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Research Article

MEASUREMENT AND STATISTICAL ANALYSIS OF AMBIENT AIR QUALITY STATUS IN CUDDALORE REGION, TAMILNADU, INDIA

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ABSTRACT

The present study deals with the assessment of ambient air quality at six different locations in Cuddalore region, Tamil Nadu, India. The 24 hours average concentration of suspended particulate matter (SPM), nitrogen dioxide (NO₂) and sulphur dioxide (SO₂) were monitored at cuddalore region, Tamil Nadu, India. The 24 hour concentration of SPM, NO₂ and SO₂ were 132.34-197.45, 56.33-89.71 and 58.78-80.68 µg/m³ respectively. In present study, it was observed that concentration of NO₂; SO₂ levels exceed the permissible limit of National Ambient Air Quality Standard (NAAQS) for residential area. Exposures of these pollutants (NO₂ and SO₂) above standard levels (NAAQS) causes serious health effects on human health, associated with cardiovascular and respiratory diseases, increased risk of premature birth morbidity and even mortality. There is a significant correlation between SPM with NO₂ (r = 0.53), and SO₂ (r = 0.46) with linear regression also analyzed. Air Quality Index (AQI) values are in order of S1 > S4 > S5 > S6 > S3 > S2, and, it is clearly indicates that among six locations, Nellikuppam (S1) is highly polluted and Thiruvandipuram (S2) is moderately polluted. This is due to combustion processes particularly industrial emissions, motor vehicles and commercial activities.

Keywords: Air pollution, Particulate matter, Correlation-Regression, Morbidity.**INTRODUCTION**

The effects of global climate change are now being threats to developmental activities. Climate changes are directly related to air pollution which includes green house gases (GHG) and major air pollutants like particulate matter (PM), nitrogen dioxide (NO₂), sulphur dioxide (SO₂), carbon monoxide (CO), ozone (O₃) and black carbon (BC).¹ According to², India is second highest after china in terms of number death (1,20,600) registered for outdoor air pollution.³ Literature survey point out how particulate matter effect on human health due to indoor and outdoor air pollution by various pollutants.⁴⁻⁶ Particulate matter (PM) represents a mixture of solid and /or liquid particles suspended in the air.⁷ It is a complex mixture of carbon, ammonium, nitrates, sulphates, minerals, trace elements and water.^{8,9} Naturally the source of pollutants are volcanic eruption, forest fire, dust storms and gaseous pollutants like sulphur dioxide (SO₂), hydrogen sulphide (H₂S) and methane (CH₄) whereas anthropogenic source of pollutants comes from burning fossils fuel, vehicular and industrial emissions, power plants, mining, drilling and construction of roads.¹⁰ Sulphur dioxide (SO₂), nitrogen dioxide and suspended particulate matter (SPM) are regarded as major air pollutants in India.^{11,12} The effect of particulates depends on its size, shape, concentration and time of exposure in relation to its mass and composition.⁹ Cuddalore is the important district of state Tamil Nadu, India and is the centre of industrialization, urbanization and commercial activity. According to 2001 and 2011 census population of cuddalore is 1,58,481 and 173,361 which

shows that present census data¹³ is increased by 9.39 % from previous data (census 2001). As cuddalore is one of the major industrial hub but there is a scarcity of literature especially on particulate matter distribution and it impacts on environment. Umapathy¹⁴ observed that some selected pollutants viz. SPM, NO₂, SO₂ and CO are not exceed the limit in Neyveli lignite mining region where as in contrast to Balashanmugan¹⁵ who observed that the pollutants like SPM, NO₂, SO₂ and CO are exceed the limit of World Health Organization. From literature it is inferred that there is no comprehensive work has been done in cuddalore so the main objective of present study is to know the source and status of air pollutants at six different stations.

Study Area

The study was carried out during 2013 on Ambient Air Quality (AAQ) monitoring in Cuddalore District, Tamil Nadu State, India. Six different sites were selected for ambient air quality monitoring which fall into six different categories; viz: industrial area, residential area, bus stand railway station, maximum population, heavy traffic, low traffic area.

