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RESEARCH ARTICLE

Air quality index for Dindigul town

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SUMMARY: Leather industries in Dindigul town, in the state of Tamil Nadu offer a unique opportunity for the study of environmental problems. In the present study, an effort has been made to study the air quality in terms of suspended particulate matter (SPM), respirable particulate matter (RPM), sulphur dioxide (SO_2) and oxides of nitrogen (NO_x) at three different locations representing tanneries, commercial -cum-traffic and residential areas of Dindigul town bimonthly during summer and winter seasons. The present study indicated the potential source for fluctuation of SPM, RPM, SO_2 and NO_x in the study region. Air quality index (AQI) for the town had been calculated and the pollution in the town had the order of site2 > site3 > site1. The oak ridge air quality index (ORAQI) was used to evaluate the relative ranking of overall air quality at different study locations of the town. The data so obtained were discussed as to the present status of ambient air quality of the study region.

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Leather industry has been categorized as one of the highly polluting industries and there are concerns that leather making activity can have adverse impact on the environment (Kanagaraj *et al.,* 2006). Though leather tanneries ensure the economic development but certainly at the risk of environmental pollution. The continuous discharge of pollutants create a problem where nature no longer is able to disperse, absorb or dispose off unwanted residue in the natural sinks of the environment. This demands for making provision and efficient use of pollution control measures to minimize the adverse environmental impacts due to emission of pollutants from various industries.

The relationship of man with the environment is necessarily the symbiotic equilibrium between the two which must be maintained at all costs. But with rapid population growth, industrialization more and more demands are made on the limited sources of energy and materials. Rapidly growing cities, more traffic load, reliance on outdated industrial processes, growing energy consumption, lack of appropriate industrial zoning and environmental regulations and poor implementation of control measures have contributed to reduced air quality (CPCB, 1993). Poor air quality can manifest itself aesthetically (as a displeasing odour, for example) and can also result in harm to plants, animals peoples and even damage to objects. Pollution of air not only causes health effects to human beings, it also interferes with functioning of natural ecosystems.

Due to rapid industrial growth, Dindigul town became the industrial zone of Tamil Nadu. Industrial growth gradually deteriorated the environment quality of that area. Now it is high time to know the status of ambient air quality for making proper planning for present and future growth of industries. An attempt has been made to monitor the ambient air quality of the Dindigul town to asses the pollutional 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.

EXPERIMENTAL METHODOLOGY

Monitoring town, Dindigul :

Dindigul is the interior region of Tamil Nadu.

It lies on the banks of Kudavanar river. The total landscape of Dindigul is 6058 SqKm. 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 centre 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.

Sampling stations :

Monitoring was carried out at three locations in the town of Dindigul broadly classified into three main categories, tanneries, commercial cum traffic and residential. All these locations are prominent places in the Dindigul town and are typical representatives of their respective categories. The frequency of monitoring for SPM and RPM was 24 hourly and 8 hourly with respect to SO_2 and NO_x. The details of monitoring locations are given in Table A.

Collection of samples and analysis :

The samples were collected bimonthly during winter and summer seasons. The parameters monitored for ambient air were suspended particulate matter (SPM), respirable particulate matter (RPM), sulphur dioxide (SO_2) and oxides of nitrogen (NO_x). The ambient air monitoring was carried out in each station and samples were collected with the help of high volume sampler, model APM-415 of Envirotech with provisions for gaseous sampling. A brief description of the sampling and analytical procedure for ambient air quality monitoring is given below :

PM sampling :

SPM and RPM were collected using standard high volume sampler fitted with respirable dust sampler. The sampler was calibrated using orifice control root meter. The particle size of the samples collected by RDS is smaller than 10µm. The samples were collected on glass fibre filter sheets (GF/A from Whatman) continuously for 24 hour every week at three different locations at 8 hourly intervals (Singh *et al,* 2008). These samples were gravimetrically analysed according to analysis procedures recommended by TNPCB. The methodologies are given in Table B.

