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ASSESSMENT OF LST, NDVI, AIR QUALITY AND POLLUTION INDICES FOR PLANT SPECIES IN TIRUCHIRAPPALLI CITY, TAMIL NADU

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Abstract: Air pollution is one of the serious environmental issues that increase day by day due to anthropogenic activities. The demand for urbanization has made it even worse these days. Tiruchirappalli city is the 4th largest and one of the oldest cities in Tamilnadu. To keep the city's development environment friendly, it is necessary to keep an eye on the air pollution indices of the city. This can help the city planners to create a pollution-free and sustainable city. Planting the right trees in the city can help in reducing the effects of air pollution. This study clearly depicts the effects of air pollution indices with respect to various local plant species in Tiruchirappalli city. The methodology of the study involves the collection of 30 leaf samples from local plant species in two types of locations- one in a residential area (Edamalaipattipudur) and another in a transport line (Tiruchirappalli – Karur National Highway), both within the city limit. 15 samples from each site were collected and tested in the biological laboratory for Air Pollution Tolerance Index (APTI) and Anticipated Performance Index (API). Land Surface Temperature (LST) and Normalized Difference Vegetation Index (NDVI) maps of the study area were created using MODIS data. Air Quality Index was calculated for the major pollutants like So2, No2, PM 10, and PM 2.5 from five air quality monitoring stations in the city. Geographic Information System (GIS) and biological assessments conjointly aid in monitoring the air quality and its effects on plants and humans in the study area.

Index Terms - Air Pollution, Land Surface Temperature, Normalized Difference Vegetation Index, Air Pollution Tolerance Index, Anticipated Performance Index, Air Quality.

I. INTRODUCTION

Clean air is the foremost requirement to sustain healthy lives of humankind (TERI. 2015). Air is as susceptible to pollution from human activities as are water and land environments (Barfield, B. J., R. L. Blevins, A. W. Flofle, C. E. Madison, S. Inamder, D. I. Carey, and V. P. Evangelou, 1992). Air pollution can be defined broadly as the introduction of chemicals, particulate matter, or biological materials into the atmosphere that cause harm or discomfort to humans and damage to the natural environment (Guy Hutton 2011). Air pollution in developing countries is due to the increase of emission sources mainly through vehicles (Chen B, Kan H. 2008) (Molina MJ, Molina LT. 2004) (Chi CC. 1994). Urban air pollution consists of a complex mix of various substances in different physical and chemical states those arise from various sources (Rinki Jain, Karnika Palwa 2015) and is made up of many kinds of pollutants including materials in solid, liquid, and gas phases (Vallero D. 2007). A global study on air pollution from 1900 to 2050 depicts that, after 2040, outdoor air pollution deaths and damage costs will exceed indoor air pollution in developing countries (Guy Hutton 2011).

Vegetation acts as a natural cleanser of pollution (Dhankhar R., Mor V., Narwal S. 2015) because it absorbs and metabolize the air pollutants (Kashish Walia, R.K. Aggrawal and Bhardwaj, S.K. 2019) and hence green belts are recognized as effective tools for alleviating air pollution (Chaudhry S., Panwar J. 2016). Trees function as absorbers of air pollutants (Rully Besari Budiyanti, Hinijati Widjaja, 2019) and play an important and positive role in atmospheric purification. The reduction of air pollutants naturally consumes the particulate matter and smoke (Luliana Florentina Gheorghe and Barbu Ion 2011) (Raina A. K., Sharma A. 2006) and thus, performs like a scavenger for pollutants (P. C. A. Swami. 2009). Trees can act as biological filters that can remove large number of air-borne pollutants and hence improve the quality of air in polluted environments (K.P. Beckett, P.H. Freer-Smith, G. Taylor. 1998). Trees play an important role in monitoring and maintaining the ecological balance by actively participating in the cycling of nutrients and gases like carbon dioxide, oxygen, and gaseous pollutants (K.P. Beckett, P.H. Freer-Smith, G. Taylor. 1998). Plants, the main greenbelt component, act as a sink and as living-filters to minimize air pollution by absorption, adsorption, detoxification, accumulation and/or metabolization without sustaining serious foliar damage or decline in growth, thus improving air quality by providing oxygen to the atmosphere (Govindaraju, M., & Ganeshkumar, R.S., Muthukumaran, V.R., Visvanathan, P. 2011). Planting of trees and shrubs forms one of the best solutions to mitigate air pollution in urban areas and plant selection criteria should not only be limited to colorful flowers, leaves, robustness, watering issues and space but it should also be able to help improve air quality (D. Mondal, S. Gupta, J.K. Datta. 2011). Plants growing along the roadsides get affected at the maximum as they are the primary recipients to different air pollutants and show varied levels of tolerance and sensitivity and plays an important role in monitoring and maintaining the ecological balance by actively participating in the cycling of nutrients and gases like carbon dioxide and oxygen (Mahecha G.S., Bamniya, B.R., Nair, Neelima, and Saini D. 2013).

The investigation of Rai and Panda indicated that the tolerant species plays a role in reducing overall pollution, and sensitive species can be regarded as primitive indicators of pollution (Rai P.K., Panda S. 2014). The recognition and classification of plants into tolerant and sensitive groups is essential because the sensitive plants can be used as an indicator and the tolerant as a sink for the pollutants in any habitat (Kuddus M., Kumari R., Ramteke P. W. 2011). Some experiments previously carried out show that leaves with wider and rough surfaces, have a high effectiveness value in adsorbing particles (Luqmanul Hakim, Priambudi Trie Putra, and Azka Lathifa Zahratu 2017). The results of an analysis carried in Jakarta suggest that the leaves of tree species like Ficus and Mahoni adsorb pollutants (Rai, Prabhat. 2014). Species like Mangifera indica and Ficus religiosa are recommended for planting, in future, to combat atmospheric particulate pollution in an industrial (Rourkela) and non-industrial (Aizawl) area (A. Balasubramanian, C. N. Hari Prasath, K. Gobalakrishnan and S. Radhakrishnan 2018). Tree species like Alstonia scholaris, Azadirachta indica, Mangifera indica and Muntigea calibera were suggested for planting in Coimbatore city. A study indicates that shrubs like Cassia auriculata and Bougainvillea spectabilis and a tree named Aegle marmelos can be used as sink towards air pollutants in the Vicinity of Cement Industry and Yogi Vemana University Campus (G. Buchchi Babu, S. Nazaneen Parveen, K. Naveen Kumar, M. Sridhar Reddy 2013).