- Nellikuppam (S1): - Nellikuppam is covered with agricultural land and the integrated sugar mill industries.
- Thiruvandipuram (S2): - Residential area with less vehicular zone.
- Tirupadripuliyur (S3): - Thick populated area surrounds with bus stand and railway station.
- Cuddalore New Town (S4): - This area is highly populated with heavy traffic zone.

- Cuddalore Old Town (S5):- This site has heavy traffic density and highly populated area.
- Sangolikuppam (S6): - This site belongs to heavy industrial (SIPCOT) cum residential and low traffic area.

MATERIALS AND METHODS

Samples were collected at six different sites for a period of average 24 hours during the period of April to June 2013. Before sampling the glass fiber filter paper were equilibrate for 24 hours and then stored in airtight petridish. The Sampling instrument (NETEL, NPM – HVS/R) was placed 1.5 m above the ground level and changing according to the site available for sampling.

Analytical Procedures

The methods adopted for measurement of suspended particulate matter (SPM), Nitrogen oxides, Oxides of sulphur are available in literature.¹⁶⁻¹⁸

Particulate Matters

Air is drawn through a size-selective inlet and through a 20.3 X 25.4 cm (8 X 10 in) filter at a flow rate of 1.5 m³/m for 8 h; Particles with aerodynamic diameter less than the cut-point of the inlet are collected by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM10 in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.¹⁶

Nitrogen Dioxides (NO₂) and Sulphur Dioxides (SO₂)

For NO₂, a known quantity of air was sampled for 8 hours through impinger containing NaOH solution, forming a stable solution of sodium nitrate. The nitrate ion produced during sampling is determined colorimetrically at 540 nm using sulphanilamide and N-(1-Naphthyl)-ethylenediamine dihydrochloride (NEDA) and for SO₂ a known quantity of air was passed for 8 hours through the impinger containing

known quantity of absorbing solution (Sodium Tetrachloro Mercurate). The absorbed solution forms a stable color complex of dichlorosulphito mercurate with p-rosaniline hydrochloride. The intensity of color developed was measured using colorimeter at 560 nm.^{17,18}

Air Quality Index (AQI)

The air quality index is a tool used by¹⁹ and other agencies to provide actual status of air pollution in a particular area. The air quality index (AQI) was calculated by the following formula:

$$AQI = 100 \times \frac{\text{Observed mean concentration of a pollutant}}{\text{Standard for the respective pollutant}}$$

Statistical Analysis

Correlation and regression of air pollutants were analyzed using software SPSS 15.0 and instat 3.03.

RESULTS

The monthly average values for suspended particulate matter (SPM), Nitrogen dioxide (NO₂), Sulphur dioxide (SO₂) at six different stations are shown (Table 1, Figure 1). The result shows that the SPM levels are in the range of 132.34-197.45 µg/m³ in residential area of cuddalore district, Tamil Nadu, India. It is observe that the concentration of SPM level is slightly below the National Ambient Air Quality Standards (NAAQS) of Central Pollution Control Board²¹ of India which is 200 µg/m³ for residential area (Figure 1); Among the six stations highest and lowest SPM concentration are observe at station S6 (Sangolikuppam) and S2 (Thiruvandipuram) respectively. The average monthly value of NO₂ and SO₂ are in the range of 56.33-89.71 µg/m³ and 62.90-80.68 µg/m³ at six different stations of cuddalore residential area. The concentration of NO₂ and SO₂ levels are within the limit 80 µg/m³ (NAAQS) except station S1, S4, S5 for NO₂ and S3 for SO₂, where the concentration are above the limit (80 µg/m³).

