic-Dindigul bus stand) and (Residential-Lakshmanapuram) have been considered for this analysis .The AQIs were calculated using IND-AQI procedure .There are many different air quality indexes ,which represent the global urban air pollution situation. Although the index proposed by USEPA gives an overall assessment of air quality, it does not include the combined effects (or synergistic effects) of the major air pollutants. So an attempt is also made to calculate the Air Quality Index based on Factor Analysis (NAQI)which incorporates the deficiencies of USEPA method .The seasonal air quality indexes were calculated by using both these methods .It is observed that a significant difference exists between NAQI and EPAQI .However, NAQI followed the trends of EPAQI when plotted against season .The suspended particulate matter mainly responsible for maximum AQI value in all three sites .The NAQI value ranking higher at traffic and tannery site during summer and winter season .Similarly the EPAQI ranking shows higher ranking at (Commercial cum traffic- bus stand) at both seasons .It is well clear that Commercial cum traffic and tannery area are found to be unhealthy and the higher ranking showed the increased pollution levels and worsening of the air quality.
Keywords : Principal Component Analysis (PCA), Ranking, Ambient Air Quality, Air Pollution, Air Quality Index, SO_2, NO_2, SPM, RSPM, IND-AQI, NAQI, EPAQI, USEPA.

Introduction

The urban population is exposed to higher levels of SO_2 and NO_x due to urbanization and industrialization, which lead to formation of SO_4^{2-} and NO_3^- aerosols. Concentrations of ambient air particulates have been found to be associated with a wide range of effects on human health[9,14,35,44]. Monitoring of air pollutants is a prerequisite to air quality control. Their impact on the chemical composition of plants is often used as an indicator and a tool for monitoring environmental pollution[1,8,21,28,29,31].

Air pollution is a well –known environmental problem associated with urban areas around the world .Various monitoring programme have been under taken to know the quality of air by generating vast amount of data on concentration of each air pollutant such as SPM,RSPM,NO_X,SO_2 in different parts of the world .The large data often do not convey the air quality status to the scientific community ,government officials ,policy makers and in particular to the general public in a simple and straight forward manner. This problem is addressed by determining the Air Quality Index(AQI) of a given area .AQI, which is also known as Air Pollution Index (API)[25,26,39,41] or pollutant standards index (PSI)[13,27] has been developed and disseminated by many agencies in U.S, Canada ,Europe, Australia ,China ,Indonesia ,Taiwan[4,5]. 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[25,41]. In most elaborate form, it combines many pollutants concentrations in some mathematical expression to arrive at a single number for air quality.

AQI is an integral part of the Environmental Quality Index (EQI), which was developed and used by National wild life federation of U.S in late 1960s[18]. In 1971 the EQI, with a numerical index scale from 0 to 100(0 for complete environmental degradation and 100 for perfect environmental conditions), had seven components : soil, water, air , living space , minerals , timber and wild life. These indexes were index of specific pollutants (eg., SPM,RSPM,NOX,SO_2 and coefficient of haze); Index of Inter-Urban Air Quality and Index of industrial emission (by taking the total emission and population of the area).In 1976 the USEPA established PSI which rated air quality from 0-500 with 100 equal to National Ambient Air Quality Standards (NAAQS) .The daily PSI is determined by the highest value of one of the five main air pollutants ; PM_{10},O_3, SO_2, CO and NO_2[11,12]applied factor analysis approach to find environmental index for Taiwan. Here, he compared the air quality index based on factor analysis method and Pollution index method. The ratings (or trends) obtained by both these methods are exactly same, but the AQI based on factor analysis shows a wider range which indicates that it is a better approach. Bezuglaya et al[3] developed an integral air pollution index (IAPI), which is the sum of individual air pollution indexes calculated by normalizing the pollution concentrations to maximum permissible concentrations (MPC).Since the main objective of AQI is to measure the air quality in relation to its impact on human health, the Environmental Protection Agency (EPA) of U.S revised the previous method to calculate daily AQI in 1999. The EPA method is based on concentrations of five criteria pollutant; Carbon monoxide (CO), Nitrogen dioxide (NO_2).Ozone (O_3), Particulate matter (PM) and Sulphur dioxide (SO_2).The concentrations values are converted into numerical indexes .The overall AQI is calculated by considering the maximum AQI among the monitored pollutants corresponding to a site or station associated with various health messages[32 – 34].