The study area, Tiruchirappalli city, is the second most polluted city in Tamil Nadu (WHO Survey May 2016). The present study is initiated to identify the specific tolerant and sensitive plants that can be used to develop a green belt around the city. To analyze the appropriate species that combat the air pollutants, indices like- the Air Pollution Tolerance Index (APTI), which is based on biochemical parameters, and the Anticipated Performance Index (API), which is based on biological and socio-economic aspects of a plant, are endorsed. An attempt is made to assess the Land Surface Temperature (LST) and Normalized Difference Vegetation Index (NDVI) and additionally the Air Quality Index are calculated in Tiruchirappalli city, Tamil Nadu.

II. STUDY AREA

The study area, Tiruchirappalli city, extends from 10° 48' 18" N to 78° 41' 8" E (News Track, 2015). It is the 4th largest city in Tamil Nadu that covers an area of 167.23 sq. km (Trichy City Corporation, 2024). The study area has a population of 847,387 people (Tiruchirappalli Census 2011). Tiruchirappalli is a busy city situated on the banks of river Cauvery with many national highways passing through that contribute significantly to the air pollution of the city. The study area map (Fig.1) shows the two locations (Edamalaipattipudur and Tiruchirappalli-Karur National Highway within the city limit pointed on it, from which the leaf samples were collected for testing.

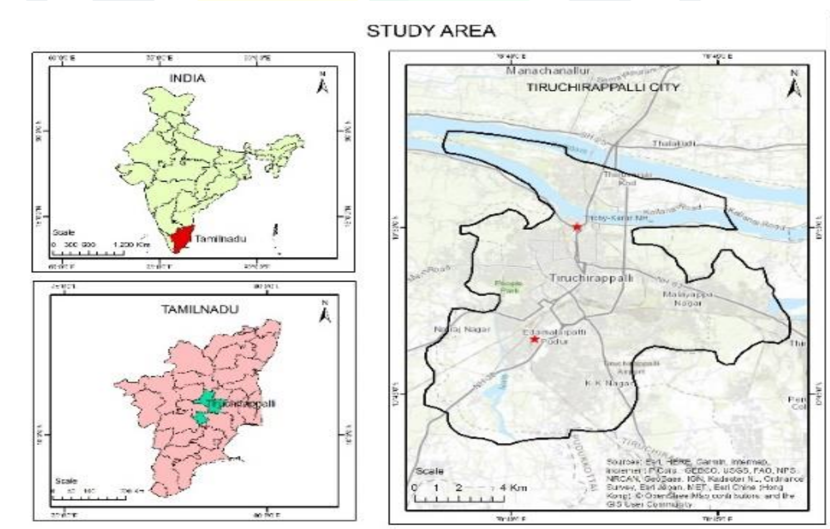


Fig. 1 Study Area

III. OBJECTIVES

-To assess the Land Surface Temperature and Normalized Difference Vegetation Index.
-To analyze the Physiological and Biological parameters of the leaf species collected in two sample locations.
-To assess Air Pollution Tolerance Index and Anticipated Performance Index of the leaf samples.
-To map the Air Pollution Index for 4 major pollutants in 5 stations.

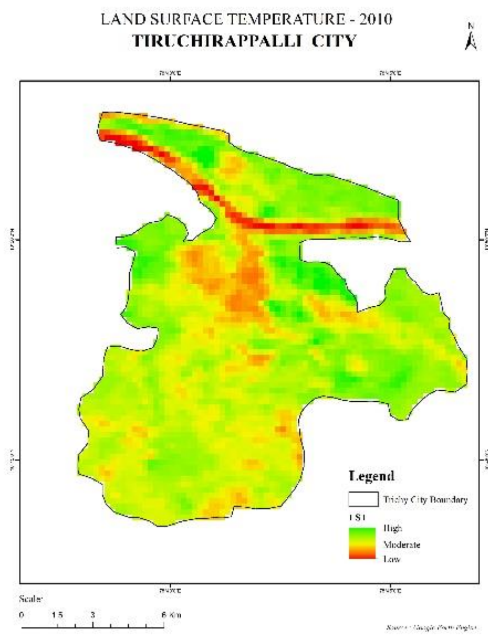
IV. METHODOLOGY AND DATA

-Create Land Surface Temperature (LST) and Normalized Difference Vegetation Index (NDVI) maps.
-Collection of leaf samples (15 each), from a residential area- Edamalaipattipudur and along the transport line- Tiruchirappalli-Karur National Highway.
-Assessment of Air Pollution Tolerance Index and Anticipated Performance Index for the leaf samples.
-Calculate Air Quality Index for 4 major pollutants, in 5 air quality monitoring stations in Tiruchirappalli city.

V. RESULTS AND DISCUSSION

5.1. LAND SURFACE TEMPERATURE (LST)

Land surface temperature (LST) is the main factor used to determine the energy exchange and surface radiation and is the key input parameters in climatic, hydrological, ecological, and biogeochemical models (Shunlin Liang, Jindi Wang, (Eds) 2020). The exchange of energy budget between the outgoing long wave terrestrial radiation emitted from the Earth surface and the sensible heat flux of the atmosphere is controlled by the LST (Copertino, V, Pierro, M. D, Scavone, G, & Telesca, V 2012). From Landsat-8 TIRS, Split Window (SW) algorithm studies were carried out for acquiring LST from band 10 and 11. The LST was derived by integrating them for the years 2010 and 2023. The analysis of LST for the study area in 2010 and 2023 is shown in Fig.2 and Fig.3 respectively.



