Eco. Env. & Cons. 28 (February Suppl. Issue) : 2022; pp. (S367-S371)

ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i02s.059

A Study on Air Quality Index for Tiruchirappalli City Corporation

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(Received 30 June, 2021; Accepted 25 July, 2021)

ABSTRACT

In recent years, Air quality monitoring and pollution control is a foremost environmental concern in the world. The World Health Organization estimates 14 million people are affected by air pollution every year. Respiratory and Heart related diseases are mostly caused by air pollutants. Tiruchirappalli is the fourth largest city in the state of Tamilnadu. The study was carried out during the months of December 2018 to March 2019. Ten locations were selected randomly for air quality analysis status for Tiruchirappalli city. The present study aims to develop air quality index, Sulphur Dioxide, Nitrogen Oxides, Respirable Suspended Particulate Matter and Suspended Particulate Matter. The study revealed that the Ariyamangalam area has higher air pollutants than other locations. PM10 and SPM exceeds the permissible limit of NAAQ Standards. SO2 and NOx within limit but continued exposure will lead to health hazards.

Keywords: *Ambient Air pollution, SO2, NOx, PM10, SPM, Air Quality Index*

Introduction

Air pollution is the release of chemicals, dust particles and biological materials to the natural environment. Major sources of air pollution are motor vehicles and fossil burning. The primary air pollutants are harmful chemicals which mix with air due to human activities. Primary pollutants react with some component of the atmosphere to generate a secondary pollutant. The World Health Organization (WHO) reported, chronic exposure of particulate matter is leading to morbidity and mortality due to Respiratory diseases of asthma and allergy (Healy *et al.,* 2007). Recently reported, the health impact of human beings mostly caused by particulate pollutants in developing countries (Yadaw *et al.,* 2012 and Chaurasia *et al.,* 2013). In an urban environment, rapid growth of vehicles is one of the major sources for air pollutants and other sources of urban air pollutants are burning of municipal solid waste and release of Industrial waste, etc. Various factors which determine the air pollution levels corresponding to meteorological properties of the atmosphere, topographical influence, emission sources, physical and chemical nature of dust particles. There are many publications reported, these pollutants are affected by different ways in human beings, such as respiratory, cardiovascular diseases. Sulfur dioxide, nitrogen oxides, total suspended particulate matter, carbon monoxide, lead and carbon dioxide are major pollutants of outdoor air pollution (Barman *et al.,* 2008). Unplanned urbanization and rapid industrialization are causing fall to the environment quality in developing countries (Sengupta *et al.,* 1996). Sulphur dioxide (SO_2) is a colourless and highly reactive gas, which is considered as an important air

pollutant. It is mostly emitted from fossil fuel consumption, natural volcanic activities and industrial processes. Oxides of Nitrogen (NO_x) are important ambient air pollutants which may increase the risk of respiratory infections. They are mainly emitted from motor engines and traffic-related air pollutants. Particulates are major parts of air pollutants and $PM_{2.5}$ is more easily penetrating to lungs than PM_{10} and SPM by respiration (Chelani *et al.*, 2001). The rapid growth of vehicles and road activities to disturb the balance of natural atmosphere (Chauhan, 2008). In India, several studies reported related to ambient air quality monitoring and calculation of Air Quality Index (AQI). IND-AQI was launched on 17 September 2014 by the Minister for Environment, Forests and Climate Change on 17 September 2014. Mamta, Bassin (2010), reported Suspended Particulate Matter is a dominant pollutant in the air quality index value more than 95% of the time at most of the locations. The present study deals with the Air quality monitoring of SO_2, NOx, PM_{10}, SPM and to develop Air Quality Index (AQI) for different locations in Tiruchirappalli city, Tamilnadu, India.

Materials and Methods

Study Area

Tiruchirappalli city is the fourth largest city in Tamil Nadu, which is situated on the banks of river Cauvery at 10.5°N78.43°E in India. Total population of the city is 8,47,387 in the 2011 census: its urban population is 1,022,518 of which 507,632 are males and 514,886 are females. The sampling locations are selected by industrial, traffic intersectional and residential zone category.