But it was found that this index suffered from eclipsing effect, i.e., when one pollutant exceeds its standards without the index exceeding its critical value[41]. Further, it was observed that on more than 90 percent of time the index estimated that the air quality falls under acceptable limits though the air quality standards for some pollutants was violated .The Maximum Operator Concept (MOC) , which is generally used by the EPA of U.S to calculate EPAQI, is suggested to overcome this problem. The MOC only considers the maximum value of any of the sub –indexes to define the overall AQI. This method has the following limitations . First, it discards the values of the other sub-indexes and harmful levels associated with other pollutants[30]. Second, the index does not include the additive or synergistic effects of pollutants together on the human health .In addition to the above limitations, the other drawbacks pertaining to the EPA method are first , the break points for calculating the index value for NO_2concentrations less than 0.65 ppm is not defined .This deficiency is also associated with troposphere ozone concentrations . Second, the sub –index describes the pollution level of the pollutant on an ordinal scale .This same scale is used for the finding the aggregate index. So the severity of the pollution level described by the aggregate index is not linear .Third, a greater part of the world is not able to adopt AQI system mainly because the lack of $PM_{2.5}$ measurement capability[5]. To address the above short comings, we propose an AQI based a simple statistical approach. The pollutants emitted from vehicular motors and industries include SO_2, NO_x SPM and RSPM. These pollutants have in varying degrees, harmful effect and potential danger to the human health by direct inhalation or other ways of infection[24,32,34,42].

During the last 20 years there is a steep increase in the vehicular population in TamilNadu which has contributed to majority in the air pollution emissions. Variety of pollutants are emitted into the atmosphere by natural and anthropogenic sources, of which particulate matters, sulphur oxides and oxides of nitrogen are having the significant role and increasing impact on urban air quality. Therefore an attempt was made to represent the overall air quality in the form of Air Quality index (AQI). AQI is a tool, introduced by Environmental Protection Agency (EPA) in USA to measure the levels of pollution due to major air pollutants .In the present study the AQI was calculated using IND-AQI specified by Sharma et al[37,38]. The study has been made to monitor the ambient air quality of the Dindigul Town to assess the pollution load of the area for planning the environmental management to abate and control the air pollution apart from a discussion of the various air pollutants and their implications .Therefore an attempt has been made to calculate a New Air Quality Index (NAQI) which is based on the factor analysis technique assisted by principal component analysis

(PCA).The details of materials and methods , result and discussion and conclusions are given in the subsequent sections

1. Materials and Methods

Dindigul is the interior region of Tamil Nadu. It lies on the banks of Kudavanar River. The total landscape of Dindigul is 6058 Sq Km. The urban population is 3,76,445. Inspite of its geographical location there are about 110 tanneries both registered and non-registered in and around Dindigul. Dindigul is noted for its locks. Also iron safe of good quality and durability are made here. A lock-manufacturing unit under co-operative sector is functioning here. It is one of the largest trading centers in Tamil Nadu for chewing tobacco and Roja supari which are produced in this town. They are being sent to various places in and around Tamil Nadu. Dindigul is flourishing with handloom industry at Chinnalapatti, which is located at 11 Km away from Dindigul on the Madurai – Dindigul road.