Sulphur dioxide (SO_2) and oxides of nitrogen (NO_x) :

Sulphur dioxide (SO_2) and oxides of nitrogen (NO_2) were collected on 8 hourly basis for 24 hour by drawing air flow at 1 L/min through potassium terachloro mercurate and sodium hydroxide as an absorbing solutions, respectively. Sulphur dioxide was determined by West – Gaeke spectrophotometric method (standard method for air sampling and analysis) and oxides of nitrogen was determined by Jacob – Hochhieiser spectrophotometric method (Katz, 1977).

The observations made during the sampling period are listed in Table C.

Table A : Sampling sites

Site No.	Site	Location description	Category
1.	Thomaiyarpuram	Tanneries, small scale industries	Industrial (tannery area)
2.	Dindigul bus stand	Traffic, hotels, shopping complex, theatre, commercial complex, market	Commercial cum traffic
3.	Lakshmanapuram	Residential areas of lower and middle classes, small shops	Residential

Table B : Monitored pollutants and the methodologies employed for ambient air quality study

Methodology	SPM	RPM	SO_2	NO_x
Indian standard No.	1S5182 P: 4-2005	1S5182 P: 4-2005	1S5182 P: 2-2001	1S5182 P: 6-1998
Sampling equipment	High volume sampler	High volume sampler	High volume sampler with impinger	High volume sampler with impinger
Duration sampling	8 hourly for 24 hour	8 hourly for 24 hour	8 hourly for 24 hour	8 hourly for 24 hour
Collection media	GF/A filter paper	Thimble	Tetrachloro mercurate	NaOH

Table C : Seasonal variations in air quality in Dindigul area in µg/m³

Parameters	Seasons	Tannery area	Commercial cum traffic area	Residential area
SPM	Winter	111.2	158.4	98.0
	Summer	99.4	147.6	65.5
RPM	Winter	47.0	66.5	50.2
	Summer	42.5	53.1	42.1
SO_2	Winter	11.4	15.0	14.2
	Summer	9.5	18.7	9.9
NO_2	Winter	32.0	25.6	20.0
	Summer	33.3	29.7	14.7

Overall difference is based on two-way ANOVA. Test was performed for comparison of all the parameters at their respective locations, where F values in ANOVA are significant. Significant difference at $\rho<0.001$ by multiple comparison tests.

Statistical analysis :

Results were statistically analyzed using two-way analysis of variance (ANOVA) (Armitage and Berry 1994). Multicomparison of analysis of variance at 99 per cent confidence interval was carried out for all the parameters at all sampling sites.

Air quality indices :

Air quality indices are tools devised to simplify interpretation of data with minimum loss of scientific information so as to provide a scale for measuring status of air pollution. Simple comparison of data with NAAQS serves the purpose to some extent, but it does very little to map periodical degradation in the air quality, particularly, if the measured values remain below NAAQS. A number of air quality indices have been formulated (Babcock, 1970; Ricci, 1979). Most of the indices take NAAQS standards as their base for devising the scale. There are few other systems, which are independent of the NAAQS and based on measuring deterioration in air quality (with due weightage to the potential capacity of pollutants to affect biophysical, health and aesthetic attributes) on an absolutely environmental quality scale and not in relation to NAAQS. Both these approaches were applied for air quality indexing of the study area.

Analysis of air pollution indices :

An environmental index is a tool that is used to report overall environmental status and trend based on a specific standard (Thomas and Ott, 1976). It has been found that the rate of progress among countries towards producing indices is highly uneven. Ambient air quality standards give an idea about the ambient air quality status. Evaluating overall air pollution due to various air pollutants is a complex understanding. It consists of an ill-defined mixture of several pollutants from different sources. Additional secondary pollutants are created in the atmosphere. Synergism can occur among certain pollutants. Despite these complexities, efforts are made to evaluate the combined effects of the individual pollutants (Behera *et al.,* 2005).