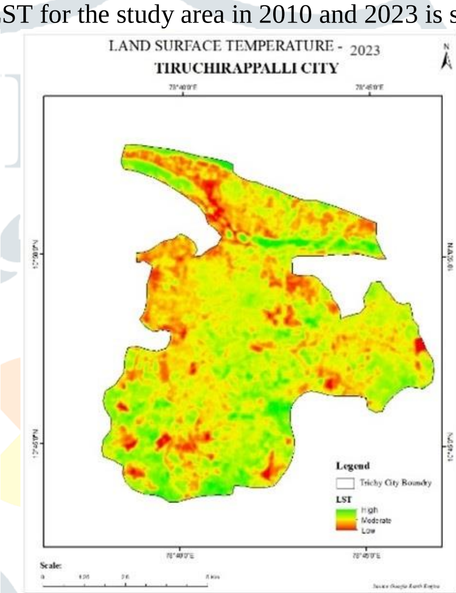


Fig. 2 LST - 2010 **Fig. 3 LST - 2023**

From the LST maps of Tiruchirappalli city for 2010 (Fig.2) and 2023 (Fig.3), the following inferences are drawn. The LST is classified as High, Moderate and Low and are represented in colour shades of green, yellow, and red respectively. The results prove that most of the study area has experienced a high to moderate Land Surface Temperature, between these year periods. It could be observed that the area where the river Cauvery passes through the city, has low LST values. And wherever the city has experienced higher land surface temperature, the vegetation cover is noticed to be minimum.

During 2010, the low LST (20.06 sq.km, 21%), is noticed in the north central parts of the study area, especially along the Cauvery River course. And the high (107.06 sq.km, 64%), and moderate class of LST (35.11sq.km, 15%) are found scattered throughout the study area. In 2023, the low class has covered 40.13 sq.km (24%), high (46.82 sq.km, 28%) and moderate (80.27 sq.km, 48%). Between 2010 and 2023, the area under high has decreased in the study area.

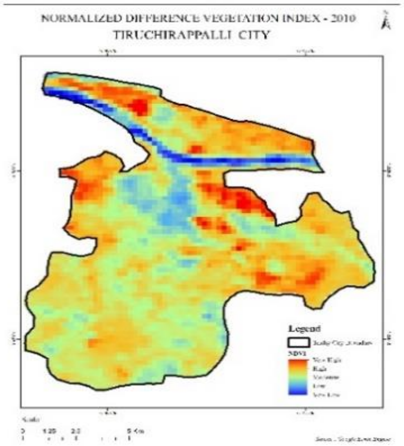


Fig. 4 NDVI - 2010

5.2. NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI)

NDVI index uses radiances or reflectance from a red channel around 0.66 µm and a near-IR channel around 0.86 µm, where the red channel is in the strong chlorophyll absorption region, while the near-IR channel is in the high reflectance plateau of vegetation canopies (Gao and Goetz 1995). The NDVI has become the primary tool for description of vegetation changes and interpretation of the impact of environmental phenomena (Kogan 1990). The Normalized Difference Vegetation Index (NDVI) is used to study the changes in vegetation and trends in occurrence of agricultural drought in any area (Sruthi and Mohammed Aslam 2015).

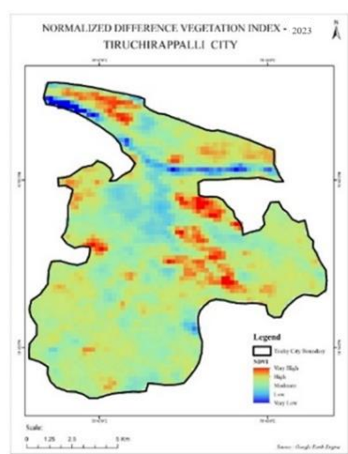


Fig. 5 NDVI - 2023

Normalized Difference Vegetation Index (NDVI) maps are prepared for 2010 and 2023. The NDVI values of Tiruchirappalli city are classified into five categories- Very high, High, Moderate, Low and Very low, with the colour shades from Red to Blue. Red represents very high NDVI value and Blue shows the areas with very low NDVI values.

From the NDVI maps of Tiruchirappalli city for 2010 (Fig.4) and 2023 (Fig.5), the following inferences are drawn. During 2010, the area under NDVI classes fall under five classes- very high (21.73 sq.km, 13%), high (16.72 sq.km, 10%), moderate (93.63 sq.km, 56%), low (20.06 sq.km, 12%) and very low (15.05 sq.km, 9%). During 2023, the area under NDVI classes falls under five classes- very high (25.08 sq.km, 15%), high (45.15 sq.km, 27%), moderate (68.56 sq.km, 41%), low (18.39 sq.km, 11%) and very low (13.37 sq.km, 8%). Between 2010 and 2023, the area of NDVI has increased under the classes of very high, high, low, and very low. The area under moderate has shown a decrease from 2010 to 2023.

5.3 ASSESSMENT OF AIR POLLUTION TOLERANCE INDEX (APTI) AND ANTICIPATED PERFORMANCE INDEX (API)

SAMPLE COLLECTION AND ANALYSIS

To assess the APTI based on the four parameters, namely leaf ascorbic acid, leaf extract pH, total chlorophyll, and relative water content, the fully matured leaves of selected plant species were collected randomly from sample 1- the residential area, Edamalaipattipudur, and sample 2-the transport line, Tiruchirappalli-Karur National Highway. The leaf samples are collected from either side of the road in the morning hours and were then transported to the laboratory in ice – box and washed with normal water and then with 0.1N HCL followed by distilled water.

The structural characteristics, including biological and Socio Economic and Laminar structure of plant species collected in sample 1- Residential area- Edamalaipattipudur is shown in table 1. The structural characteristics, including biological and socio economic and laminar structure of plant species collected in sample 2- Transport line- Tiruchirappalli-Karur Highway is shown in table 2. The tables 1 and 2 show the name of the plant species, habit, canopy structure, type, leaf size, texture, hardiness, and its economic value.