1.1 Air Quality Monitoring

Monitoring in Dindigul town was carried out at three air quality monitoring sites namely industrial (Thomaiyar puram by pass), commercial cum traffic (Dindigul Bus stand) and residential (Lakshmanapuram). Sampling was carried out at three different locations using High Volume Samplers (HVS) and Respirable Dust Samplers (RDS). The frequency of the sampling was once in a month in a year. The collected samples were analyzed for various parameters using standard methods prescribed by Central Pollution Control Board (CPCB)[6,7] and originally described by APHA[2]. Particulate matter that is SPM and RSPM were estimated by gravimetric method. A known amount of air is drawn through reweighed glass fiber filter paper, GF/A at a flow rate of 0.8-1.3 m^3/min on 8 hourly bases for 24 hours. Gaseous pollutants namely SO_2 and NO_2 were collected on four hourly bases for 24 hours by drawing air flow of 1L/min and were analyzed by west and Geake and Jacob and Hochheiser method respectively. Concentrations of the pollutants were measured in micrograms/cubic meter ($\mu g/m^3$). In the present study the AQI was calculated using IND-AQI. The index has been developed based on the dose-response relationship of various pollutants. The major air pollutant, which could cause potential harm to human health has been included are SO_2, NO_2, SPM and RSPM.

1.2 Exceedence Factor

The Air Quality of different sampling stations at Dindigul town with respect to criteria pollutants such as SO_2, NO_x, SPM and RSPM has been compared with the respective NAAQS and has been categorized into four broad categories, based on a Exceedence Factor (EF)[6,7] .EF is calculated as follows

Exceedence Factor = (Observed annual mean concentration of criteria pollutant)/ (Annual Standard for the respective pollutant and area class)

Table1 The four Air Quality Categories are given below

Critical Pollution(C)	When EF is more than 1.5
High Pollution(H)	When EF is between1.0- 1.5
Moderate Pollution(M)	With and EF between0.5- 1.0
Low Pollution(L)	Where the EF is less than 0.5

1.3Air Quality Index by using EPAQI

The AQI measures daily pollution index of the pollutants for which EPA has established National Ambient Air Quality Standards (NAAQS).The index combines the NAAQS with an epidemiological function to determine a descriptor of human health effects due to short-term exposures (24 hour or less) to each pollutant[13,11] .The index for a pollutant is calculated using the mathematical expression[12].

Table-2 Sub Index and Break Point Pollutant Concentration For Indian Air Quality Index (IND-AQI)

Sub-Index	Category	Pollutants (µg/m³)			
		SO_2	NO_X	SPM	RSPM
		24-h_{avg}	24-h_{avg}	24-h_{avg}	24-h_{avg}
0-100	Good	0-80	0-80	0-200	0-100
101-200	Moderate	81-367	81-180	201-260	101-150
201-300	Poor	368-786	181-564	261-400	151-350
301-400	Very poor	787-1572	565-1272	401-800	351-420
401-500	Severe	>1572	>1272	>800	>420

The concentrations of the four pollutants are used to calculate the index, although desirable. The index is so designed that as the minimum, three pollutants SPM, SO_2 and NO_2 are sufficient to calculate the index. The method involved formation of sub indices for each pollutant and aggregation of sub-indices. Table-2 shows the linear segmented relationship for sub-index values and the corresponding pollutant concentrations that are calibrated to Indian conditions[36 – 38]. The mathematical equations for calculating sub-indices were developed by considering health criteria as shown Table-2.

$$IP = \frac{(1H1 - 1LO)}{(BPH1 - BPLO)}(CP - BPLO) + 1LO \text{.......eqn (1)}$$

Where IP is AQI for pollutant “P” (Rounded to the nearest integer), CP the actual ambient concentration of Pollutant “P”, BPHI the upper and break point concentration that is greater than or equal to CP, BPLO the lower end break point concentration that is less than or equal to CP, ILO the sub index or AQI value corresponding to BPLO, IHI the Sub index or AQI value corresponding to BPHI in Table- 2. The indexes for each of the pollutants NO_2,O_3,PM_{10},CO and SO_2 were obtained from equation (1) using their respective break points and associated AQI values[12] .Having calculated IP of each pollutant ,the EPAQI is evaluated by considering the maximum index value (IP)of the single pollutant. Mathematically, it is expressed as

EPAQI =Max $_{IP}$.

