

## Development of a Low-Cost, High-Accuracy Particulate Matter (PM) Sensor for AQI Monitoring: Design and Validation of Model for Predicting AQI in Different Areas

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**Abstract:** In Bangalore, the second greatest and fastest-growing city in India, measurements of fine particulates less than or equal to 10  $\mu\text{m}$  (PM10) were taken continuously using a dust-resistant sampler (APM 460 BL). We followed the usual procedures advised by the Environmental Protection Agency (EPA) for both collecting samples and following inspection for in contact with air particulates particles. The lead level fluctuated between 0.21 to 1.18  $\mu\text{g}/\text{m}^3$ , whereas PM10 values were recorded to range from 88.1 to 226.9  $\mu\text{g}/\text{m}^3$ . The yearly medians of the amounts of substances currently of significance showed that they were typically consistent with those found in the majority of other Indian metropolitan regions and were largely beneath the Indian environmental guidelines. Concurrently, the anticipated and estimated quantities of PM10 were compared in order to confirm the AERMOD framework. The information repository created by the current study on pollution levels could be utilized for additional investigations and citywide efforts to reduce pollution.

**Keywords:** Air Contamination, Atom, Air Quality Index (AQI), Particulate Matter (PM) Sensor

### 1. Introduction

It is commonly recognized that the toxic nature of the aerosols determines the adverse health impacts they cause. The size of the infiltrating nano particles mostly determines how much airborne debris enter the lungs of humans (Balachandran et al. 2000). Several epidemiological investigations (Dockery 1993; Hoek et al. 1997; Harrison and Yin 2000; Sammet et al. 2000) have shown an immediate relationship between breathing disorders, asthma

destruction, and immortality, particularly in urban settings and atmosphere inhabitable particulates. Thus, one of the most important requirements for studies on epidemiology, air quality control, and air pollution reduction is the determination of the amounts of in contact with air particles and its primary hazardous element, lead (Pb), in urban settings (Chow et al. 2002; Querol et al. 2001). For this reason, we have tracked the quantity of Pb and fine particulates smaller than or greater than 10  $\mu\text{m}$  (PM<sub>10</sub>). The spreading of PM<sub>10</sub> across Madurai, the second-biggest city in Tamil Nadu, India, has also been modeled by us. For one year, from July 2005 to June 2006, the measurement procedures (sample gathering) and chemical analyses were conducted using the average level procedure advised by the Agency for Environmental Protection (EPA), USA. We used the EPA-developed AERMOD model (EPA 2005; Cinderella et al. 2005; Kesarkar et al. 2007) to examine the distribution of contaminants over Madurai city. In this inquiry, the findings from PM<sub>10</sub> and Pb observation and PM<sub>10</sub> modeling are given. The structure of this document is as follows. This paper's "A description of the investigations" section provides information on the PM<sub>10</sub> and Pb measurements conducted over Madras city. "The outcomes and comments" discusses the findings of the measurement and simulation of PM<sub>10</sub> propagation employing the constant-state plume propagation model AERMOD. The "Conclusions" section contains the main arguments.

#### Specifics of the studies Observation of breathing pollutants

Often referred to as the City of Temples, which are Chokecherry city (9°54' N, 78°84' E, and 100 m above sea level) has a significant spiritual, artistic, and economic legacy in South India. In 2001, there were approximately 1.2 million people living in this metropolis, which has an aggregate area of 52.8 km<sup>2</sup> (Jeba Rajasekhar et al. 2004). The burning of oil and gas from both fixed and roaming sources has a significant impact on the city's environmental atmosphere, and it has been noted that the amount of burned fossil fuels has been rising over the years. Samples of Pb and ingested fine particulates were made at six distinct sample locations in order to examine the spread of environmental contaminants throughout Coimbatore city. These locations were chosen because of the human actions that were already taking place there and causing contaminants in the air. The different densities of motorists, industries, and households inside the city's boundaries were examples of these actions of people. To determine the amount of the particle contaminants that are currently of anxiety, airborne particles were taken at regular intervals for a year. Following is an explanation of the landscape's use and probable factors contributing to airborne pollutants in the areas surrounding the websites.

Located in the centre of the city, this is the primary bus terminus. This bus stop has a very small footprint and is encircled by winding roadways. As a result, there are constantly traffic bottlenecks and bottlenecks at this location, which slows down traffic flow. The primary source of pollutants in the atmosphere at this location is exhaust from professional and governmental vehicles, including automobiles, buses, auto rickshaws, and two-wheedles. Because of the tall crossroads stores, homes, and constructions, this location may experience an increase of air pollution (Bhaskar, et al., 2008).

Situated in the city's northern region, this business location is extremely bustling. Near this location are numerous stores, eateries, and training sessions, as well as a few public facilities including Governmental Rajaji Institution (the largest institution in the southern Tamil Nadu region), colleges, and universities. Because of the high concentration of cars and encroaching on the roadway's sides, transportation moves slowly and is extremely overcrowded regardless of roadways are comparatively broader compared to those in the city's enter.

Numerous bungalows and small businesses, primarily in the furnishings, grilling, flexible, and rubber businesses, as well as lathes, electrolytic facilities, rice mills, and domestic colonies, surrounds this location. The neighboring bus terminal is the reason for the constant traffic flow that is seen here. Emitted pollutants from the business and home industries, in addition to those from autos, add to the overall environmental load at this sample location.

