

AMBIENT AIR QUALITY IN AN URBAN AREA AND ITS EFFECTS ON PLANTS AND HUMAN BEINGS: A CASE STUDY OF TIRUCHIRAPPALLI, INDIA

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ABSTRACT

Though water and land pollution is very dangerous, air pollution has its own peculiarities, due to its transboundary dispersion of pollutants over the entire world. In any well planned urban set up, industrial pollution takes a back seat and vehicular emissions take precedence as the major cause of urban air pollution. Air pollution is one of the serious problems faced by the people globally, especially in urban areas of developing countries like India. All these in turn lead to an increase in the air pollution levels and have adverse effects on the health of people and plants. Western countries have conducted several studies in this area, but there are only a few studies in developing countries like India. A study on ambient air quality in Tiruchirappalli urban area and its possible effects selected plants and human health has been undertaken, which may be helpful to bring out possible control measures.

Keywords: ambient air quality, respiratory disorders, APTI, human health

INTRODUCTION

It is known fact that 60 % of air pollution in city is caused by automobiles only. The effect of these pollutants is observed at acute level on sensitive species both plants and animals. Plants are considered for investigation of effect of auto exhaust pollutants. Response of plants towards air is being assessed by air pollution tolerance index. Acute and chronic symptoms were observed to support the investigation regarding accumulation of pollutants. Some plant species and varieties are so sensitive that they can be conveniently employed as biological indicators or monitors of specific pollutants. They can further assist planner in managing the urban cities.

Human health is very closely linked to environmental quality, as the Etiology of most of the human diseases being related to the status of the living environment of man. According to statistics, 25% of all preventable illnesses are caused by detrimental environmental factors [UNEP, United Nations Children's Fund, WHO 2002]. In Africa, the environmental influence on disease incidence is even higher, being about 35 % (Gopalan H.N.B, 2003). Both the developed and developing countries are faced with the problems related to environmental pollution, caused by anthropogenic activities of man, disturbing the habitat around. Smoky indoor air, polluted ambient air, poor sanitation and

contaminated water play a crucial role in causing ill health. Existing cities are expanding, new cities are being created, and adjacent cities are merging. As a transportation systems are increasing everywhere. Therefore, air pollution has become a growing problem in cities through out the globe, and transportation is recognized as the major source of air pollution in many cities. In developing countries the air quality crisis in cities often attributes in large measures (40–80%) to vehicular emission. Despite the improved performance of technology is presently insufficient to counteract the growth of vehicles (Anon., 1980) and associated pollution problems. Thus, it is necessary to evaluate the status of urban air pollution continuously and to assess its impact on human health and plants. So that proper mitigative measures can be implemented.

MATERIALS AND METHODS

The study has been done in the Tiruchirappalli city (10.5°N , 78.43°E, 78.8 MSL), situated on the banks of the river Cauvery, India. It is the fourth largest city in Tamil Nadu. It spreads over an area of 146.90 sq. Km with total population of above 7, 50,000. Tiruchirappalli the fourth largest city of Tamil Nadu is very rapidly growing in terms of its population and number of vehicles. The 4 major highways NH 45, NH 67, NH 210 and NH 277 pass through the city. The heavy traffic on these highways has been significantly contributed to air pollution in the city.