Calcultion of IPI :

For calculation of AQI, a number of equations are available in the literature. In some equations, it was assumed that all pollutions are of equal importance. In some other equation, different weightings were given for different pollutants (Vijay Ratan and Surendra Kumar 2005). For each pollutant there is individual pollutant index (I_i), which is defined as :

$$I_i = (C_i/C_s)^{ni} - - - - - 1) \qquad (1)$$

where, C is the current concentration level of a pollutant, C_s is standard for that pollutant for the same average time period and n_i is the weighting for that pollutant (n_i = 1 if all pollutants have equal importance). An individual pollutant index greater than 1 means that actual concentration level has exceeded the standard value.

Air quality indices (NAAQS dependent) :

For indexing of the air quality status, an assumption is made that all the pollutants are of equal importance. Using observed and standards values calculated the quality rating for each pollutant and the geometric mean of all the parameters give the quality index for air. Based on this assumption, the quality index was derived in the manner outlined below. The existing pollution levels of pollutants were compared with ambient air quality standards (with the standard being assumed as reference baseline for each pollutant) and then converted to the concentration of pollutants into ratio of the standard.

$$Q_i = C_i/S_i - - - - - - 2 \qquad (2)$$

where,

Q_i - Quality rating for a particular i
C_i - Concentration of pollutant i
S_i – Air quality standard for pollutant i

Air quality index (AQI) = $(Q_1 x\ Q_2 x....x\ Q_n)^{1/n}$ ....(3)

where, n-Number of pollutants considered. A typical rating scale for air quality index (AQI) is given in Table D.

Table D : Rating scale for air quality index

Index value	Remark
< 0.3	Least polluted
> 0.3-0.6	Slightly polluted
> 0.6-0.9	Moderately polluted
> 0.9-1.2	Highly polluted
> 1.2-1.5	Severely polluted
> 1.5	Extremely polluted

Air pollution index :

The air quality index is the result of acute need to reduce a large quantity of data to its simplest form, retaining all the essential information in the data (Mohanty, 1999). Thus, an index is the mean for general public to know the air quality in a simplified way. On the basis of computed air quality index (Q), the quality rating of each parameter is obtained by the following formula :

$$Q = \frac{100xO}{O_s} \quad \text{......(4)}$$

where,

q – quality ratings
O – observed value
Os – prescribed standard as permissible limit

If 'n' number of parameters is considered, the geometric mean of these 'n' number of quality ratings is found out, which is known as the overall air quality index (AQI).

Table E : Air quality categories based on air quality index

AQI	Description of ambient air quality
< 10	Very clean
Between 10 and 25	Clean
Between 25 and 50	Fairly clean
Between 50 and 75	Moderately polluted
Between 75 and 100	Polluted
Between 100 and 125	Heavily polluted
Beyond 125	Severely polluted

For urban areas in India, an equation has been developed to determine AQI. In India, generally four pollutants [SO_2, NOx, SPM, and respirable particulate matter, that is size less than 10µm (RPM)] are monitored continuously in urban areas. For the proposed equation, these four pollutants have been considered. Equal weightage is given to all pollutants (that is $n_i = 1$). The scale recommended by ORNL is selected.

At a level corresponding to unpolluted background the AQI is taken as 10 and at a level equal to standard, the AQI is taken as 100 (that is an AQI value of 10 describes the background level and of 100 is the equivalent of all pollutants concentrations reaching the national ambient air quality standards). The background levels for the four pollutants considered are: NO_2–0.001 ppm, SO_2-0.0002 ppm, SPM - 37µg/ m^3, and RPM – 14 µg/ m^3.