Sampling Locations

Srirangam, No 1 Tollgate TVS Tollgate, Mannarpuram, Kajamalai, K.K. Nagar, Somarasam Pettai, Thuvakudi, Thiruvarambur,

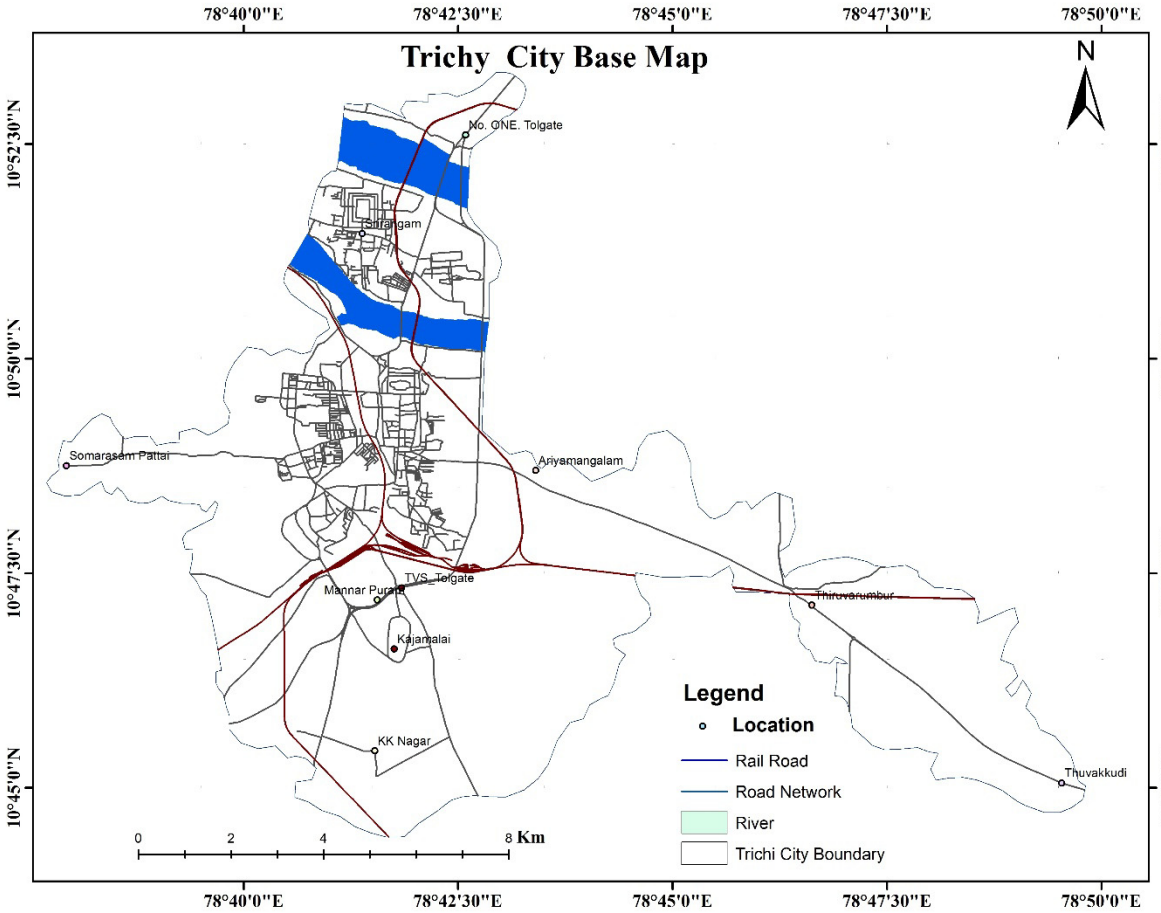

Fig. 1. Map of Monitoring Stations in Tiruchirappalli City Corporation

Ariyamangalam. Samples are collected for analysis during December 2018 to March 2019.

Sampling and Analysis

The Ambient air samples are collected by using a Respirable Dust Sampler (APM 460 NL) with Gaseous pollutant attachment (APM 400 TE). Whatman filter paper (25.4X 24.5) used for measurement of Dust particles of size 10 microns (PM10): SPM was collected by cyclone bottle in Respirable Dust sampler. The absorbent of Sodium tetra Chloro-mercurate solution and Sodium hydroxide solution was prepared for determination of Gaseous pollutants such as SO_2 and NOx. The instrument was continuously running for 8 hrs, flow rate is 1.6 LPM. After sampling, the Absorbent was taken into further analysis at the laboratory.

Determination of Sulphur Dioxide [IS-5182 (Part-2), 2001]

West and Geake Method is used for this study. The Gaseous pollutant of Sulphur Dioxide (SO2) was absorbed from the Sodium tetra Chloro-mercurate solution in Impinger. After sampling, the solution was further analysed in the lab. Formaldehyde was used for colour reaction. Finally, the colour intensity was measured at 560 nm in Double Beam UV-Spectrophotometer (ELICO SL210). Results are expressed in terms of µg/m^3.