Table 1: Structural Characteristics of Sample 1 – Residential area-Edamalaipattipudur

Sl. No.	Plant Name	Biological and Socio-economic			Laminar Structure			
		Plant Habit	Canopy Structure	Type of Plant	Leaf Size	Texture	Hardiness	Economic Value
1.	Azadirachta indica	Tall tree	Irregular	Deciduous	Small	Smooth	Delineate	Medicinal uses, Oil seed
2.	Polyalthiya longifolia	Tall tree	Symmetrical Pyramidal Growth	Evergreen	Medium	Smooth	Delineate	Medicinal uses, Timber, Noice pollution Control
3.	Hibiscus rosa-sinensis	Shrub	Irregular	Evergreen	Medium	Smooth	Delineate	Medicinal and ornamental uses
4.	Thespesia populanae	Large tree	Irregular	Evergreen	Medium	Coriaceous	Hardy	Timber and ornamental uses
5.	Citrus limen	Shrub/ Medium sized tree	Round Crown Globular	Evergreen	Medium	Smooth	Delineate	Grown for fruit
6.	Annona squamosa	Medium Sized tree	Irregular	Evergreen	Medium	Coriaceous	Hardy	Fruits/Medicinal uses
7.	Mangifera indica	Large tree	Irregular	Evergreen	Medium	Coriaceous	Hardy	Fruits
8.	Psidium guajava	Medium tree	Open	Evergreen	Medium	Coriaceous	Hardy	Fruits
9.	Tectona grandis	Tall tree	Open	Deciduous	Large	Coriaceous	Hardy	Timber
10.	Murraya koenigii	Shrub/ Medium tree	Open	Evergreen	Small	Smooth	Delineate	Medicine, Curry leaf
11.	Ficus religiosa	Tree	Irregular	Deciduous	Medium	Smooth	Delineate	Medicine for more than about 50 disorders
12.	Moringa oleifera	Tree	Open	Deciduous	Small	Smooth	Delineate	Vegetable, Medicinal uses
13.	Atrocarpia heterophyllus	Tree	Irregular	Evergreen	Medium	Smooth	Hardy	Fruit yielding tree, Medicinal uses
14.	Millettia pinnata	Tree	Spreading dense	Deciduous	Medium	Smooth	Delineate	Medicinal uses
15.	Prosopis juliflora	Tree	Open	Evergreen	Small	Smooth	Hardy	Used in soil reclamation, wind breaker

Table 2: Structural Characteristics of Sample 2 – Transport line-Tiruchirappalli – Karur National Highway

Sl. No.	Plant Name	Biological and Socio-economic			Laminar Structure			
		Plant Habit	Canopy Structure	Type of Plant	Leaf Size	Texture	Hardiness	Economic Value
1.	Millettia pinnata	Tree	Spreading dense	Deciduous	Medium	Smooth	Delineate	Medicinal uses
2.	Annona squamosal	Medium sized tree	Irregular	Evergreen	Medium	Coriaceous	Hardy	Fruit/Medicinal uses
3.	Atlanthas excels	Tree	Open	Deciduous	Large	Coriaceous	Delineate	Medicinal, fire sticks
4.	Terminalia arjuna	Large tree	Irregular	Deciduous	Medium	Coriaceous	Hardy	Timber, Medicinal uses

5.	Citrus limen	Shrub/Medium sized tree	Rounded Crown/ Globular	Evergreen	Medium	Smooth	Delineate	Grown for fruit
6.	Carica papaya	Shrub to Medium tree	Globular	Evergreen	Large	Coriaceous	Hardy	Fruit and several medicinal uses
7.	Mangifera indica	Large tree	Irregular	Evergreen	Medium	Coriaceous	Hardy	Fruit
8.	Azadtracha indica	Large tree	Irregular	Deciduous	Small	Smooth	Delineate	Medicinal uses Oil seed
9.	Morinda tinctoria	Tree	Globular to dense	Evergreen	Medium	Smooth	Delineate	Medicinal, Dye yielding properties
10.	Calotropis gigantean	Shrub	Globular	Evergreen	Large	Coriaceous	Leathery	Medicinal and Fiber yielding plant
11.	Madhaca longifolia	Tree	Spreading dense	Deciduous	Medium to large	Smooth	Delineate	Timber, Medicinal uses
12.	Albizia saman	Tree	Spreading dense	Semi Deciduous	Small	Smooth	Delineate	Ornamental, Timber and medicinal uses
13.	Jatropha curcas	Shrub	Dense	Semi Evergreen	Large	Smooth	Delineate	Oil seed Medicinal uses
14.	Ziziphus jujube	Tree	Irregular	Deciduous	Small	Coriaceous	Hardy	Medicinal uses
15.	Pithecellobium dulce	Tree	Irregular	Evergreen	Small	Smooth	Delineate	Medicinal and for fruits

ANALYSIS OF BIOCHEMICAL PARAMETERS

Ascorbic acid

To estimate leaf ascorbic acid content of selected plant species 10g of the sample was taken. The sample was homogenized in metaphosphoric acid (3%) and filtered. The volume of the filtrate was made to 100ml by metaphosphoric acid (3%). The aliquot measuring 10ml was taken and titrated against standardized dye to an end point of pink colour as per the standard procedure (Association of Official Agricultural Chemists 1980). The ascorbic acid content was expressed in milligrams per grams (mg g-1).
Ascorbic acid (mg/100g) = Dye factor × Titre reading × Volume made × 100 / Weight of leaves taken × Volume taken for estimation.

Leaf extract pH

Leaf extract pH of the sample was analyzed by the method suggested by Barrs and Weatherly (Barrs, H. D. and Weatherly, P. E. 1962) Fresh leaf sample (10g) was homogenized using deionised water (50ml) and the supernatant obtained after centrifugation was collected for the determination of pH using a digital pH meter.