Ambient air quality was monitored for major air pollutants viz Suspended Particulate Matter (SPM), Sulphur dioxide (SO₂) and Oxides of Nitrogen (NO_x). High volume sampler (Envirotech APM-430) is used for sampling. SO₂ and NO_x were absorbed in Sodium tetrachloromercurate and Sodium hydroxide. Analysis of this solution by West and Gaeke method, and Griess – Saltzman method, respectively. SPM was collected on pre weighed glass fiber filter (Whatman). Filter paper was again weighed after sampling and the difference in weight were used to calculate concentrations of SPM in respective areas and expressed as µg/m³ of air. The monitoring was done for 24 hours. This research work was carried out from August 2008 to January 2009 (Six months). Eight sampling stations were selected to represent 8 different traffic volumes and activities. They are Central bus stand, Chattram bus stand, Puthur, Palakarai , Srirangam, Main guard gate, TVS toll gate and Old Paalpanne Circle. Leaf samples were collected from 15 different plants growing commonly in traffic areas of Tiruchirappalli city and their Air pollution tolerance index (APTI) was determined (Singh and Rao 1983). The Polythene bags were used for storing leaf samples during transportation. The leaf samples were refrigerated at about 20⁰ C, when they had to be stored. The samples were estimated for Leaf-extract pH (Singh and Rao 1983), relative moisture content (Wealtherly, 1965), total chlorophyll (Arnon, 1949) and ascorbic acid (Keller and Schwanger, 1977). Estimation of Leaf-extract pH: 0.5 g of leaf material was ground to paste and dissolved in 50 ml of distilled water and Leaf-extract pH was measured by using calibrated digital pH meter. Estimation of relative moisture content: Fresh leaf samples collected from the study area and were brought immediately to the laboratory and washed thoroughly. The excess water was removed with the help of filter paper. The initial weight of samples were taken (W1 g) and kept in oven at 60⁰ C until constant weight was obtained and the final weight was taken (W2 g). Total Chlorophyll was estimated by acetone extraction method and ascorbic acid was estimated by 2,6-dichlorophenol indophenol's dye method. APTI given

by $APTI = \{[A(T + P) + R] / 10\}$. Where A is the ascorbic acid in mg/g; T is the total chlorophyll in mg/g; P is pH of leaf sample; and R is relative water content in mg/g. Data related to adverse effects of vehicular pollution on human health in eight different locations of Tiruchirappalli has been collected by the 'Questionnaire method', covering many individuals. A questionnaire was prepared and survey was conducted particularly in case of suspected allergic population by inquiring the recurrence of the type of allergic symptoms and other respiratory diseases. The occasions of this onset was recorded with each individual to assess the allergic status. The secondary data were collected from various health centers, hospitals and clinics which belong to the area under study.

RESULTS & DISCUSSION

Table-1 shows average concentrations of SPM, SO₂ and NO_x at each sampling station. The highest concentration of SPM, SO₂ is recorded at Palakarai, while the highest NO_x concentrations are recorded at Chattram bus stand. SPM concentrations ranged from 417.81 to 1400.49 μg/m³. SO₂ concentrations ranged from 10.88 to 33.70 μg/ m³. NO_x concentrations ranged from 132.22 to 177.01 μg/ m³.

Table: 1 Average concentration of SPM, SO₂ and NO_x (μg/m³) at sampling stations

Sampling Station	SPM	SO ₂	NO _x
Central Bus Stand	1111.38	23.78	173.69
Chattram Bus Stand	1400.49	19.05	177.01
Puthur	417.81	13.01	166.90
Palakarai	1324.96	33.70	171.26
Srirangam	863.63	10.88	132.22
Main Guard Gate	924.40	19.21	164.73
TVS Toll Gate	1102.04	19.70	167.43
Old Paalpanne Circle	991.61	18.29	119.55

Except Puthur SPM concentrations exceeded ambient air quality standards of Central pollution control board (CPCB) at all sampling stations. High traffic volume in this region is major reason for these high values. But SO₂ is well within the standards of CPCB all sites. Whereas NO_x concentrations exceeded quality standards of CPCB at all sampling stations except Srirangam.

The air pollution tolerance index (APTI) value of 15 different plants growing commonly in traffic area of the city is given in table 2. In the present study the maximum APTI is observed in *Azadirachta indica* 12.95 and minimum in *Enterolobium saman* 7.12 (Table 1). Nrusimha et al., (2005) have studied the APTI of many plant species and established the maximum APTI value for *Azadirachta indica* to be 16.50 and minimum in

Pongamia glabra. Agarwal et al., (1991) studied APTI of some selected plants and described *Mangifera indica* as reliable bioaccumlator plant. Rao (1972), Agarwal and Agarwal (1988) also reported high sensitivity of *Mangifera indica*, *Azadirachta indica*, *Psidium guajava*, *Mangifera indica*, *Bougainvillea glabra*, *Lagerstroemia indica*, *Morinda tinctoria*, *Hibiscus rosasinensis*, *Ixora coccinea*, *Polyalthia longifolia*, *Achras sapota* and *Cassia fistula* are reported high APTI values and considered as tolerant plant.