Determination of Nitrogen Oxides [IS-5182 (Part-6), 2006]

Modified Jacob-Hochheiser Method used for this analysis. Oxides of Nitrogen (NOx) are collected from respective absorbents of Sodium Hydroxide solution. After sampling, NEEDA was used for colour reaction. The colour intensity was measured at 540nm in Double Beam UV-Spectrophotometer. Finally, the results are expressed in terms of µg/m^3.

Measurement of Respirable Suspended Particulate Matter [IS-5182 (Part-23), 2006]

Respirable Particulate Matter (PM10) was determined by the Gravimetric Method. The mass concentration of PM10 is calculated by measuring the initial and final weight of glass filter Sheets (Whatman filter paper (25.4X 24.5)) in volume of air sampled. The final results are expressed in terms of µg/m^3.

Measurement of Suspended Particulate Matter (SPM) [[IS-5182 (Part-23), 2006]]

Suspended Particulate Matter was collected by a Cyclone bottle that is holder in Respirable Dust Sampler (RDS). Also, the same Gravimetric method and calculation followed by PM10. Finally, results are expressed in terms of µg/m^3.

Calculation of AQI (IND-AQI Method)

The Air Quality Index was calculated according to the formula given by Central Pollution Control Board (CPCB), under guidelines and regulation to be followed.

Results and Discussion

In the present study, the concentration of Sulphur dioxide, Nitrogen oxides, Respirable Suspended Particulate Matter and Suspended Particulate Matter were measured in different 10 locations in the study area. Further, that data was used to calculate the Air Quality Index (AQI). Results are represented in following Fig. 2, 3, 4, 5 and Table 1.

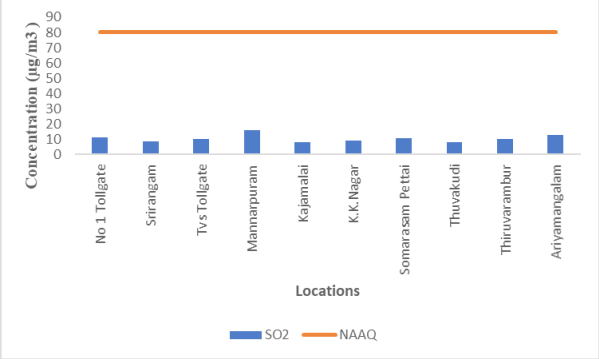

Fig. 2. Eight Hours Average concentration of Sulphur dioxide.

The concentration of Sulphur dioxide ranges from 7.9 µg/m^3 and 15.88 µg/m^3 found in Thuvakudi and Mannarpuram respectively. The average value of 8.0 µg/m^3 was measured in Srirangam, Kajamalai and K.K. Nagar. The concentration of Sulphur dioxide is within the permissible limit (80 µg/m^3) of CPCB prescribed standard in all areas, found in Fig 2.

The concentration of Nitrous oxides value is 25.36 µg/m^3 measured in the Ariyamangalam area that is higher than other areas. The lowest value is 14.47 µg/m^3 measured in Kajamalai. The average value

seen in Thiruverumbur, No 1 Tollgate and Srirangam. Obtained concentration of Nitrogen oxides value is within the permissible limit (80 µg/m^3) of the CPCB prescribed Standard, in all locations of the study area, results are presented in the Fig. 3.

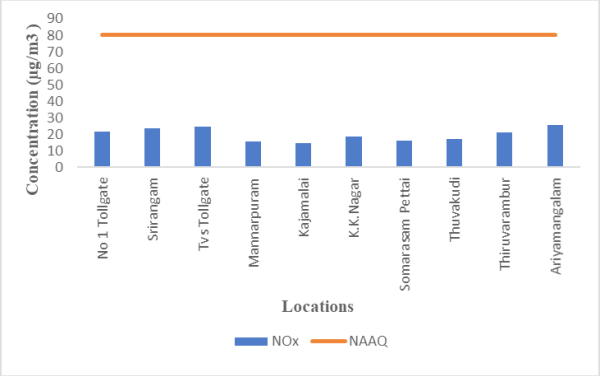

Fig. 3. Eight hours average concentration of Oxides of Nitrogen.