Total chlorophyll

For the estimation of total chlorophyll content of the leaves, 10mg of the leaf sample was homogenized with 7ml dimethyl-sulphoxide and was kept in an oven at a temperature of 60- 65ºC for 30-35mins. The samples were filtered and volume was made to 25ml by dimethyl-sulphoxide. The absorbance was measured at 663nm and 645nm in spectrophotometer and chlorophyll was estimated using the following equation (Hiscox, J. D. and Israelstam G. F. 1979).
Total chlorophyll (mg g-1) = $20.2\ A_{645} + 8.02\ A_{663}$ x V / a × 1000 × w Where;

V is volume of extract made
a is length of light path in cell (usually 1cm)
W is weight of sample
A_{645} is absorbance at 645nm
A_{663} is absorbance at 663nm

Relative water content

Relative water content of the samples was estimated using the method proposed by Singh [40] and was computed by using following equation

RWC = (FW – DW) / (TW – DW) × 100 Where;
RWC is relative water content (%)
FW is fresh weight of leaf sample
DW is dry weight of leaf sample
TW is turgid weight of leaf sample. (Kashish Walia, R.K. Aggrawal and Bhardwaj, S.K. 2019)

AIR POLLUTION TOLERANCE INDEX (APTI)

Air pollution tolerance index (APTI) is used to choose tolerant species and helps in monitoring plant tolerance towards air pollution (Trivedi M., Raman A. 2001), (Panda L. R. L, Aggarwal R. K, Bhardwaj D. R. 2018) and this index based on biochemical parameter is generally employed for recognizing the tolerance level of plants (Govindaraju, M., Ganeshkumar, R. S., Muthukumaran, V. R. and Visvanathan, P. 2012). This index provides a reliable method for screening large numbers of plants with respect to their susceptibility to air pollution (Lohe R.N., Tyagi B., Singh V., Kumar P.T., Khanna D.R., Bhutiani A., 2015). The more lenient plants based on APTI are considered suitable utensils for the urban environment to decrease the air pollution and anticipated performance index worth is utilized to estimate the fitness of plant species for green belt formation (Chaudhry S., Panwar J. 2016). The role of plants in assessing the air pollution is being increasingly recognized and is used in evaluating the Air Pollution Tolerance Index which is a species dependent plant attribute and expresses the inherent ability of plant to encounter stress arising from air pollution and helps in identifying the tolerance levels of plant species based on biochemical parameters viz. ascorbic acid, pH of leaf extract, total chlorophyll and relative water content (Shannigrahi, A. S., Sharma, R. C. and Fukushima, T. 2003).

The APTI serves as an important guiding tool to suggest the tolerance of a particular plant species against air pollution. A single parameter cannot suggest the behaviour of a plant species towards air pollution. Hence, APTI is a dependent parameter which is based on four biochemical parameters viz. leaf extract pH (P), total chlorophyll content (TC), ascorbic acid content (AA) and relative water content (RWC) (Chandan Sahu, Sanjat Kumar Sahu 2015). Plants with higher APTI value are tolerant to air pollution and can be used to mitigate air pollution while those with low index value show less tolerance and can be used to signify levels of air pollution (Madan, S. and Chauhan, S. 2015). Plants with high APTI value like Azadirachta, Psidium, Mongifera, Bougainvillea, Largerstromia, Morinda, Hibiscus, Ixora, Polyalthia, Achras and Cassia as tolerant in Tiruchirappalli city (Sirajuddin. M. Horaginamani, M. Ravichandran 2010). APTI is based on four biochemical parameters such as chlorophyll content, leaf extract pH, and relative water content and ascorbic acid in leaf samples and APTI determination provides a reliable method for screening large numbers of plants with respect to their susceptibility to air pollution (Lohe R.N., Tyagi B., Singh V., Kumar P.T., Khanna D.R., Bhutiani A., 2015).

By using the parameters like chlorophyll content, leaf pH extract, relative water content and ascorbic acid content, the APTI was computed by using the following equation:

$$\text{APTI}=\frac{[A(T+P)]+R}{10}$$

Where;
A is ascorbic acid (mg/g), T is total chlorophyll (mg/g)
P is leaf extract pH
R is relative water content (%)

The calculation of APTI of plant species collected in sample 1- Residential area- Edamalaipattipudur is shown in table 3 and the sample 2- Transport line- Tiruchirappalli-Karur Highway is shown in table 4.

Table 3: Calculation of APTI (Air Pollution Tolerance Index) – Sample 1 – Residential area-Edamalaipattipudur

Sl. No.	Plant Name	Biological Parameters					
		RWC %	pH	TCH (mg/g)	AA (mg/g)	Leaf Area (Cm^2)	APTI
1.	Azadtracha indica	76.28	6.5	47.72	7.2	6.5	46.66
2.	Polyalthiya longifolia	80	6.7	12.62	5.4	71	18.43
3.	Hibiscus rosa-sinensis	75.65	6.0	42.23	4.6	19	29.75
4.	Thespesia populanae	73	6.6	23.27	7.8	105.5	30.59
5.	Citrus limen	81	5.8	38.28	5.9	25	34.10
6.	Annona squamosa	68	5.8	20.32	6.7	50.5	24.30
7.	Mangifera indica	41	6.4	15.55	8.7	59	23.19
8.	Psidium guajava	52	6.6	39.06	6.3	16	33.96
9.	Tectona grandis	23	5.4	11.61	3.8	281	8.76
10.	Murraya koenigii	41	5.8	19.19	4.7	4.5	15.84

11.	Ficus religiosa	64	6.8	48.19	3.7	56	26.74
12.	Moringa oleifera	74	6.3	44.34	6.3	3.5	39.30
13.	Atrocarpia heterophyllus	42	5.2	6.42	5.1	55.5	10.12
14.	Millettia pinnata	69	6.5	15.45	5.2	30.5	18.31
15.	Prosopis juliflora	74	5.8	10.40	3.8	1	13.55

Table 4: Calculation of APTI (Air Pollution Tolerance Index) – Sample 2 – Transport line-Tiruchirappalli – Karur National Highway