1.4 New Air Quality Index by Factor Analysis (NAQI)

In factor analysis, we have used the technique of Principal Component Analysis (PCA).The basic purpose of PCA is to account for the total variation among the “n” number of subjects (variables) in 3-dimensional space by forming a new set of orthogonal and uncorrelated composite variates. Each member of the new set of variates is a linear combination of the original set of measurements[17,23].The linear combinations are generated in such a manner that each of the successive composite variates will account for a smaller portion of the total variation. The first composite (principal component) will have the largest variance; the second will have a variance smaller than the first but larger than the third, and so on. If first few principal components (or, eigen vector –eigen value pairs) account for more than 60%of the total variance, then there is hardly any requirement in taking more principal components (PCs)[10,16,19] to compute the composite over all Air quality index .The higher order Principal Components (PCs) explain only minimal amounts of total variance and are therefore, treated as noise[10,19,20,40].

2-Results and Discussion

2.1Seasonal Variation of Air Pollutant Concentration during different Season

Table-3 show that the average concentration of SO_2 in the winter season at tannery, commercial cum traffic area and residential area are 11.4, 15.0 and 14.2 µg/m³ respectively. Similarly in the summer season it was analyzed as 9.5, 18.7 and 9.9 µg/m³ respectively. The NO_2 concentration for winter season at tannery, traffic cum commercial and residential area is 32.0, 35.6 and 20.0 µg/m³ respectively. In summer season, NO_2 concentration was found to be 33.3, 29.7 and 14.7 µg/m³ respectively. During winter season at three different sampling sites, SPM concentration was found to be 111.2, 158.4 and 98.0 µg/m³ respectively. Similarly during summer season it was found 99.4, 147.6 and 65.5 μg/m^3 respectively. RPM concentration in the urban town of Dindigul at Tannery, commercial cum Traffic area and residential area during winter season was found to be 47.0, 66.5 and 50.2 μg/m^3 respectively. During summer season it has been found as 42.5, 53.1 and 42.1 μg/m^3 respectively.

Table-3 Seasonal Variation of Air Pollutant Concentration in Dindigul Town

Parameters	Seasons	Tannery area	Commercial cum Traffic	Residential area
SO_2	Winter	11.4	15.0	14.2
	Summer	9.5	18.7	9.9
NO_X	Winter	32.0	25.6	20.0
	Summer	33.3	29.7	14.7
SPM	Winter	111.2	158.4	98.0
	Summer	99.4	147.6	65.5
RSPM	Winter	47.0	66.5	50.2
	Summer	42.5	53.1	42.1

From the perusal of the result it was inferred that the air pollutant concentration such as SO_2, NO_x (except industries and traffic site), SPM and RSPM has been increased during the winter season compared to the summer season. A gradual increase in concentration of NO_2 at the residential sites during winter seasons was found. At such high temperatures, more nitrogen from the air compresses and reacts with oxygen in the combustion chamber of CNG driven vehicles in comparison to petrol driven vehicle and thus produces more NO_x by Goyal[15]. The maximum pollutant concentration such SO_2, SPM and RSPM occurs during winter months and a general trend of minimum values occurs in summer season. During the summer season, frequent rains washes down the air borne particulates, therefore summer is cleaner period in the year. However summer months are calm than other months. The calm conditions facilitate more stability to atmosphere and results in slow dispersion of pollutants which leads to higher concentrations of pollutants in the ambient air.