The national ambient air quality standards for these pollutants in India are given in Table A (CPCB, 2004). The equation developed for calculation of AQI is as follows :

$$AQI = \left(13.7 \sum_{i=1}^{4} \frac{c_i}{s_i}\right)^{1.15} \quad \text{......(5)}$$

There are several methods and equations used for the determination of the Air Pollution Indices (API). In this study, oak ridge air quality index (ORAQI) has been used for the relative ranking of overall air quality status at different study locations (Ghose, 2004: Inhabier; 1974). ORAQI can be calculated using the following formula:

$$ORAQI = 9.61x\left(\frac{C_{spm}}{S_{spm}} + \frac{C_{SO_2}}{S_{SO_2}} + \frac{C_{NO_x}}{S_{NO_x}}\right)x1.37 \quad \text{......(6)}$$

where, C, Concentration of i^{th} pollutant, and S, Standard of i^{th} pollutant. The relative scale of API is given below:

Table F : Relative scale of air quality index

Index value	Remarks
<25	Clean air
26.50	Light air pollution
51-75	Moderate air pollution
76-100	Heavy air pollution
>100	Severe air pollution

The AQI values obtained by equation 5 are compared with ORAQI equation modified for the 4 pollutants in the present study, keeping the exponent same as 1.37. The modified ORAQI equation has been developed as:

$$\text{Modified ORAQI} = \left(7.21 \sum_{i=1}^{4} \frac{c_i}{s_i}\right)^{1.37} \quad \text{......(7)}$$

On the basis of AQI values, the ambient air quality status is described in the present study as follows:

Table G: Ambient air quality status for modified ORAQI values

Modified ORAQI values	Ambient air quality status
<20	Excellent
20-30	Good
40-59	Fair
60-79	Poor
80-99	Bad
100 and above	Dangerous

Experimental Findings and Discussion

The individual pollutant index values for all the pollutants were calculated by equation 1, keeping n equal to unity. The AQI for all the three locations of Dindigul for the years from 2009 to 2010 has been calculated by using both proposed equation 5 and Modified ORAQI equation 7 and reported in Table 1. It was found that the AQI values obtained from equation 5 was very close to values calculated from equation 7.

Leather tannery area :

Near the tanneries, level of SPM, RPM, SO_2 and NO_x were 111.2 mg/m^3, 47.0 mg/m^3, 11.4 mg/m^3 and 32.0 mg/m^3, respectively. It was found that the level of SPM, RPM, SO_2 and NO_x were within the standards during the winter season. The individual pollutant index for SPM, RPM, SO_2 and NO_x were 0.222, 0.313, 0.095 and 0.267, respectively. An individual pollutant index is not greater than one, which implies that actual concentration level has not exceeded the standard value. An individual pollutant index for winter and summer seasons is tabulated in Table 1.

Table 1 : Individual pollutant index for the parameters during winter and summer seasons

Location	Seasons	Q_{SPM}	Q_{RPM}	Q_{SO2}	Q_{NOx}	AQI
Tanneries	Winter	0.222	0.313	0.095	0.267	0.205
	Summer	0.199	0.283	0.079	0.278	0.188
Commercial	Winter	0.792	0.665	0.188	0.320	0.422
cum traffic	Summer	0.738	0.535	0.234	0.371	0.430
Residential	Winter	0.490	0.502	0.178	0.250	0.323
	Summer	0.328	0.421	0.124	0.184	0.237

At tannery zone, the concentrations of SPM, RPM, SO_2 and NO_x during summer season were 99.4 mg/m^3, 42.5 mg/m^3, 9.5 mg/m^3 and 33.3 mg/m^3, respectively. The concentrations did not exceed TNPCB standards. During the summer season, quality rating for particular pollutant SPM, RPM, SO_2 and NO_x are 0.199, 0.283, 0.079 and 0.278, respectively. Individual index values lies below one indicating actual concentration level has not exceeded the standard value.

Air quality index calculated from individual pollutant index at the tannery area during winter and summer seasons were 0.205 and 0.188, respectively showing the rating scale as the least polluted area as the index value was below 0.3. But air quality index during the winter season was greater than the summer season. The impact of individual pollutant was more during the winter season compared to summer season.

Air quality index at the tannery area during winter was 0.205, which showed that the area was least polluted as the index value was below 0.3. The air quality index (AQI) was calculated using the formula as given below :

$$Q = \frac{100xO}{O_s} \quad \text{.........} (4)$$

The data of air quality index during winter and summer seasons are given in Table 2.