Sl. No.	**Plant Name**	**Biological Parameters**					
		RWC %	pH	TCH (mg/g)	AA (mg/g)	Leaf Area (Cm^2)	APTI
1.	Millettia pinnata	53	6.7	25.43	3.2	31.5	15.58
2.	Annona squamosal	34	5.9	21.21	4.6	80.5	15.87
3.	Atlanthas excels	22	5.8	20.18	5.4	14.8	16.22
4.	Terminalia arjuna	31	5.6	28.91	6.3	76.1	24.84
5.	Citrus limen	16	6.0	29.31	4.8	53	18.54
6.	Carica papaya	8	6.6	22.82	6.7	154.5	20.51
7.	Mangifera indica	46	6.7	44.56	6.8	34	39.45
8.	Azadtracha indica	9	6.8	44.65	8.6	15.5	45.14
9.	Morinda tinctoria	44	5.9	23.20	4.6	30.3	17.78
10.	Calotropis gigantean	60	6.2	38.62	5.2	73.5	29.30
11.	Madhaca longifolia	33	5.6	34.56	4.3	53	20.56
12.	Albizia saman	18	7.1	22.34	5.3	4.6	17.40
13.	Jatropha curcas	8	7.2	10.70	7.6	120.2	14.40
14.	Ziziphus jujube	18	6.5	22.82	7.8	2.2	24.66
15.	Pithecellobium dulce	56	6.8	42.92	3.8	3.3	24.49

ANTICIPATED PERFORMANCE INDEX (API)

The Anticipated performance index worth is utilized to estimate the fitness of plant species for green belt formation and it is a statistic used to assess dominant species' ability to remove pollution in the atmosphere and create green belts (Chaudhry S., Panwar J. 2016) (Enete I.C., Alabi M.O., Chukwudelunzu V.U. 2012). A research study was carried out in order to assess the API and APTI of some frequently grown trees and ornamental shrubs at urban sites in Quetta and the University of Balochistan for the growth of green belts (Saadullah Khan Leghari, Ali Akbar , Said Qasim , Sami Ullah , Mudassir Asrar , Huma Rohail , Sheikh Ahmed , Khalid Mehmood , Imran Ali 2019).

The API and APTI of several commonly cultivated trees and ornamental shrubs at residential and national highway areas in Tiruchirappalli for the growth of green belts were assessed in a study. The anticipated performance index, which was developed by evaluating and grading tree species based on their APTI and some biological and socioeconomic features, changed from not recommended to good. The highest values of API (1) is calculated where Thespesia populanae, Psidium guajava & Tectona grandis are considered as good for green belt development and with API value (2), species like Carica papaya, Calotropis gigantean, Annona squamosal and Atlanthas excels are considered as moderate.

The plant growing along the residential area- Edamalaipattipudur and transport line- Tiruchirappalli-Karur National Highway varied significantly in their tolerance levels (Table 5 and 6).

Table 5: Grading Anticipated Performance Index (API) – Sample 1 – Residential area-Edamalaipattipudur

Sl. No.	Plant Name	Assessment Parameters				Laminar Structure				Grade Allotted		
		APTI	Plant Habit	Canopy Structure	Tree Type	Size	Texture	Hardiness	Economic value	Total plus	% Scoring	API Grade
1.	Azadtracha indica	+++++	++	-	-	-	-	+	+	9	46.66	1
2.	Polyalthiya longifolia	++++	++	+	+	+	-	-	+	10	18.43	2
3.	Hibiscus rosa-sinensis	+++++	+	-	+	+	-	-	+	9	29.75	1
4.	Thespesia populanae	+++++	++	++	+	+	+	+	+	14	30.59	7
5.	Citrus limen	+++++	+	-	+	+	-	-	+	9	34.10	4
6.	Annona squamosa	+++++	+	-	+	+	+	+	-	10	24.30	3
7.	Mangifera indica	+++++	++	+	+	+	+	+	-	12	23.19	4
8.	Psidium guajava	+++++	+	+	+	+	+	+	+	12	33.96	7
9.	Tectona grandis	+	++	+	-	++	+	+	-	8	8.76	5
10.	Murraya koenigii	++	+	-	+	-	-	-	+	5	15.84	1
11.	Ficus religiosa	+++++	+	-	-	+	-	-	+	8	26.74	-1
12.	Moringa oleifera	+++++	+	+	-	-	-	-	+	8	39.30	-1
13.	Atrocarpia heterophyllus	+	+	-	+	+	-	+	+	6	10.12	3
14.	Millettia pinnata	++++	+	++	-	+	-	-	+	9	18.31	2
15.	Prosopis juliflora	++	+	-	+	-	-	+	+	6	13.55	3

Table 6: Grading Anticipated Performance Index (API) – Sample 2 – Transport line-Tiruchirappalli – Karur National Highway

Sl. No.	Plant Name	Assessment Parameters				Laminar Structure				Grade Allotted		
		APTI	Plant Habit	Canopy Structure	Tree Type	Size	Texture	Hardiness	Economic value	Total plus	% Scoring	API Grade
1.	Millettia pinnata	++	++	++	-	+	-	-	+	8	15.58	3
2.	Annona squamosal	++	+	-	+	+	+	+	+	8	15.87	5
3.	Atlanthas excels	+	++	+	-	++	+	-	+	8	9.42	5
4.	Terminalia arjuna	++	++	-	-	+	+	+	+	8	13.58	4
5.	Citrus limen	+++	+	+	+	+	-	-	-	7	18.54	1
6.	Carica papaya	++++	+	+	+	++	+	+	+	12	20.51	8
7.	Mangifera indica	+++++	++	-	+	+	+	+	-	11	39.45	4
8.	Azadtracha indica	+++++	++	-	-	-	-	-	+	8	45.14	-2
9.	Morinda tinctoria	++++	++	+	+	+	-	-	+	10	24.32	4
10.	Calotropis gigantean	++++	-	+	+	++	+	+	+	11	29.30	6
11.	Madhaca longifolia	++++	++	++	-	++	-	-	+	11	20.56	4
12.	Albizia saman	+++	++	++	-	-	-	-	+	8	17.40	1
13.	Jatropha curcas	++	-	+	+	++	-	-	+	7	14.40	2
14.	Ziziphus jujube	++++	++	-	-	-	+	+	-	8	24.66	1
15.	Pithecellobium dulce	++++	++	-	+	-	-	-	+	8	24.49	1

The assessment of APTI and API for sample 1- Residential area- Edamalaipattipudur is shown in table 7 and sample 2- Transport line-Tiruchirappalli-Karur Highway is shown in table 8.