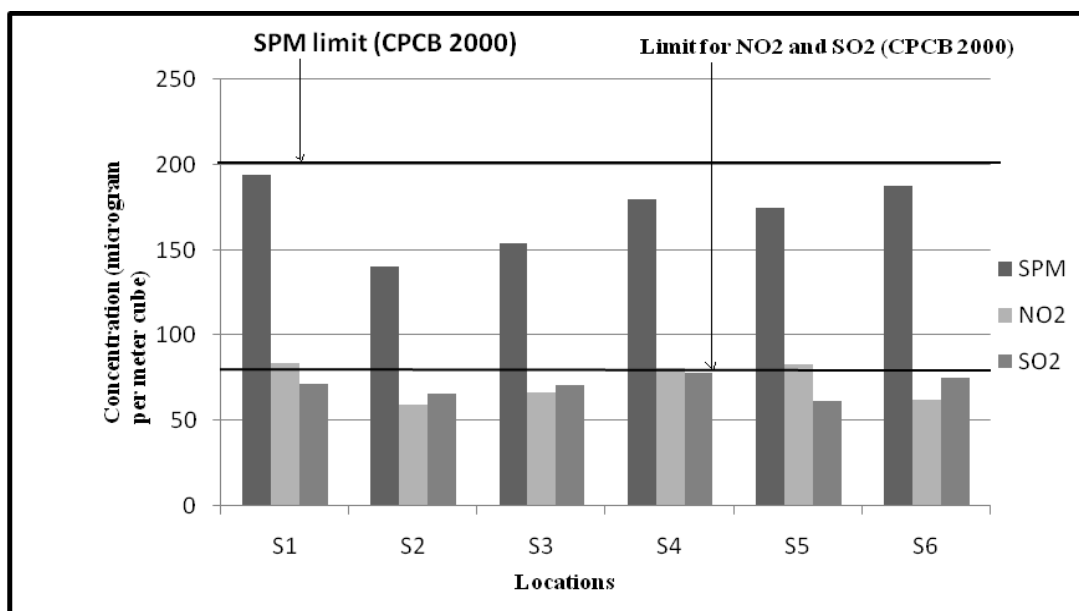


Figure 1. Showing the mean concentration of SPM, NO₂ and SO₂ levels at six different sites (S1-S6) during the period of April-May-June 2013 in Cuddalore District, Tamil Nadu

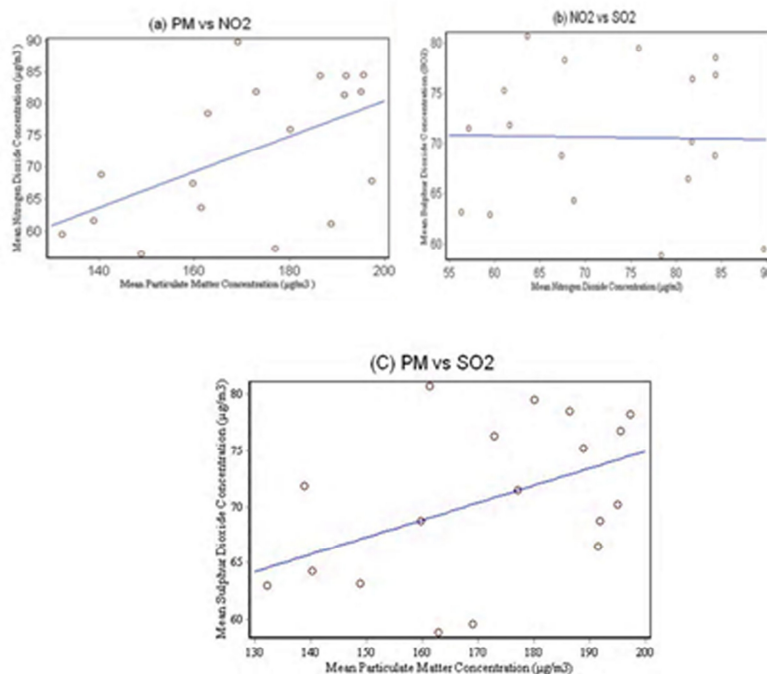


Figure 2 (a), (b) and (c) showed the correlation and linear regression equations between PM, NO₂ and SO₂.

Regression Equations

$$\begin{aligned} Y(\text{NO}_2) &= 0.279221X(\text{PM}) + 24.5651 \quad (\text{Eqn. 1}) \quad (R^2 = 0.2888) \quad (r = 0.53) \\ Y(\text{SO}_2) &= 71.46 - 0.0119X(\text{NO}_2) \quad (\text{Eqn. 2}) \quad (R^2 = 0.0004) \quad (r = -0.01) \\ Y(\text{SO}_2) &= 0.1538X(\text{PM}) + 44.18 \quad (\text{Eqn. 3}) \quad (R^2 = 0.216) \quad (r = 0.46) \end{aligned}$$