2.2 Results of Exceedence Factor

The Air Quality status of the study area based on the exceedence factor SO_2, NO_X, SPM and RSPM is shown in the Table 4

Table 4 Exceedence Factor (EF) for the Air Pollutant of Dindigul Town

Pollutant	Seasons	Tannery	Traffic	Residential
SPM	Winter	0.2224	0.3168	0.49
	Summer	0.199	0.295	0.328
RPM	Winter	0.3133	0.443	0.502
	Summer	0.2833	0.354	0.421
SO_2	Winter	0.0905	0.125	0.178
	Summer	0.0792	0.1558	0.124
NO_X	Winter	0.2667	0.2133	0.25
	Summer	0.2775	2.475	0.1837

The exceedence factor calculated for the different sampling sites tannery, commercial cum traffic and residential area during summer and winter were found to be less than 0.5.It was at low pollution category (L).The low pollution category (L) has a pristine air quality and such areas are to be maintained at low pollution levels by adopting preventive and control measures.

It is obvious from the categorization table 8 that the locations in either of the first two categories are actually violating the standards, although with varying magnitude .Those, falling in the third category are meeting the standard as of now, but likely to violate the standards in future, if pollution continues to increase and is not controlled .However, the locations in low pollution category have a rather pristine air quality and such areas are to be maintained at low pollution level , by way of adopting preventive and control measures of air pollution[7].

2.3 Results of AQI

Data obtained from monitoring of ambient air at three different sampling sites such as Tannery, commercial cum Traffic and residential sites is used to calculate the sub-indices for critical parameters. The calculated AQI values for 24 hourly averages SO_2, NO_2, SPM and RSPM concentrations are categorized as good and good to moderate during the study period (summer and winter) at all the three sites. The Air quality index were calculated criteria pollutant SO_2, NO_2, SPM and RSPM using IND-AQI procedure. AQI calculated for SO_2, NO_2, SPM and RSPM during winter and summer season were found to be under the good category. The AQI calculated for SPM was found to be good to moderate category. It was also found out at commercial cum traffic site IND-AQI for SO_2 pollutant was found to be nearly equal to 200 which indicate the traffic site was moving towards poor category that is severe air pollutant.

Table-5 Indian Air Quality Index of SO_2, NO_X, SPM and RSPM at Different Sampling Sites at Different Sites at Different Seasons

Sampling sites	Different season	SO_2	NO_2	SPM	RSPM
Tannery	Summer	11.88	41.63	124.25	53.13
	Winter	14.25	40.0	139.0	58.75
Traffic	Summer	23.38	37.13	184.5	66.38
	Winter	18.75	32.0	198.0	83.13
Residential	Summer	12.38	18.38	81.88	52.63
	Winter	17.75	25.0	122.5	62.75

2.4 Results of New Air Quality Index(NAQI)

Set the matrix X present the data set of contents of air pollutant in ambient air, X= (C_{ij}), where C is the Concentration of air pollutant in ambient air and i is the different air pollutant, i∑ (SO_2, NO $_X$, SPM and RSPM), j is the sample numbers j∑ (1, 2….6). The results of PCA was shown in Table 8.During the winter season the first two Principal Components (PCs) account for 99.99% of the total variance .They can present in the ambient air pollutant levels in study area .The first Principal Components account for 65.48% and second Principal Components (PCs) 34.51%.The values of these two Principal Components can be presented by the concentration of air pollutant in the ambient air and the Eigen vectors of the PCs is given in equation 2and 3.

Z_1= [0.489×C_{SPM}+0.591C_{RSPM}+0.573C_{SO2}+ (-0.289) C_{NOX}]….. (2)

Z_2= [0.520× C_{SPM}+0.247C_{RSPM}+ (-0. 320) CSO_2+ 0.75C_{NOX}]….. (3)

Where Z_1 and Z_2 are the values of the first two PCs respectively, C_i i∑(SO_2, NO $_X$, SPM and RSPM),is the concentration of air pollutant in the ambient air in order to get the comprehensive pollution level of air pollutant of different samples the values of Z_1 and Z_2 should be weighted sum by each Eigen values of their following will take sample 1 (S_1) as an example to explain the computational process of comprehensive pollution by Principal Component Analysis.

Table-6 The results of Principal Component Analysis during winter season.