Table 7: Assessment of APTI and API – Sample 1– Residential area-Edamalaipattipudur

Sl. No.	Plant Name	Total Grade Allotted	% Score	API Value	Assessment
1.	Azadtracha indica	+++++	46.66	1	Good
2.	Polyalthiya longifolia	++++	18.43	2	Moderate
3.	Hibiscus rosa-sinensis	+++++	29.75	1	Moderate
4.	Thespesia populanae	+++++	30.59	7	Moderate
5.	Citrus limen	+++++	34.10	4	Good
6.	Annona squamosa	+++++	24.30	3	Moderate
7.	Mangifera indica	+++++	23.19	4	Good
8.	Psidium guajava	+++++	33.96	7	Moderate
9.	Tectona grandis	+	8.76	5	Poor
10.	Murraya koenigii	++	15.84	1	Poor
11.	Ficus religiosa	+++++	26.74	-1	Moderate
12.	Moringa oleifera	+++++	39.30	-1	Good
13.	Atrocarpia heterophyllus	+	10.12	3	Poor
14.	Millettia pinnata	++++	18.31	2	Moderate
15.	Prosopis juliflora	++	13.55	3	Poor

Table 8: Assessment of APTI and API – Sample 2 – Transport line-Tiruchirappalli – Karur National Highway

Sl. No.	Plant Name	Total Grade Allotted	% Score	API Value	Assessment
1.	Millettia pinnata	++	15.58	3	Moderate
2.	Annona squamosal	++	15.87	5	Moderate
3.	Atlanthas excels	+	9.42	5	Poor
4.	Terminalia arjuna	++	13.58	4	Poor
5.	Citrus limen	+++	18.54	1	Moderate
6.	Carica papaya	++++	20.51	8	Moderate
7.	Mangifera indica	+++++	39.45	4	Good
8.	Azadtracha indica	+++++	45.14	-2	Good
9.	Morinda tinctoria	++++	24.32	4	Moderate
10.	Calotropis gigantean	++++	29.30	6	Good
11.	Madhaca longifolia	++++	20.56	4	Moderate
12.	Albizia saman	+++	17.40	1	Moderate
13.	Jatropha curcas	++	14.40	2	Poor
14.	Ziziphus jujube	++++	24.66	1	Moderate
15.	Pithecellobium dulce	++++	24.49	1	Moderate

From the tables, it could be inferred that, in sample 1-the residential area, Edamalaipattipudur, among the investigated plant species, Azadtracha indica has the highest APTI (46.66) and Tectona grandis has the lowest 8.76 APTI. In Tiruchirappalli- Karur National Highway, the maximum APTI of 45.14 was found in Azadtracha indica, and the lowest APTI of 9.42 in seen in Atlanthas excels.

The present investigation concludes that Azadtracha indica was the most tolerant of all the plant species, that was grown in both the sample areas of the study area, has proved with high APTI and API values. This species has a high economic and aesthetic value. Hence it can be recommended for planting this species, throughout the study area, that could support to minimize the air pollution. The findings also shows that the plant species -Citrus limen (Lemon Tree), Mangifera indica (Mango Tree), and Moringa oleifera (Moringa Tree), grown in Sample -1, the residential area Edamalaipattipudur, have shown a good APTI and API values, followed by Azadtracha indica. Similarly, Mangifera indica (Mango Tree), and Calotropis gigantean (Erukku Tree) grown in Sample-2, transport line Tiruchirappalli- Karur National Highway, has proved the good APTI and API values.

Hence, Azadtracha indica (Neem Tree), Citrus limen (Lemon Tree), Mangifera indica (Mango Tree), Moringa oleifera (Moringa Tree), and Calotropis gigantean (Erukku Tree) are the plant species that are recommended for planting throughout the study area, as they could play a vital role in minimizing the air pollutants in Tiruchirappalli city.

5.4 AIR QUALITY INDEX

AQI is a tool that is used to report the overall air quality status gives an idea about the environmental status and tells the public to understand how clean or polluted the breathing air is (Shivangi Nigam, B.P.S. Rao, N. Kumar, V. A. Mhaisalkar 2015). The establishment of ambient air quality standards can provide a basis and guarantee the management of ambient air quality to protect human health, maintain ecological environmental safety, and promote harmonious, sustainable development that protects people, society, and nature (Fang, M., Chan, C.K. and Yao, X. 2009). The air quality levels of three cities (Anqing, Hefei, and Suzhou) in Anhui Province were investigated, compared, and discussed for the nonepidemic period and the epidemic prevention and control period to gain more insight into the variations in air quality during that period (Kaijie Xu, Kangping Cui, Li-Hao Young, Ya-Fen Wang, Yen-Kung Hsieh, Shun Wan, Jiajia Zhang. 2020). Studies have shown that fine particulate pollution (PM2.5) is highly correlated with population mortality and morbidity (Shen, F.Z., Ge, X.L., Hu, J.L., Nie, D.Y., Tian, L. and Chen, M.D. 2017). Air quality Index is measured and compared with relative ORAQI values (Bhuyan P. K., Samantray P., Rout S. P. 2010).

Air Quality Index was done based on dose-response relationships of pollutants to obtain breakpoint concentration (U. S. Environmental Protection Agency (USEPA). 2006). It is identified that PM10 as the dominant pollutant in the index value (Pipalatkar. P. P., Gajghate. D.G and Khaparde V.V. 2012). The main sources of atmospheric particulate matter include fossil fuel combustion, motor vehicle exhaust emissions, industrial production, construction, road dust, biomass combustion, and secondary particulate matter generation (Song, Y., Tang, X., Xie, S., Zhang, Y., Wei, Y. and Zhang, M., Zeng, L. and Lu, S. 2007). The AQI works like a thermometer that runs from 0 to 500 degrees. However, instead of showing changes in the temperature, the AQI is a way of showing changes in the amount of pollution in the air (How is air quality measured? Updated July 14, 2022).