Two significant coal-based rubber businesses that manufacture rubber-based household goods are located on this Coimbatore municipal factory site. There is a significant volume of business on the National Highway (NH-47) Extended that passes close to this location. As a result, the main causes of airborne pollutants in this area are pollutants from vehicles and

factories. Apparently are also a few home complexes of well-known individuals in this location.

With several private territories Purdue is a rapidly developing city expansion district. In this field of study, there are also several governments, schools and colleges, and business organisations. Light-tonnage vehicles, particularly two-wheeler, and heavy-tonnage automobiles, primarily public buses, make up the majority of the traffic flow. Traffic pollution are high due to the roadways' narrowness and unsafe state. The outer edges of Purdue are home to a manufacturing complex with small-scale businesses which includes metalworking and smelting facilities, whose may be contributing through environmental exposures.

Tamilnadu is known as the pilgrimage centre of south India because of its abundance of buildings. The city's landmark, the Sree Methinks temple, is situated in the heart of the city. The temple is surrounded by a large number of businesses. As a result, the site is extremely congested and has constant visitor flow nearly all the time. The pollutants in the air loads at the analysand location are influenced by pollutants from homes, businesses, and cars.

With the exception of the south instructions, the geography of Chennai city climbs somewhat in everywhere as one walks out from the city centre. The ground surrounding the city slopes gently. The area inside the Madurai Corporation limits is devoid of hills. As a result, this city's current geography enjoys more or less steady-state weather and virtually uniform wind flow. Pollutant buildup is prevented under such circumstances (Benson 1989). Construction architecture on the two sides of small highways, nevertheless, is a crucial factor in describing the movement and dissemination of airborne contaminants in this city's central areas. This shape is sometimes known as a "street gorge" because it can be thought of as an underpass that is open at the top. This characteristic may also identify heightened amounts of pollutants at some of the sampling locations, which are in the city center (the copper and Alley 1986; Buckland and Middleton 1999).

#### Evaluation of PM10 collection

The easily accessible Breathed in Dust Analyzer (Envirotech APM 460BL) was used to collect the PM10 sample continuously. The air sampler's flow rate ranged from 0.9 to 1.4 m<sup>3</sup>/min under free-flow conditions minus a filter. It had a 28-hour operating time. Particles from PM10 were collected using Whitman micro filter sheets (EPM 2000). For this study, an 8 x 10 inch glass fiber filter was employed, with a 7 x 9 inch section of the filter revealed to the polluted air sampling. The big particles were eliminated using the centrifugal force approach. All of the sites underwent uninterrupted and synchronous assessment for a year, from July 2005 to June 2006. When measuring PM10 over the duration of July 2005 to June 2006, groundwater level environmental conditions—temperature, gusts, wind direction, sun electromagnetic energy, precipitation and percentage humidity—that are necessary for environmental simulation were concurrently recorded on a 30-minute basis.

#### Environmental evaluation of PM10 readings

Employing an arrangement of screen sheets, the measurements of PM10 in the air have been measured via gravity for this investigation. Immediately prior to and after the calculating the weight, the filters which were used to collect PM10 particles were dried in a high-volume the desiccator with 5% relative moisture for 48 hours. The preservation, the drying process, and weighting operations were carried out in a dark room at an elevation of 20±1°C and an equivalent saturation of 50±5%. Four-by-five-cm strips of exposed filter paper were cut out. The metal analysis strips were washed in a low-temperature asher, and the ashed filter was subsequently put in a glass tube that was heated for five hours after being treated with ten millilitres of nitric acid, five millilitres of hydrochloride acid, and five millilitres of chlorine acid. The material had been dried until it was completely dry after its metabolism was completed multiple times. Double-distilled materialized water was used to make up to 50 ml of the biological remnants in the volumetric flask after they had been dispersed into 1% nitric acid and allowed to cool. The extracts were diluted, whirled for approximately 30 minutes at 2,000 rpm, and the resulting liquid precipitate was poured into polyethylene tubes, which were closed and kept for further examination (Katz 1969; Tripathi 1994). The same process was used for breaking down an unfinished filtering paper in a similar manner. After that, atomic absorption spectroscopy (AAS) was used to make the analysis. By contrasting the absorption of samples

with that of standardized metal answers, the quantities were estimated using a widely accessible AAS (VarianSpectra220). Shortly before they were used, the stack equivalents were converted into typical approaches for the substances being studied.

#### Weather-related assessments

In research on contaminants in the air, meteorological is essential. The air quality standards are actually modulated by a high periodicity in the climatic conditions (Espinosa et al. 2004; Karar et al. 2005). According to Singh and Prasad (2005), wind (such as the speed and orientation), rain (the amount and intensity), temperatures in the air, and humidity percentage are the key meteorological factors influencing the pollution levels over Chennai. The examination of environmental records from July 2005 to June 2006 revealed that the summertime session (March–May) had the highest reported air temperature of 44.8°C and the greatest average ultraviolet radiation of 1,024 w/m<sup>2</sup>. Wind speeds ranged from 0.3 to 8.4 m/s and were found to be highest in July (8.4), August (6.8), and November (5.5). The northern monsoon season became the one with the highest wind velocity. The recorded wind speeds in the summer season ranged from 0.2 to 6.2 m/s and was somewhat slower than those in the winter. towards the northeast, so eastward, the southeast, and western were the most common winds encountered within the investigation period. Due to the intensity of the northern monsoon, the month of October had the highest average rainfall (501 mm) and the greatest number of rainy days (41). Relative humidity fluctuated from wintertime to summertime (66% to 57%), then increased gradually throughout the rainfall season (67% to 78%), and finally stayed constant during the winter (68%).