	Eigen Values			Eigen Vectors		
	Eigen value	Proportion	Cummulative	Air Pollutant	Principal 1	Principal 2
1	2.619	65.481	65.481	SPM	0.489	0.520
2	1.380	34.509	99.89	RPM	0.591	0.247
3				SO_2	0.573	-0.320
4				NO_x	-0.289	0.75

The values of $Z_1$and Z_2 of S_1 (Z_1 S_1 and Z2 S_1) can be calculated by equation 2 and 3 and the concentration of pollutant in ambient air which is Z_1 S_1 =79.95 and Z_2S_1 =73.815, respectively and then comprehensive pollution level of air pollutant in S_1 can be obtained which is

$PCAS_1$= [Z_1 S_1×2.619/2.619+1.380]+ [Z_2 S_1×1.38/2.619+1.380]=77.88

Similarly comprehensive pollution level of pollutant of ambient air for other sampling sites was calculated by this procedure. The results of Principal Component Analysis during summer season is given in Table 7

Table7 The results of Principal Component Analysis during summer season.

	EigenValues			EigenVectors		
	Eigen value	**Proportion**	**Cummulative**	**Air Pollutant**	**Principal 1**	**Principal 2**
1	3.029	75.715	75.715	SPM	0.580	0.497
2	0.328	8.197	83.912	RPM	0.556	-0.399
3				SO_2	0.530	-0.446
4				NO_x	0.271	0.628

The New Air Quality Index by the PCA method was determined for the ambient air pollutant during winter and summer season by the above procedure and results were showed in the table 8.

2.5 Seasonal variations of EPAQI and NAQI

The variations of NAQI and EPAQI with respect to different seasons and different sampling are shown in the Fig1. A perusal of these graphs reveals that NAQI follows almost a similar trend as EPAQI for winter and summer seasons.