Table 2 : Air quality index during winter and summer seasons

Location	Seasons	AQI (SPM)	AQI (RPM)	AQI (SO_2)	AQI (NO_X)
Tanneries	Winter	22.2	31.3	9.5	26.7
	Summer	19.9	28.3	7.9	27.8
Commercial cum traffic	Winter	79.2	66.5	18.8	32.0
	Summer	73.8	53.5	23.4	37.1
Residential	Winter	49.0	50.2	17.8	25.0
	Summer	32.8	42.1	12.4	18.4

Air quality index calculated from the pollutants SPM, RPM, SO_2 and NO_x for the winter season were 22.2, 31.3, 9.5, and 26.7, respectively. Analyzing the air quality categories, it was found that RPM and NO_x showed fairly clean where as SPM showed clean and SO_2 implied very clean category, respectively. In the tannery area, the impact of RPM and NO_x were more compared to SPM and SO_2.

During the summer season, air quality index (AQI) from the individual pollutants SPM, RPM, SO_2 and NO_x were 19.9, 28.3, 7.9 and 27.8, respectively. Air quality index for RPM and NO_x lied between 25 and 50, which describes fairly clean ambient air quality, but AQI for the pollutants SPM and SO_2 were 19.9 and 7.9, which showed clean and very clean category respectively. Air quality index rating for winter season was greater than the summer season.

The CPCB (Central Pollution Control Board) standards of 200mg/m^3 for SPM, and 80 mg/ m^3 for SO_2 and NO_2 have been considered for arriving at the AQI (Air quality index) (Dayal and Nandini, 2000). Although ambient air quality study gives an idea about the ambient air status, it is possible to represent the same in a better way with air quality index as the commutative effect of all the pollutants and related standards can be taken into account.

The values calculated using the equation 5 for the winter and summer seasons is given in Table 3.

Table 3 : Air quality index during winter and summer seasons

Location	AQI(Winter)	AQI (Summer)
Tanneries	17.904	16.579
Commercial cum traffic	44.160	41.877
Residential	30.364	21.623

$$\mathbf{AQI} = \left(\mathbf{13.7}\sum_{i=1}^{4}\frac{c_i}{s_i}\right)^{1.15} \quad \text{...(5)}$$

Air quality index calculated from the above formula during winter and summer seasons were 17.094 and 16.579, respectively. The AQI value lied below 20 during both seasons implies excellent ambient air quality. There was not more difference in AQI value during winter and summer seasons. AQI was calculated by following the equation 6.

$$\mathbf{ORAQI} = \mathbf{9.61}\mathbf{x}\left(\frac{C_{spm}}{S_{spm}} + \frac{C_{SO_2}}{S_{SO_2}} + \frac{C_{NO_x}}{S_{NO_x}}\right)\mathbf{x1.37} \quad \text{.....................(6)}$$

The data for ORAQI during winter and summer seasons are tabulated in Table 4.

Table 4 : Air quality index during winter and summer seasons

Location	ORAQI (Winter)	ORAQI (Summer)
Tanneries	7.689	7.320
Commercial cum traffic	17.115	17.682
Residential	12.086	8.373

AQI at the tannery area during the winter and summer seasons were 7.689 and 7.320, respectively. AQI for winter was greater than summer season and these values lied below 25 denoting the clean air near the tannery areas.

The air quality index (AQI) values were calculated by modified ORAQI equation 7 for the four pollutants in the present study and the AQI values for winter and summer seasons are tabulated in Table 5.

Table 5 : Air quality index during winter and summer seasons

Location	Modified ORAQI (Winter)	Modified ORAQI (Summer)
Tanneries	12.903	11.774
Commercial cum traffic	37.781	35.509
Residential	24.211	16.157

AQI during the winter and summer seasons were 12.903 and 11.774, respectively. AQI during the winter season was found to be greater than the summer season. But AQI lied below 20 showing excellent ambient air quality (Table 6).