## 2. Findings and Conversations statistical assessment

Tables 1 and 2 provide summaries of the measured PM<sub>10</sub> and lead levels respectfully. Goripalayam (site 2) had the highest average PM<sub>10</sub> concentration, being followed by Periyar (site 1), Pudur (site 5), Palanganatham (site 3), Kochadai (site 4), and Sree Meenakshi Temple (site 6), in order of decreasing magnitude. Malayalam (site 2) has the highest average deviation, following in order of decreasing variance by Periyar (site 1), Kochadai (site 4), Sree Meenakshi Temple (site 6), Pudur (site 5), and Palatinat (site 3). The average Pb content was also found to be highest at Malayalam (site 2), followed in order of decreasing value by the Periyar (site 1), Palatinat (site 3), Pudur (site 5), Kochadai (site 4), and Sree Methinks Temple (site 6). With an acceptable deviation of 16%, the Goripalayam (site 2) had the highest fluctuation in Pb contents.

At the majority of the collecting locations, PM<sub>10</sub> showed a very strong inverse relationship with dampness (0.68 to 0.94) and a strong positive correlation with air temperature (0.71 to 0.91). Using a combination of regression analyses, it was discovered that in the majority of the monitoring stations, PM<sub>10</sub> and temperatures exhibited a significant correlation (0.33 to 0.49). The quantitative the analysis's subjective results showed that there was a positive connection (0.49) between temperatures and particle pollution quantities. The environment's velocity of wind, and temperature, nevertheless did not correlate with Pb. For the sites Periyar bus stand, Goripalayam, Palanganatham, Kochadai, Pudur, and SreeMeenakshi Temple, the actual concentrations of PM<sub>10</sub> were 16.4%, 19.6%, 8.5%, 23.1%, 10.7%, and 13.9%, respectively, according to the computed coefficient of variance (CV), which is an estimate of the relation between two ranges of data (Zar 2004). Likewise, the computed CV of the measured lead levels for the locations Periyar Busstand, Goripalayam, Palanganatham, Kochadai, Pudur, and Sree Meenakshi Temple were 14.1%, 18.4%, 14.6%, 16.7%, 18.0%, and 12.2%, respectively.

According to Tables 3 and 4, the computed CV of the measured values varied from 8.5% to 23.1% for PM<sub>10</sub> and from 12.2% to 18.4% for Pb.

Transmission by Seasons

Monthly dispersal has been computed to comprehend the yearly shifts of the contaminant concentrations of and the results are shown in Tables 5 and 6. Table 5 showed that the amounts of PM10 were lowest throughout the monsoonal season (June–September) and highest throughout the height of summer (March–May). Together with other elements including sources brightness along with additional atmospheric characteristics, photo chemical responses may be responsible for the summer's greatest particulate matter accumulation. Rainfall-induced scavenging of particulate matter from airborne particles may be the reason for the monsoon's smallest concentrations of PM10 (Stern 1976). Throughout the south-western monsoon months, site 2 showed the highest fluctuation of PM10. With the exception of sites 1 and 2, the median levels of phosphorus at all sites were almost the same across every time of year, according to Table 6. Site 6 showed the highest Pb fluctuation, with a CV of 21.9% (Table 7).

Transmission every month

Fig. 1a–f shows each month's changes in PM10 and Pb concentration. According to this figure, the month of May had the most elevated PM10 concentrations recorded to date across each location, while the month of December of had the lowest concentrations. The median value during summer months was 158.8 µg/m<sup>3</sup>, while the mean value during the winter was 109.1 µg/m<sup>3</sup>. The heat of the summer month had the lowest mean Pb levels across all test sites, at 0.52 µg/m<sup>3</sup>, while November, a winter month, had the highest average Pb content, averaging 0.66 µg/m<sup>3</sup>.

Table 1: PM10 levels assessment at six Coimbatore metropolitan locations (Bhaskar, et al., 2008).