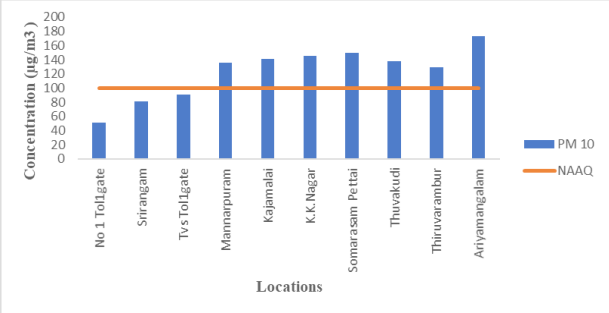

Fig. 4. Eight Hours Average concentration of Particulate Matter (PM_{10})

The concentration of Respirable Suspended Particulate Matter (RSPM) is overdoing as per the permissible limit (100 µg/m^3) of CPCB standard. The concentration ranges from 51.38 µg/m^3 to 173 µg/m3: the areas No 1 Tollgate and Ariyamangalam respectively. Ariyamangalam has a higher dust pollution in the study area. The average value is recorded in Mannarpuram, Thuvakudi, Kajamalai and K.K Nagar, represented in Fig. 4.

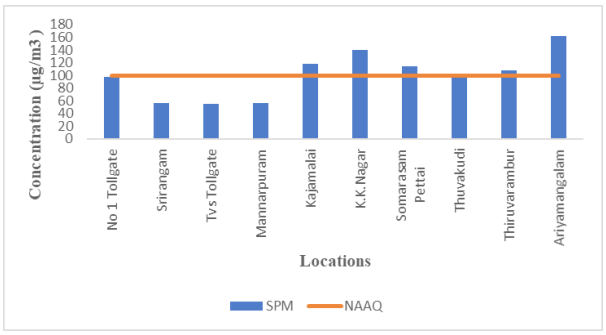

Fig. 5. Eight Hours Average concentration of Suspended Particulate Matter.

The concentration of Suspended Particulate Matter (SPM) was exceeding the permissible limit (100 µg/m^3) of CPCB Standard. The concentration ranges from 55 µg/m^3 to 162 µg/m^3: low value recorded in TVS Tollgate; higher value recorded in Ariyamangalam exceeds the level of standard. Srirangam, TVS Tollgate, Mannarpuram and Thuvakudi has within the limit of standard, results are found in Fig. 5.

Air quality status of a particular area was identified by Air Quality Index (AQI) method. Maximum 'Moderate' level of pollution found in Mannarpuram, Kajamalai, K. K. Nagar, Somarasam Pettai, Thuvakudi, Thiruvarambur and Ariyamangalam. Good condition air quality found in No 1 Tollgate area. Srirangam and TVS Tollgate has a minimum impact in the pollution called as 'Satisfactory' level.

Table 1. Location wise AQI and Health impacts

Locations	AQI	Pollution	Health impact
No 1 Tollgate	51	Good	Minimal Impact
Srirangam	81	Satisfactory	Minor Breathing discomfortTo sensitive people
TVS Tollgate	90	Satisfactory	
Mannarpuram	124	Moderate	Breathing discomfort to the people with lungs, asthma and heart diseases
Kajamalai	127	Moderate	
K.K. Nagar	130	Moderate	
Somarasam Pettai	133	Moderate	
Thuvakudi	125	Moderate	
Thiruvarambur	120	Moderate	
Ariyamangalam	149	Moderate	

Conclusion

The present study reveals that Sulphur dioxide and Nitrous oxide are within the limit of national ambient air quality standards (NAAQ) but dust particles of RSPM or PM10 and SPM exceeds the permissible limit in the following locations Ariyamangalam, Kajamalai, K.K. Nagar, Somarasam Pettai, Thuvakudi, Thiruverumbur The 'Moderate level' of air quality index measured in the area of Mannarpuram, Kajamalai, K.K. Nagar, Somarasam Pettai, Thuvakudi, Thiruvarambur, Ariyamangalam, this area peoples have breathing discomfort and respiratory diseases mortality. The 'Satisfactory' levels found in Srirangam and TVS Tollgate, sensitive peoples mostly affected in living in this area. This study can refer to air pollution control and management to initiate necessary action which leads to protecting the natural environment.

Acknowledgement

The authors are greatly thankful to the Ministry of Environment, forest and Climate change (MoEF & CC), RUSA 2.0 providing equipment facility to carry out the research work.

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