Commercial -cum-traffic area :

Near the commercial cum traffic area, level of SPM, RPM, SO_2 and NO_x were 158.4 mg/m^3, 66.5 mg/m^3, 15.0 mg/m^3 and 25.6 mg/m^3, respectively. It was found that the level of SPM, RPM, SO_2, and NO_X were within the standards during the winter season. The individual pollutant index for SPM, RPM, SO_2 and NO_x were 0.792, 0.665, 0.188 and 0.320, respectively. Individual pollutant index was not greater than one, which implies that actual concentration level has not exceeded the standard value.

At traffic zone, the concentrations of SPM, RPM, SO_2 and NOx during summer were 147.6 mg/m^3, 53.1 mg/m^3, 18.7 mg/m^3 and 29.7 mg/m^3, respectively. The concentrations did not exceed TNPCB standards during the summer season. Individual pollutant index for particular pollutant SPM, RPM, SO_2 and NO_x were 0.738, 0.535, 0.234 and 0.371, respectively. Individual index values lied below one indicating actual concentration level has not exceeded the standard value.

AQI calculated from individual pollutant index was 0.422 and 0.430 for winter and summer seasons, respectively which lied between 0.3 and 0.6 showing the rating scale as the slightly polluted area. But AQI during the winter season was less than

Table 6 : Geometric mean of all AQI values

Sites	Seasons	AQI $(Q_1 x Q_2 x \ldots x Q_n)^{1/n}$	AQI $\frac{100 \times O}{O_s}$	AQI $\left(13.7 \sum_{i=1}^{4}\frac{c_i}{s_i}\right)^{1.15}$	ORAQI 9.61 $\left(\frac{C_{spm}}{S_{spm}}+\frac{C_{SO_2}}{S_{SO_2}}+\frac{C_{NO_x}}{S_{NO_x}}\right)$ 1.37	M.ORAQI $\left(7.21 \sum_{i=1}^{4}\frac{c_i}{s_i}\right)^{1.37}$	MeanAQI
Site 1	Winter	0.205	22.425	17.904	7.689	12.903	12.225
	Summer	0.188	20.975	16.579	7.320	11.774	11.367
Site 2	Winter	0.422	49.125	44.160	17.115	37.781	29.721
	Summer	0.430	46.950	41.877	17.682	35.509	28.489
Site 3	Winter	0.323	35.500	30.364	12.086	24.211	20.497
	Summer	0.237	26.425	21.623	8.373	16.157	14.563

that of the summer season. The impact of individual pollutant was more during summer season compared to winter season.

AQI was calculated using the equation 4 and data are presented in Table 2. Air quality index calculated from the pollutants SPM, RPM, SO_2 and NO_x for winter season were 79.2, 66.5, 18.8 and 32.0, respectively. Analyzing the air quality categories it was found that SPM showed polluted where as RPM was moderately polluted and So_2 showed clean where as NO_x showed fairly clean categories. In the traffic area, the impact of SPM and RPM were more compared to SO_2 and NO_x.

During the summer season, the AQI from the individual pollutants SPM, RPM, SO_2 and NO_x were 73.8, 53.5, 23.4 and 37.1, respectively. AQI for SPM and RPM showed moderately polluted where as SO_2 implied clean and NO_x showed fairly clean categories, respectively. AQI rating for winter season was greater than the summer season.

AQI calculated from the equation 5 during winter and summer seasons were 44.160 and 41.877, respectively. The AQI value, which lied between 40 to 59 during both seasons, implies low ambient air quality.

AQI calculated using the equation 6 at the traffic area during the winter and summer seasons were 17.115 and 17.682, respectively. AQI for summer season was greater than that of winter season and these values lied below 25 denoting the clean air near the commercial cum traffic area.

AQI values calculated using equation 7 during the winter and summer seasons were 37.781 and 35.509, respectively. AQI during the winter season was found to be greater than the summer season but AQI lied between 20 to 39 showing good ambient air quality.