Concentrations of PM10 at the sleep site (µg/m<sup>3</sup>)

		Percentile			Max	Min	Mean	SD
		25th	50th	75th				
1	Site1	134.9	147.2	175.2	210.4	108.5	152.9	25.2
2	Site2	139.1	170.9	190.7	226.9	108.5	166.8	32.8
3	Site3	121.2	126.1	135.1	149.5	100.2	127.8	10.9
4	Site4	80.8	89.6	111.1	149.5	70.5	97.2	22.5
5	Site5	120.1	130.7	139.6	155.2	102.1	129.4	13.9
6	Site6	102.0	115.2	129.1	145.1	88.1	115.6	16.1

Table 2: Overview of Lead The amount at Six Chennai Municipal Locations

Concentrations of PM10 at the sleep site (µg/m<sup>3</sup>)

		Percentile			Max	Min	Mean	SD
		25th	50th	75th				
1	Site1	0.78	0.86	0.93	1.07	0.49	0.85	0.12
2	Site2	0.76	0.86	0.97	1.18	0.49	0.87	0.16
3	Site3	0.44	0.49	0.52	0.76	0.31	0.48	0.07
4	Site4	0.39	0.42	0.44	0.62	0.21	0.42	0.07
5	Site5	0.42	0.51	0.58	0.71	0.35	0.50	0.09
6	Site6	0.46	0.49	0.52	0.62	0.38	0.49	0.06

Since 1987, the Institute of Environmental at Madurai Kamaraj University's Department of Energy, The surroundings, and Resource Management has conducted studies on contaminants levels in different parts of the city. Particles levels in Madurai City's ambient air have really been continuously measured since 1998. Fig. 2 displays the average particles quantities that were measured. The figure makes it clear that there has been an increase in particulates contaminants over time.

Fair functionality fashion modeling

For the evaluation of the levels of pollutants from different sources, AERMOD is an a stable state model (EPA 2005; Cimorelli et al. 2005; Kesarkar et al. 2007). In comparison to

the commercial the source complex (ISC) model, AERMOD offers a better method for describing the basic surface layer variables and the vertical shape of the outside world. It also better represents plume buoyancy, access, and urban the evening. boundaries layer (Cimorelli et al. 2005). It can dynamically represent resources as either rural or urban, and it offers changeable urban responses to horizontal dispersal as an expression of city populations. Hourly subsurface and upper air meteorology readings are necessary for AERMOD to simulate the dispersal of pollutants. Based on a current description of the meteorological boundary layer, AERMOD models transmission and distribution from several points, areas, or volumetric sources. Receptors can be found in both simple and complicated terrain, whereas sources can be found in both urban and rural regions. Structure wake effects, or plume down wash, are also taken into consideration by AERMOD. Hourly sequential preprocessed meteorological data is used in the model.

information to calculate amounts for average periods ranging from one hour to a year (EPA 2004). According to this model, the expected distribution for a pollutant's concentration throughout the stable outer layer is Parabolic in the horizontal as well as the vertical directions. The vertical distribution in the convection layer that borders can be represented by an abi-Gaussian chance function, whereas the lateral dispersal is Gaussian. The atmospheric factors needed for the distribution to be vertical are produced using the comparable connection and environmental measurements. The AER-MET processors in the AERMOD model uses local surface properties, such as roughness and Bowen has ratio, in conjunction with requirements meteorological assessments (wind speed, direction of wind, humidity, and the cloud cover) for determining planetary frontier layer parameters, such as interaction velocity, Monin–Obukhov length, convection velocity scale, temperatures scale, mixing height, and surface heat flux. The prospective gradient of temperatures in AERMOD, transverse and perpendicular turbulence changes, and perpendicular characteristics of wind speed are then computed using these settings. The purpose of this model is to simulate the spreading of pollutants at short distances (less than 50 km).

According to the AERMOD model, the amount present at a receptor in order which is situated at a point (x, y, z), is the average of the two concentrations estimations, and the resulting plume is assumed to exist in both states. The plume goes over the terrain in the second one, indicating surge materials above the line of division optimist although the first one is straight, reflecting plumes materials below the splitting streamlined. The horizontally plume "dominates" and carries more weight under stable situations, whereas the plume moving over the ground is more significant (heavily weighted) in moderate and unsettled settings. The intensity calculation decreases to the form for an individual plume in flat terrain. The general density at any level of the land can be expressed generally as follows:

Table 3: PM10 Hazardous Regressive factors

Variables	Site1	Site2	Site3	Site4	Site5	Site6
Temperature	0.38	0.50	-0.40	0.43	0.44	0.48
Windspeed	-0.33	-0.27	-0.26	-0.38	-0.30	-0.27
Humidity	-0.18	0.062	-0.19	-0.10	-0.19	-0.15

Table 4: Pb contaminant multi-regression estimates

Variables	Site1	Site2	Site3	Site4	Site5	Site6
Temperature	-0.09	-0.10	-0.20	0.06	-0.24	-0.20
Windspeed	-0.39	0.07	0.19	0.13	0.17	-0.06
Humidity	-0.09	0.30	0.08	0.15	0.09	0.05

$$C_i(x,y;z)=f*C(x,y;z)+(1-f)*C(x,y;Z_{eff}) \tag{1}$$

in which  $z$  is the receptors height (including the elevation beyond local terrain),  $f$  is the weighting factor associated to the proportion of The plume substance that is beneath the highest point,  $H_c$ , of the multiplying optimise  $z_{eff}$  is a "productive" receptor height (which is the same as the flat terrain), and  $C(x, y, z)$  is the flat-terrain level calculation suitable for the specified equilibrium circumstances. The horizontally plume's participation is represented by the first component on the right-hand side of Equation 1 and is assessed at receptors altitude ( $z$ ). In contrast, the following term reflects the terrain-adjusted plume's participation and is assessed at an efficient receptors altitude. The Stochastic statement is the form of the AERMOD intensity calculation  $C(x,y,z)$  in Equation 1 that is suitable for steady situations ( $L > 0$ ) in flat terrain (and is comparable to that of ISC2):

$$C(x, y, z) = Q/U \times Fz(x, z, hp) Fy(y) \tag{2}$$

where

$$F_z = \frac{1}{\sqrt{2\pi}\sigma_z} \times \sum_{n=-\infty}^{\infty} \left[ \exp\left[-\frac{(z - h_p + 2nh_a)^2}{2\sigma_z^2}\right] + \exp\left[-\frac{(z + h_p + 2nh_a)^2}{2\sigma_z^2}\right] \right] \tag{3}$$

$$F_y = \frac{1}{\sqrt{2\pi}\sigma_y} \exp\left[-\frac{y^2}{2\sigma_y^2}\right] \tag{4}$$