Table: 2 APTI of some selected plant species

Name of the plant Species	pH	% of Relative moisture content	Total Chlorophyll mg/g	Ascorbic acid mg/g	APTI
<i>Achras sapota</i>	4.3	88.22	0.97	1.71	9.72
<i>Azadirachta indica</i>	5.9	90.77	0.42	6.14	12.95
<i>Bauhinia purpurea</i>	4.1	87.39	0.40	0.70	9.05
<i>Bougainvillea glabra</i>	5.5	90.56	1.56	2.80	11.03
<i>Cassia fistula</i>	4.2	80.01	0.30	3.23	9.45
<i>Citrus aurantifolia</i>	3.9	79.00	0.24	1.89	8.68
<i>Enterolobium saman</i>	4.9	65.31	0.69	1.07	7.12
<i>Hibiscus rosasinensis</i>	4.2	91.49	0.71	2.40	10.32
<i>Lagerstroemia indica</i>	4.2	84.94	1.60	3.51	10.52
<i>Mangifera indica</i>	6.9	81.43	0.50	5.10	11.91
<i>Morinda tinctoria</i>	4.7	90.93	0.26	2.41	10.28
<i>Polyalthia longifolia</i>	5.2	90.99	0.18	1.43	9.86
<i>Pongamia glabra</i>	4.4	84.30	0.38	0.93	8.87
<i>Psidium guajava</i>	6.6	81.97	0.21	6.64	12.71

Total exposure to an individual to a specific pollutant is determined by the concentration of contaminant and the duration of its exposure (Spengler and Dockery,1981). Exposure to indoor and outdoor air quality is different because they always change with time and diurnal pattern (TERI, 1995). Exposure to SPM is also an equally serious risk to health SPM includes all air-borne particles in the size range of 0.5 μ to 100 μ . The actual health damage caused by dust particles depends upon its nature and composition (Binder *et al.*, 1976). The effects attributed to mild eye irritation mortality (David,1995). The data generated from the survey were analysed to assess the percentage of allergic population and the suspected allergy causing agents. The results are shown in Table-3. The assessment of respiratory disorders (RDs) was obtained from the questionnaire survey from the doctors. On the basis of the survey of the SPM-related RDs each disease was recorded for indexing the imprint class I to IV. The highest imprint score depicts the maximum severity of RDs.

Table: 3 Estimation of allergic symptoms

Complaint	Total no. cases	Condition	No. of person	Percent of incidence.
Neck block	20	Allergic	17	85
		Non- Allergic	3	15
Sneezing	35	Allergic	30	86
		Non- Allergic	5	14
Cough	60	Allergic	50	83
		Non- Allergic	10	17
Hyperacidity	29	Allergic	18	62
		Non- Allergic	11	38

Table: 4 Imprint classifications of respiratory diseases

Imprint score	Symptoms
0.0	No RD: healthy, free from any respiratory disease
2.5	Mild RD: suffering from only upper track respiratory infections (UTRI)
5.0	Moderate RD: suffering from UTRI as well as lowest track respiratory infections
10.0	Severe RD: Suffering from bronchitis, asthma, allergic thintis, fibrosis, asbestosis, pneumoconiosis and non-malignant RDs

CONCLUSION

From the results, it can be concluded that Suspended Particulate Matter (SPM) is the main pollutant within the Tiruchirappalli city. Except at Puthur, in all eight sampling stations, the concentration of SPM exceeded the ambient air quality standard by CPCB . The reason is being the growing number of automobiles and poorly and congested road with heavy traffic. This problem can be overcome by adapting advance eco-friendly transport systems, usage biofuels and widening of roads. The plants with low APTI

value like *Bauhinia*, *Pongamia*, *Citrus* and *Enterolobium* were categorized as sensitive and plants with high APTI value like *Azadirachta*, *Psidium*, *Mongifera*, *Bougainvillea*, *Largerstromia*, *Morinda*, *Hibiscus*, *Ixora*, *Polyalthia*, *Achras* and *Cassia* as tolerant. Further studies on Air pollution tolerance index in respect to different areas of Tiruchirappalli city are required to find out the tolerance of various plants to air pollutants. The study reveals that urban air pollutants have adverse effects on human health. In Tiruchirappalli city, many individuals residing near by traffic intersections are suffering from respiratory diseases. Proper environmental awareness and personal protective devices may be useful in avoiding health problems.

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