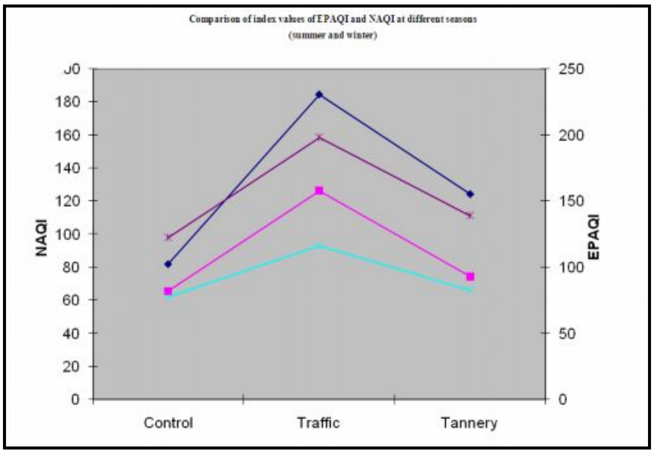

Fig-1

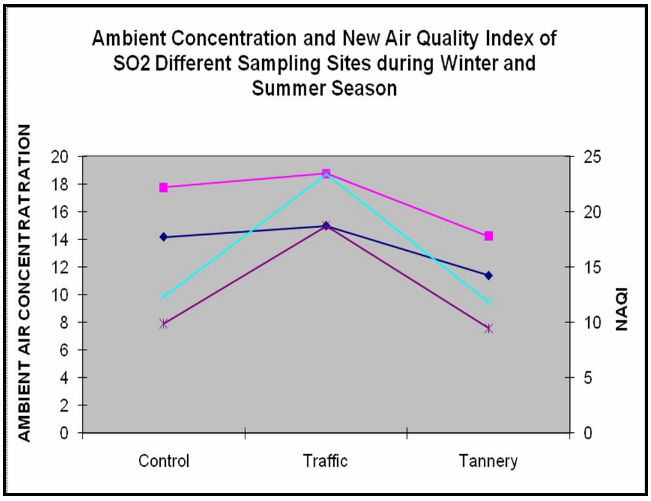

Fig-2

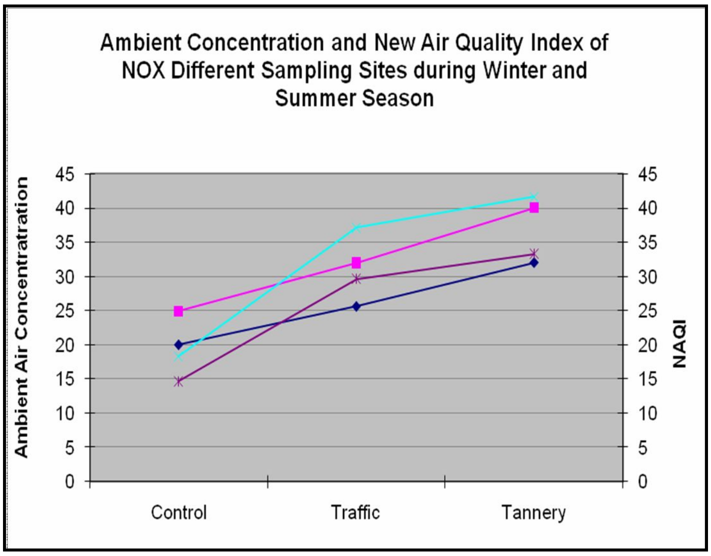

Fig-3

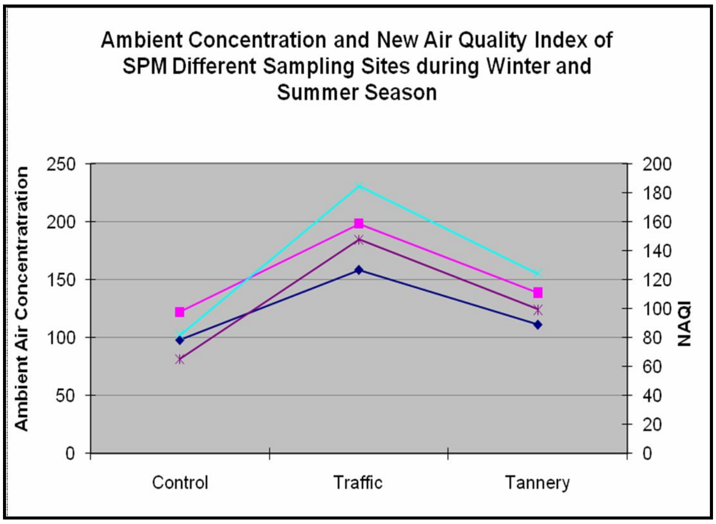

Fig-4

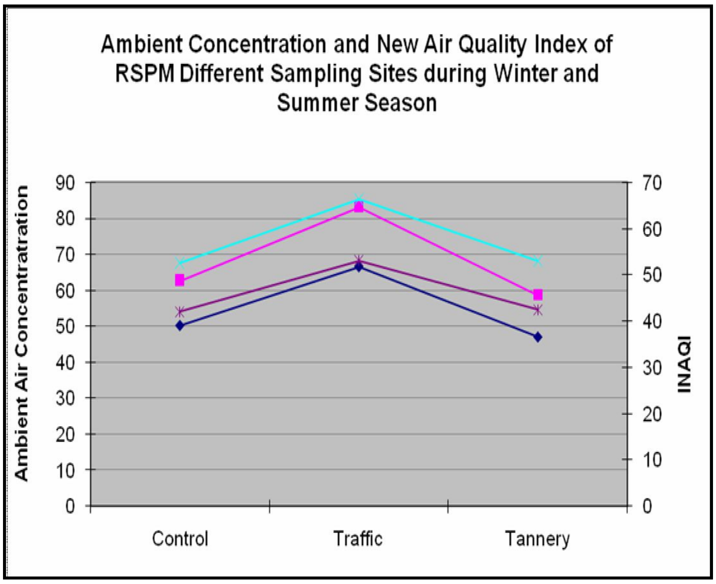

Fig-5

Table 8 Frequency of occurrence of Air Quality Categories during the day in different seasons.