These formulae use effective layer boundaries characteristics to compute particle dispersion and particle propagation. The plumes height is actually denoted by  $h_p$ , the plume-related dispersing factors by  $\sigma_y$  and  $\sigma_z$  are, and the level at which mixing takes place can be restricted by  $h_a$  ( $=\max(h_p, h)$ ), whereby  $h$  signifies the permanent (skeletal) mixed layer elevation and  $h_p$  is proportional to the stack elevation plus column rise ( $\Delta h$ ).

$$C_d(x, O, z) = \frac{Q}{2\pi U \sigma_y} \frac{\lambda_1}{\sigma_{2d1}} \sum_{m=0}^{\infty} \left[ \exp\left(-\frac{(z - h_{cd1} - 2mz_i)^2}{2\sigma_{2d1}^2}\right) + \exp\left(-\frac{(z + h_{cd1} + 2mz_i)^2}{2\sigma_{2d1}^2}\right) \right] + \frac{\lambda_2}{\sigma_{2d2}} \sum_{m=0}^{\infty} \left[ \exp\left(-\frac{(z - h_{cd2} - 2mz_i)^2}{2\sigma_{2d2}^2}\right) + \exp\left(-\frac{(z + h_{cd2} + 2mz_i)^2}{2\sigma_{2d2}^2}\right) \right] \tag{5}$$

AERMOD uses the phrase for instances of instability.

Actually,  $\sigma_b$  is the amount of dispersion caused by buoyancy-induced entrainment, while  $\sigma_{zd}$  and  $\sigma_{jd}$  are the efficient source altitude and perpendicular dispersal characteristic. The generic problem for the pattern of concentrations throughout the plumes centro id is equation 5. The AERMOD model was used to forecast the amounts of the contaminants at every monitoring location in the current study by giving the necessary inputs, such as pollution and weather data. Human-caused factors such as logistics, manufacturing, and household actions

are responsible for the particle pollution in the subject area. Rubber-based household and business gadgets are produced by two main businesses. The primary local operations consist of

Table 5: Periodic Variability in Coimbatore City's PM10Those (Bhaskar, et al, 2008).

		monsoon	monsoon		
1	Site1	146.1(CV=10%)	130.2(CV=9.2%)	147.5(CV=8.9%)	187.8(CV=8.0%)
2	Site2	163.2(CV=20.1%)	149.3(CV=15.8%)	152.3(CV=18.1%)	202.4(CV=7.6%)
3	Site3	135.3(CV=6.1%)	115.8(CV=6.6%)	128.5(CV=13.7%)	137.9(CV=5.7%)
4	Site4	126.0(CV=4.1%)	119.8(CV=7.9%)	126.0(CV=8.4%)	139.4(CV=5.1%)
5	Site5	116.5(CV=9.1%)	102.9(CV=10.2%)	109.4(CV=13.9%)	133.4(CV=6.8%)
6	Site6	89.0(CV=14.8%)	79.8(CV=4.6%)	96.3(CV=19.0%)	123.8(CV=17.5%)

Table 6: Tamil city's seasonal shifts in levels of lead.

		Southwest monsoon	Northeast monsoon	Winter	Summer
1	Site1	0.92(CV=7.6%)	0.76(CV=10.0%)	0.80(CV=16.0%)	0.90(CV=13.8%)
2	Site2	0.70(CV=12.0%)	0.87(CV=13.5%)	0.92(CV=6.0%)	0.93(CV=18.0%)
3	Site3	0.56(CV=13.5%)	0.43(CV=16.1%)	0.48(CV=16.9%)	0.55(CV=10.6%)
4	Site4	0.49(CV=8.7%)	0.49(CV=13.3%)	0.48(CV=12.5%)	0.49(CV=13.0%)
5	Site5	0.51(CV=5.3%)	0.45(CV=17.0%)	0.47(CV=17.2%)	0.51(CV=17.9%)
6	Site6	0.44(CV=9.2%)	0.39(CV=15.2%)	0.39(CV=13.4%)	0.45(CV=21.9%)

combustion of fuels such as a fuel such as fuel wood, LPG, and farm waste. A traffic study was carried out by manually registering cars across the city, encompassing the sample site of the current inquiry, in order to create a greenhouse gas inventories. The investigated area was really separated into several rectangular grids with an expanse of one kilometer. A combination of cars and road lengths were used to calculate the total kilometers run for each grid. The total kilometres driven by the cars and the carbon footprint rate of Indian autos were then used to compute automotive source intensity.