Residential area :

At residential area, the pollutants SPM, RPM, SO_2 and NOx were 98.0 mg/m^3, 50.2$mg/m^{3,}$ 14.2mg/m^3 and 20mg/m^3, respectively. During winter season, the levels of pollutants were within the standards. The individual pollutant index for SPM, RPM, SO_2 and NO_x were 0.490, 0.502, 0.178 and 0.250, respectively. These values were not greater than one, which implies that the actual concentration level has not exceeded the standard value. During summer, the concentrations of SPM, RPM, SO_2 and NO_x at residential area were 65.5mg/m^3, 42.1mg/m^3, 9.9mg/m^3 and 14.7 mg/m^3, respectively. These values did not exceed TNPCB standards. The quality rating for pollutants SPM, RPM, SO_2 and NO_x during summer was 0.328, 0.421, 0.124 and 0.184, respectively. Since the individual index values were below one, the actual concentration does not exceed the standard value.

AQI calculated using equation 2 for summer season was 0.237 indicating the rating scale as least polluted area. The comparison of AQI for winter and summer season indicated that winter season has greater value than that of summer. Winter season has more impact of individual pollutants than summer season.

During the winter season, the air quality index calculated from the pollutants SPM, RPM, SO_2, and NO_x were 49.0, 50.2, 17.8 and 25.0, respectively. The analyses of AQI showed that SPM implied fairly clean, RPM implies moderately polluted where as SO_2 and NO_x showed clean categories. At the residential area, the impact of SPM and RPM were more compared to SO_2 and NO_x.

The AQI form the individual pollutants SPM, RPM, RPM, SO_2, and NO_x during summer season were 32.8, 42.1, 12.4 and 18.4, respectively. The AQI for SPM and RPM lied between 25 to 50 indicating fairly clean ambient air quality where as AQI for SO_2 and NO_x lied between 10 and 25 indicating clean ambient air quality. Hence, AQI rating for winter was greater than that of summer reason.

Air quality index calculated using equation 5 for residential area, for winter and summer reasons were 30.364 and 21.623, respectively. These values lied between 20 and 39 indicating good ambient air quality.

AQI values calculated using the equation 6 during winter and summer seasons were 12.086 and 8.373, respectively. The AQI for winter season was higher than the summer season. These values were below 25 denoting clean air near residential area.

Using Modified ORAQI equation, the AQI values calculated during winter and summer seasons were 24.211 and 16.157, respectively. AQI during the winter season was greater than that in the summer season. The AQI for winter season lied between 20 and 39 indicating good ambient air quality where as subsequent value for summer season lied below 20 representing excellent air quality.

The geometric average of all AQI values of all the locations was reported as average AQI value for Dindigul (Table 6).

Conclusion :

In the present study, ambient air quality monitoring was carried out at three grid points in Dindigul area of Tamil Nadu. Following conclusions have been drawn from the study:

– SPM, RPM, SO_2 and NO_x at tannery, traffic and residential area were well below the permissible standards prescribed for residential and industrial area.
– Particulate matter such as SPM and RPM are said to be higher in concentration compared to gaseous pollutant SO_2 and NO_x.
– Though SPM values were high at all the locations during most of the monitored sites, the air quality index has indicated a fairly clean environment in the area.
– Based on the air quality index, the ambient air quality in the study area is said to be fairly clean area.
– Based on AQI, commercial-cum-traffic area is said to be polluted compared to other two areas. This is due to the

heavy vehicular pollution, which has been reflected from the vehicle census of the two and four wheelers.

Recommendations :

Based on the above conclusion the following recommendations are suggested

– An air quality index (AQI) be calculated, forecast and reported to the public on a daily basis. Some details have already been published (Rajola *et al.*, 2002).

– More stringent measures should be taken to control the vehicular and industrial pollution.

– Source apportionment studies of SPM be carried out, to ascertain the sources and then to put up relevant control measures in place.

– Studies on the effect of pollutants on human health should be carried out in India, so that we have first hand data of the health effect of pollutants in Indian conditions.

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