DISCUSSION

Particulate matters are distributed throughout all stations below the limit 200 µg/m³ (Figure 1) Among the six different stations at sangolikuppam the SPM level was highest of 197.45 µg/m³ close to the threshold level by international standard 200 µg/m³. The present value (197.45 µg/m³) was less than the previously reported (260 µg/m³) by Balashanmugum *et al.*¹⁶ at sangolikuppam in cuddalore. The result clearly indicates that the SPM level was decreased but still it is in threshold level so it will be early to say that, there have been significantly decrease in SPM level according to time. A significant positive correlation is shown in (Table 2) and linear regression [Figure 2 (a)] is observe between SPM and NO₂ ($r = 0.53$). The major constituent of SPM is traffic system, burning of cashew leaves, road construction, burning of municipal wastes and unpaved road. Majewski and Przewozniczuk²¹, reported that the particulate matter (PM) pollution are relation to spatial and temporal, where as Prasad²² observed the relation between SPM and respirable particulate matter (RSPM) was due to local polluting sources rather than meteorology and climate change of places. Furthermore, everyday in India population and traffic increases so more chances of SPM level will above the critical level (200 µg/m³). Nitrogen Dioxide (NO₂) was within the limit 80 µg/m³ at all stations except few stations

(S1, S4, S5). NO₂ level was highest at S5 (Cuddalore Old Town) of 89.71 µg/m³ exceed the limit for residential area of 80 µg/m³. Present value is 12.13 % higher than standard value (80 µg/m³). At the same place NO₂ concentration is 26.58 % higher (101.27 µg/m³) than limit (80 µg/m³) reported by.¹⁶ Burnett *et al.*²³ analyze 12 canadian cities and concluded that, main source of NO₂ comes from traffic and other combustion sources. Present values is above the limit for NAAQS which means Cuddalore Old Town (S₅) air is polluted, and, the reason is industrial emissions, automobiles, heavy traffic, domestic and commercial activities. Whereas highest concentration of SO₂ was observed at S₃ (Tirupadripulur) station of 80.68 µg/m³ is above 0.85 % from the limit 80 µg/m³ (NAAQS). Figure 2 (b) and Table 2 shows that there is no clear correlation ($r = -0.01$) and regression ($R^2 = 0.0004$) between NO₂ and SO₂ but significant positive correlation and regression observe between PM and SO₂ ($r = 0.46$). In this study we observe, SO₂ levels is increase (80.68 µg/m³) in comparison to previous study (62.92 µg/m³) by.¹⁰ Tirupadripulur (S₃) is near to bus stand and railway station so the reason of pollution is automobiles and heavy vehicles pressures. The 24 h mean concentration of Air Quality Index (AQI) is in the ranges of 75.47-97.05 (Table 3) and is revealed that all the six different stations are polluted except S2

(Thiruvandipuram) which is moderately polluted. Among the six station the AQI levels are in order of S1 (Nellikuppam) > S4 (Cuddalore New Town) > S5 (Cuddalore Old Town) > S6 (Sangolikkuppam) > S3 (Tirupadripuliyur) > S2 (Thiruvandipuram). Nellikuppam is polluted as it was near to sugar mill complex and mostly surrounded by sugarcane lands where as Thiruvandipuram (S2) was residential area with less vehicular zone. A higher index value indicates higher health risks to human being.

CONCLUSION

The 24 hour average concentration of SPM, NO₂ and SO₂ are higher than the National Ambient Air Quality Standards (NAAQS). It is clearly indicated that there is positive correlation and regression between PM with NO₂ and SO₂. Except station (S2) other stations (S1, S3, S4, S5, and S6) are moderate to polluted category by Air Quality Index (AQI). Present study is also confirmed that, there is increasing in SO₂ levels in comparison to before studied at the same place. The major sources of pollutants are mainly industrial, vehicular emissions, unpaved road, construction work, burning of municipal wastage and commercial activities. On the basis of finding in our study the suggestions are like: avoid move on unpaved road, newly constructed road, and use mask when going outside, intake sufficient vitamins and minerals which can improve immunity. Present work is limited in concern to the time period and six locations observations, again there is no fixed distance among the stations and meteorological conditions are not accounted at Cuddalore but these problems will more clear when further and continuous research going on.

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