Table 7: Particulates contamination vitality in motorbike materials (Bhaskar, et al., 2008).

SI Number	Survey points	PM emissions ( $10^{-3} \text{ g m}^{-1} \text{ s}^{-1}$ )	Pb emissions ( $10^{-3} \text{ g m}^{-1} \text{ s}^{-1}$ )
1	West Tower street	53.41	1.949
2	West Masi street	84.69	2.656
3	North Masi street	51.84	1.422
4	East Masi street	75.32	2.260
5	South Masi street	126.80	3.910
6	Nethaji street	122.24	3.849
7	East Veli street	119.74	3.183
8	Simmakkal	202.99	6.168
9	South Gate	114.25	2.724
10	Nirmala School	196.21	5.022
11	Madura College	226.52	6.466
12	Aarapalayam	115.01	2.754
13	Kalavasal	233.85	6.599
14	Sellur	87.82	2.427
15	Avaniyapuram	172.44	4.468
16	Corporation office	198.99	5.517
17	Jaihind Puram	77.05	1.943
18	Kochadai*	119.88	3.497
19	Anna bus stand	146.76	3.989
20	K. Pudhur*	130.66	3.587
21	Periyar*	374.86	10.237
22	Goripalayam*	410.64	12.358
23	Palanganatham*	197.05	5.324
24	Meenakshi Temple*	100.98	3.084
25	Teppakulam	91.81	2.544

\*Sampling stations

SI Number    Surveypoints    PMemissions    Pbemissions

		$(10^{-3}gm^{-1}s^{-1})$	$(10^{-3}gm^{-1}s^{-1})$
1	WestTower street	53.41	1.949
2	WestMasi street	84.69	2.656
3	NorthMasi street	51.84	1.422

Particularly for particles and lead, the computed vehicle emission intensities throughout the city varied between  $51.84 \times 10^{-3}$  to  $410.64 \times 10^{-3}$ , and from  $1.42 \times 10^{-3}$  to  $12.36 \times 10^{-3} gm^{-1}s^{-1}$ , accordingly. It was observed that these heavy-tonnage automobiles had comparatively larger particle matter outputs compared to medium-tonnage automobiles. Additionally, two- and three-wheeler made up a significant portion of Madurai city's overall lead load—more than 70% in numerous traffic zones. Due to the functioning of an extensive number of motorized two- and three-wheeler, the impact was about three to five times bigger, despite the fact that their lead pollution factor (g/km) is comparatively lower than that of medium-tonnage automobiles (Pundiretal, 1994; Vivacious, 1990). The AERMOD models was initialized using an existing automobile-based pollution database. Only the period under review was used to create the pollution assessment. Nevertheless, in order to support future study, our team is creating a yearly pollution database for both fixed and mobile power sources. For PM10, the expected values varied between 121.7 and 226.9  $\mu g/m^3$ . The highest measured and anticipated amounts of PM10 were found at sites 1 and 2, which may be directly connected to the car exhaust, the use of charcoal for being cooked, the paved and untreated road (resuscitation) dusts, vehicle exhaust, and diesel-based electric generators in these sample sites. Even though AERMOD underestimated pollution by a factor of 1 to 1.5 in the levels for all measure locations, it was found from the created dataset relating to the expected and measured amounts that the overall trend of fluctuation of anticipated and measured values operated uniformly. One possible explanation for the lower projected concentrations is the absence of good greenhouse gases characteristics form emitters.