Air quality categories	EPAQI values
Good to Moderate	0-100
Unhealthy	101-200
Very unhealthy	201-400
Hazardous	>400

It is clearly seen from the table 8 and fig that during the winter season all the sampling sites such as tannery, commercial cum traffic and residential area are said to be unhealthy [EPAQI (101-200)] .During the summer season tannery and traffic sites are said to be unhealthy [EPAQI (101-200)].But the EPAQI for the residential site was found to be 81.88. It means that the residential site was found to be good to moderate.

During winter season the highest NAQI value found in the commercial cum traffic site followed by tannery and residential area respectively .The highest index value during the winter season is in accordance with Varshney and Singh[43]; Kumar et al[22]. During summer the highest index value was found to commercial cum traffic area followed by tannery and residential area. During winter and season, traffic cum commercial area was found to be polluted more.

A careful examination of the trends of the EPAQI and NAQI reveals that the variations in NAQI closely follows that of EPAQI .Whereas , the magnitude of the values of EPAQI is solely determined by the maximum value of a sub index of a given pollutant. The value of NAQI takes into account the variances of concentrations in different pollutants .Incase ,where a particular pollutant is dominant (i.e., the concentration of the pollutant for exceeds the permissible standards) and it also has large variances in its concentration values , both the indexes are excepted to have higher magnitudes .Since in the present study the dominant pollutant is SPM which is associated with large variances in its concentration value , the trends of EPAQI and NAQI are similar to each other .

Table 9 Rating of different season with respect to standard NAQI

Index	Summer			Winter			Standard
	Tannery	Traffic	Residential	Tannery	Traffic	Residential	CPCB
NAQI	74.33	126.18	65.712	83.072	116.39	77.883	10.37
Ranking	3	7	2	5	6	4	1
EPAQI	124.25	184.5	81.88	139.0	198.0	122.5	73
Ranking	4	6	2	5	7	3	1

The comparison of EPAQI and NAQI value with prescribed standard limit of pollutant as per central pollution control board norms are given in table 9.Now the various seasons have been ranked in terms of standard NAQI with respect to the rank of NAQI taken as 1. An examination of NAQI value indicates the air quality is worst during the summer and winter season at traffic cum commercial site. The least NAQI value and EPAQI value were observed during summer season at residential area.

Conclusion

The overall AQI can give clear view about ambient air and the critical pollutant mainly responsible for the quality of air quality which can be easier for a common man to understand. The AQIs were calculated to assess the ambient air quality at three different sites namely the industrial, commercial and residential sites in Dindigul Town during the year 2013-2014. The AQIs were calculated according to Indian Air Quality Index (IND-AQI). The AQI study reveals that suspended particulate matter (SPM) was mainly responsible for maximum times in all sites in Dindigul Town. The majority of AQI values of SPM fall under the category of poor. Sharma et al[37] and Goyal[15] also have identified SPM as the dominant pollutant. This could be due to rapid increase in urban population, growth of vehicular population, frequent dust storms. Further, the average concentration and AQI for particulate matter shows a maximum pollutant concentration during winter months and a general trend of minimum values occurs in summer season. The proposed index (NAQI) is basically an air stress index with no established standards, i.e., the index would not show a pronounced relation to the health of the people. Therefore, it is not possible to characterize the air quality associated with values of NAQI and also draw any definitive inferences about the category of air quality as in the case of EPAQI .But it has the advantages of self consistency as it combines the synergistic effects of all the four criteria pollutants. The NAQI is very much useful in defining the status of air in relative terms. For instance if the value of NAQI has increased at a given location, it would mean worsening of the air quality and vice versa. The assessment of NAQI revealed that during winter and summer seasons, the traffic cum commercial area shows the highest ranking which show increased pollution level at this site at both seasons .These measures include use of clean fuel CNG by vehicles, closure of industrial units and encouraging people to use public transport means like high capacity buses.

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