The air quality index of Tiruchirappalli city is calculated in 5 air quality monitoring stations- Gandhi market, Main Guard Gate, Bishop Heber College, Golden Rock and Central Bus Stand, for 4 major pollutants- SO2, NO2, PM10 and PM2.5, for the years 2010 and 2023. The values of four major pollutants, for 5 stations for the years 2010 and 2023 is shown in table 9 and 10. From the tables it could be inferred that the values of **So2, No2, PM10 and PM 2.5** has decreased in all stations, between these years' periods.

Location	**So2**	**No2**	**PM 10**	**PM 2.5**
Gandhi Market	11	16	36	19
Main Guard Gate	14	18	54	19
Bishop Heber College	10	15	35	19
Golden Rock	10	15	35	46
Central Bus Stand	14	18	45	35

Table – 9: Air Quality Index of Tiruchirappalli City – 2010

Table – 10: Air Quality Index of Tiruchirappalli City – 2023

Location	So2	No2	PM 10	PM 2.5
Gandhi Market	11	16	36	19
Main Guard Gate	14	18	54	19
Bishop Heber College	10	15	35	19
Golden Rock	10	15	35	46
Central Bus Stand	14	18	45	35

Location	So2	No2	PM 10	PM 2.5
Gandhi Market	16	20	113	50
Main Guard Gate	16	21	114	37
Bishop Heber College	11	15	43	46
Golden Rock	11	15	45	42
Central Bus Stand	16	20	120	146

The air quality index of Tiruchirappalli city for 5 air quality monitoring stations, for the years 2010 and 2023 is shown in table 11 and 12. From the tables it could be observed that, in 2010, the air quality of Gandhi market and Main Guard Gate is moderate, Bishop Heber College and Golden Rock is satisfactory and Central Bus stand is observed with very poor air quality. In 2023, the air quality in Gandhi market and Bishop Heber College is good; and the other locations Main Guard Gate, Golden Rock and Central Bus Stand is observed with satisfactory air quality.

Table 11: Major pollutants of Tiruchirappalli city – 2010

Station	AQI	Quality of Air
Gandhi market	109	Moderate
Main Guard Gate	109	Moderate
Bishop Heber College	77	Satisfactory
Golden Rock	70	Satisfactory
Central Bus Stand	320	Very Poor

Table 12: Major pollutants of Tiruchirappalli city – 2023

Station	AQI	Quality of Air
Gandhi market	36	Good
Main Guard Gate	54	Satisfactory
Bishop Heber College	35	Good
Golden Rock	77	Satisfactory
Central Bus Stand	58	Satisfactory

The Air Quality Index (AQI) is calculated for the years 2010 and 2023 and is shown in Fig. 6 and Fig. 7. From the figures, it could be observed that the air quality of Tiruchirappalli city has increased between 2010 and 2023. Overall air quality of the study area has improved from moderate to satisfactory in a decade. This could be also due to the increase in NDVI and decrease in LST values, throughout the study area. The study of air quality in Tiruchirappalli city and could also due to the increase in NDVI and decrease in

LST values, throughout the study area

Fig. 6 AQI - 2010

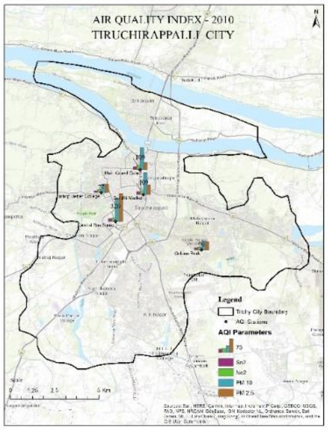
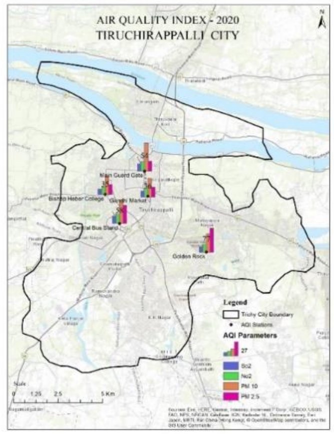


Fig. 7 AQI - 2023



From the results of the present study, it could be concluded that the planting of air pollution tolerance plant species like- Azadtracha indica (Neem Tree), Citrus limen (Lemon Tree), Mangifera indica (Mango Tree), Moringa oleifera (Moringa Tree), and Calotropis gigantean (Erukku Tree), would help in maintaining the air quality in Tiruchirappalli city.

VI. CONCLUSION

The calculation of Land Surface Temperature, Normalized Difference Vegetation Index (NDVI), Air Pollution Tolerance Index, Anticipated Performance Index, and Air Quality Index for two time periods 2010 and 2023 in Tiruchirappalli City has improved in 2023 compared to 2010. This shows that the air quality of the city is reduced due to decreased LST and increased NDVI values. This improvement is due to the presence of a greater number of trees found all over the study area. The type of trees present in the area plays a major role in contribution to reducing the pollution of the surroundings, so it is very important to focus on plating the right trees. In recent times Tiruchirappalli city has many parks situated, there are about 24 parks under 4 zones with in Tiruchirappalli city. Tiruchirappalli stands 4th in the list of smart cities. These public parks have a greater number of trees with high APTI and API values. The findings shows that Azadtracha indica (Neem Tree), Citrus limen (Lemon Tree), Mangifera indica (Mango Tree), Moringa oleifera (Moringa Tree), from Sample -1 Edamalaipattipudur which is a residential area and Mangifera indica (Mango Tree), Azadtracha indica (Neem Tree), Calotropis gigantean (Erukku Tree) from Sample-2 Karur National Highway which is a transportation area has Good APTI and API values. These trees can tolerate pollution efficiently and provide good amount of oxygen to the environment.

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