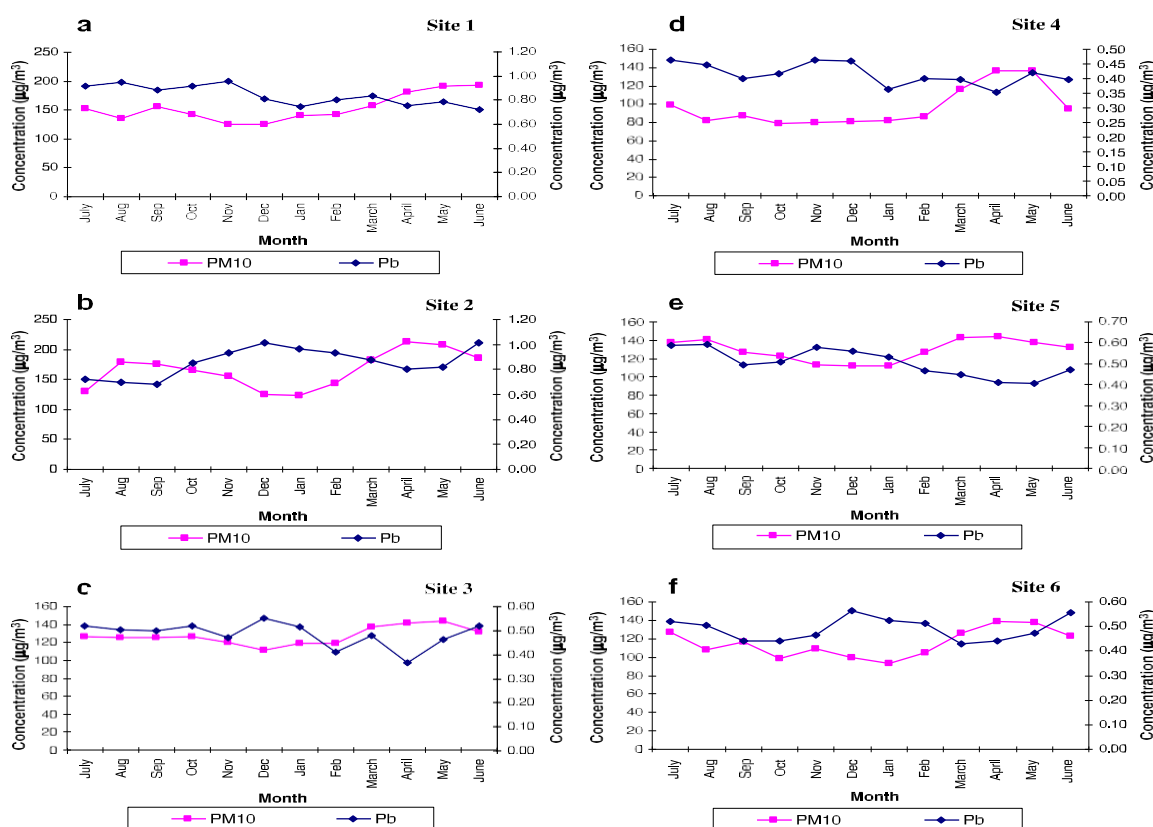


Figure 1. a-f Monthly average pollutants concentrations at different sites

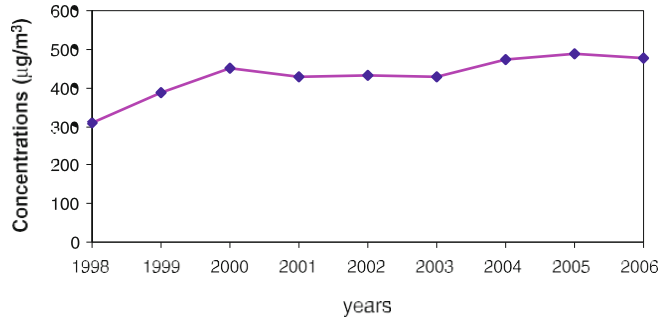


Figure 2. Comparison of observed particulate concentrations from 1998- 2006 sites

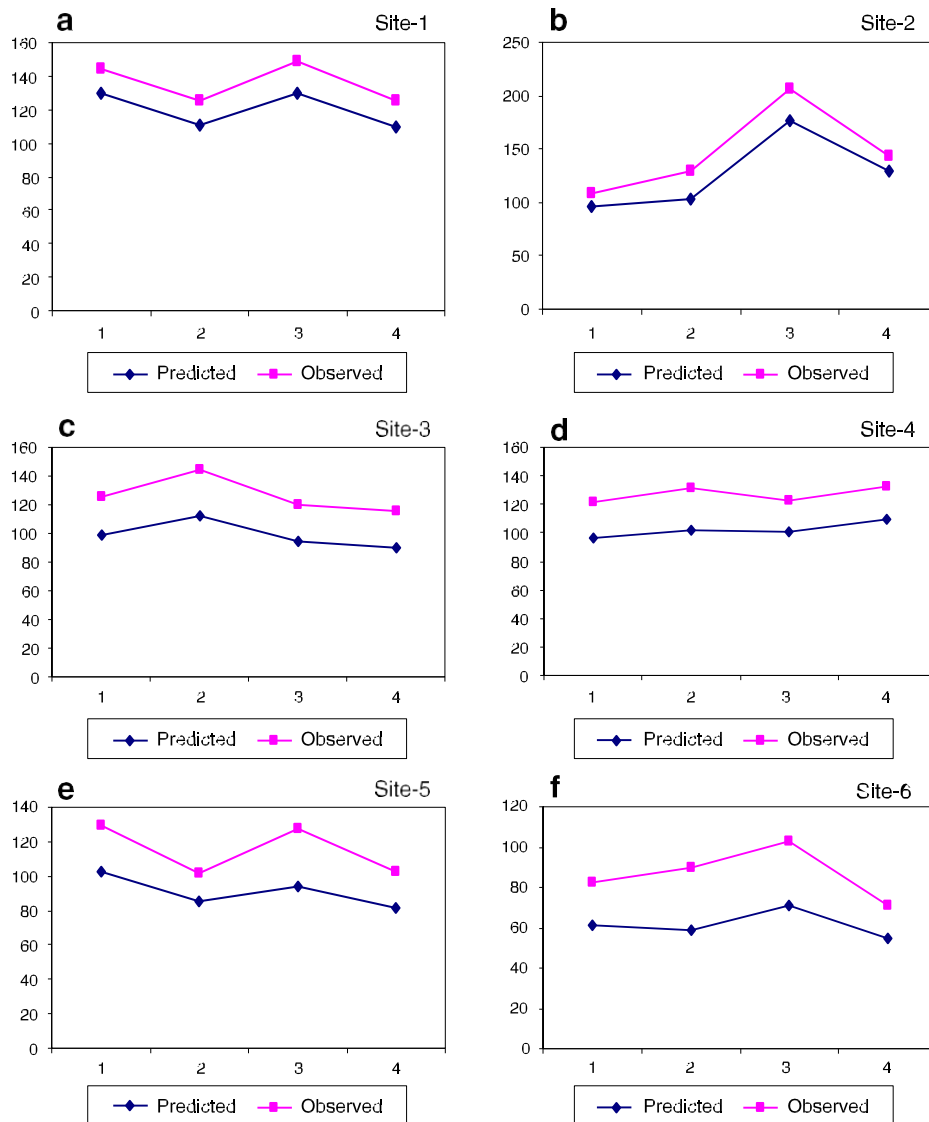


Figure 3. a-f Comparison of predicted and observed PM10 concentration at different

### 3. Conclusions

The main causes of particle pollution in the city are often determined to include transportation, small-scale industry, and a high rate of traditional fuel burning for both business and residential reasons (Kulandai 2003; Adachi and Tainosho 2004). In addition to motor vehicles, other sources of particles include pollutants from asphalt surfaces, expertise quantities

from technological and semi-industrial regions throughout the city, and the functioning of diesel-powered power plants, which were used in shops and restaurants throughout power outages, particularly during the summer. The total level of pollutants and atmosphere fine particles quantities in an Indian city may also be influenced by cooking in homes, schools, and business premises, burning trash in homes and public areas, and burning municipal waste in open spaces (Surya Chandrasekhar Alpatpat 1999; Salve et al. 2006). Throughout the city, the gritty sand that lines the bottoms of the highways is not regularly cleared. As a result, all of those substances work together to cause the city's PM<sub>10</sub> levels to range from 88.1 to 226.9 µg/m<sup>3</sup>. Madurai is encircled by farming regions, and there are against the wind locations and nearby areas that offer possible supplies.

Malayalam experienced the biggest volume of traffic across the sample stations throughout the research duration, despite the fact that PM<sub>10</sub> contamination activity were distributed throughout the city. Vehicle emissions may be the cause of Malayalam's maximum average PM<sub>10</sub> and lead readings. In actuality, there were a lot of light-tonnage automobiles operating here, particularly motorised two-wheelers (62,145). Since this site hyperlinks almost every one of the the north parts of the city, severe traffic jams (caused by slow automobiles and arbitrarily urban motorist techniques of functioning), prolonged delays at the signals that are and delays in traffic tend to occur throughout peak traffic hours (Tripathi et al., 2000; Katiyaretal., 2005). Additionally, abrasive mechanisms of auto parts such the brake or tire wear resulted in the emission of traffic-derived particulate matter into the environment (Viana et al., 2006). Consequently, together with pollutants from some small-scale industries, the combustion and erosion of automotive parts may be the main causes of the soft otal particulates (Harrison et al. 2004). There may be a correlation between the greatest level of deviations experienced at Goripalayam and transportation disruptions from the remainder of the city along the roadways of this monitoring location. The Sree Meenakshi Religious buildings monitoring site, which may be regarded as a hypersensitive region with the greatest traffic density amongst the collection locations, had the smallest amounts of PM<sub>10</sub> and lead. There was relatively little traffic considering the roads surrounding the monastery are one-way. Additionally, the flow of heavy-tonnage automobiles was restricted in this vicinity.

According to the outcomes of the transportation survey, there were not many cars operating at this location. The majority of automobiles used in this region are light-duty, petrol-powered cars that generate essentially no particles (Pundiretal, 1994; Jeba Rajekha, 2005; Gertler, 2006). The raised structure might limit the views of the adjacent semi-industrialised districts. It was also observed that only a small percentage of retail businesses are involved in combustion-related operations. The predicted production intensities of particulates as well as the observed quantities of PM<sub>10</sub> were similarly determined to be beneath since the area had significantly less suppliers.

The PM<sub>10</sub> and Pb levels over Coimbatore were found to be close to the allowable limits at all sample sites for the majority of the year, according to the experimental study on the air quality with specific regard to the median particle pollution. It is important to note that PM<sub>10</sub> has acceptable limits (for 24 hours) of 150, 100, and 75 µg/m<sup>3</sup> for highly sensitive, homeowners, and rural, and commercial and mixed areas, correspondingly, while Pb has acceptable inhibits of 1.5, 1.0, and 0.75 µg/m<sup>3</sup> for sensitive to homeowners, and rural, and commercial and mixed areas, accordingly

But for commercial and combined, dwellings and rural, as well as susceptible areas, PM<sub>10</sub> has reasonable limits (annual stands) of 120, 60, and 50 µg/m<sup>3</sup>, respectively, while for manufacturing and mixed, housing and rural, and receptive areas, Pb has acceptable limits of 1.0, 0.75, and 0.50 µg/m<sup>3</sup>, accordingly It was predicted that eventual increases in populace, traffic, industry, and individual energy use will raise the pollution load and worsen the air condition over Madurai. The city's public mental and physical well-being are at risk for long-term negative repercussions due to the rate at which air pollutants are increasing. Previous

research on particle pollution indicates that the percentage of fine particles has been increasing over time. Consequently, for a good current and tomorrow that is environmentally friendly, strict adherence of ecological standards and appropriate remediation methods is required. Variations of the amount of PM10 are predicted by the AERMOD framework by a number of 1 to 1.5. Therefore, it is necessary to monitor the city's concentrations of PM10 over an extended period of time and to include inventory of pollutants for other sources that remain stationary.

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