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AIR QUALITY STUDY OF SELECTED AREAS IN KERALA STATE

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Abstract - *Air is an important and vital component of earth's environment and slight change in its composition can have varied effects on growth and development of organisms on this planet. Rapid industrialization and vehicular traffic especially in the urban areas of India leads to the deterioration of air quality by adding toxic gases and other substances to the atmosphere. In developing countries like India, automobile exhaust plays a vital role in causing air pollution. Specifically in Kerala, transportation is one of the most important sources of air pollution. The exponential growth of automobiles in Kerala has been considerably increased faster than the rate of population growth. This study mainly aims at analyzing the previous year data for air quality at locations specified by KSPCB and the vehicle population data collected from the Motor Vehicle Department and to study the role of vehicular emission in the air quality deterioration at the same districts. Using this data, an index called Air Pollution Index is generated for the corresponding data. Similarly vehicular emission from the vehicle population data is also calculated. Time series forecasting is the important method nowadays to use these data and to forecast them for the future years to do the proper corrective measures.*

***Key Words*: Air Pollution, Air Pollution Index, Vehicular emission, Air quality status, Projected air quality status**

1. INTRODUCTION

Air is an important and vital component of earth's environment and slight change in its composition can have varied effects on growth and development of organisms on this planet. Air pollutants released by automobiles exerts detrimental effects on vegetation. The major reason for air pollution is the industrial as well as the automobile emissions. The air pollution is having a lot of adverse effects on various platforms. So it is very much important to monitor the air quality status of an area to know whether it is polluted or not. Along with the current monitoring of pollutant concentration, it is also important to know about the previous year data regarding the pollutants. This gives us an idea about the air quality trend of a particular place for a specific period. Among various other air pollutants, particulate matter, sulphur dioxide and oxides of nitrogen are having a significant role in effecting the air quality and thereby causing harm to human health. The present study mainly analyses the data regarding the concentration of various pollutants since 2005 at the selected study areas in Thrissur, Malappuram and Kozhikode districts of Kerala state. The data included concentration of various parameters like Sulphur dioxide, Nitrogen dioxide, Particulate Matter etc. These parameters were then considered to determine an index called Air Pollution Index. An index always facilitates an easy understanding of the current air quality status than going through a large amount of data regarding the pollutant concentrations. Along with the air quality data, data regarding the number of registered motor vehicle in the respective districts were also collected from the Motor Vehicle Department.

2. MATERIAL AND METHODS

2.1 Study Area

Knowledge of existing air pollutants levels and patterns within the area are essential for deciding the number and distribution of sampling stations. The number of monitoring stations in a city can be selected based on the background information collected on sources and emissions, population figures which can be used as indicators of region variability of the pollutant concentration.

The area under study includes districts like Thrissur, Malappuram, and Kozhikode in Kerala State, India. The selection of station is done as per IS 5182 Part 14; 2000 and they cover almost all the direction sectors of each district.

The Kerala State Pollution Control Board has selected mainly four stations for the ambient air quality monitoring in the three districts. In Thrissur they selected Poonkunnam, in Malappuram they selected Kakkanchery, and in Kozhikode, they selected Nallalam and KSRTC bus stand. The secondary data of ambient air quality of the above said stations are collected between the years 2005-2010.

Table -1: Details of study area

District	Secondary data collection from KSPCB
Thrissur	Poonkunnam
Malappuram	Kakkanchery
Kozhikode	Nallalam
	KSRTC Stand

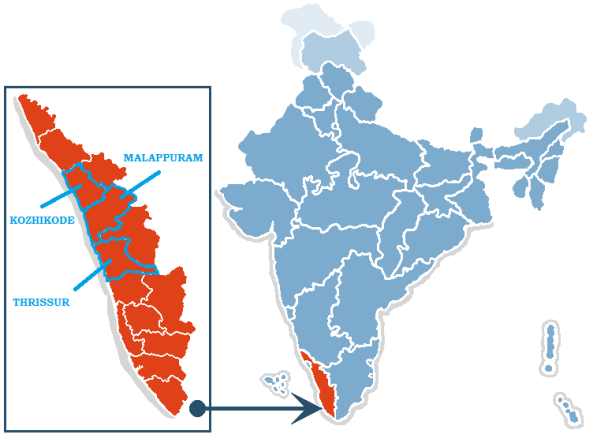


Fig -1: Study area including three districts of Kerala State

2.2 Methodology

A time series database has been created collating secondary data obtained from Kerala State Pollution Control Board (KSPCB) and Motor Vehicle department for the period between 2005 and 2015 and these are used for the trend line method to forecast the future air quality status as well as the vehicular emissions of respective districts. The air quality data included concentration of various parameters like Sulphur dioxide, Nitrogen dioxide, Particulate Matter and they are used for calculating the Air Pollution Index (API). The vehicular emission is calculated using the emission factor method wherein the number of various categories of vehicles as well as the emission factor of that particular category is being considered. All these data are then projected for future years and analysed the area where pollution is maximum among the three districts.

2.3 Air Pollution Index

The API is an index determined by calculating the degree of pollution in the city or at the monitoring station and includes four pollutants- Suspended Particulate matter (SPM), Respirable Suspended Particulate matter (RSPM), Sulphur dioxide (SO2) and Nitrogen dioxide (NO2). Each of these pollutants has an air quality standard which is used to calculate the overall API of the city. The air pollution index can be determined by the following equation:

Air Pollution Index (API) =

$$1/4\left[\frac{SO_2}{SSO_2}+\frac{NO_2}{SNO_2}+\frac{RSPM}{SRSPM}+\frac{SPM}{SSPM}\right]X\,100 \qquad \textbf{(i)}$$

Where,
SO_2 = Concentration of Sulphur dioxide in sample collected
S_{SO2} = Standard Concentration of Sulphur dioxide
NO_2 = Concentration of Nitrogen dioxide
S_{NO2} = Standard Concentration of Nitrogen dioxide.
RSPM = Concentration of respirable suspended particulate matter in sample collected
S_{RSPM} =Standard Concentration of respirable suspended particulate matter
SPM = Concentration of suspended particulate matter in sample collected
S_{SPM} =Standard Concentration of suspended particulate matter

The API for the last 10 years is calculated and the air quality trend of these selected cities is identified thereafter.

2.4 Vehicular emission

The huge increase in number of vehicles has always resulted in a significant increase in the emission load of various pollutants. Type of pollutants emitted by vehicles varies significantly by the category of vehicles and the type of fuel used for propulsion, say petrol driven or diesel run engines. With the traffic volume data which is collected both as primary and secondary data, emission of various pollutants are calculated. The traffic volume data included the categorized number of various vehicles over a specific time period in the study area. The level of emission from different categories of vehicles would be different. This is identified using a term called emission factor. In general the vehicular emission can be estimated using following equation:

$$Ei = \sum[(Veh_j \text{ x } D_j) \text{ x } E_{i,j,km}] \qquad \textbf{(ii)}$$

Where,

Ei – Emission of compound (i)

Veh_j – Number of vehicles per type

D_j – Distance travelled by vehicle type

$E_{i,j,km}$ – Emission factor (i), vehicle type (j) per driven kilometer

The vehicular emission depends upon the type, age and condition of vehicle, congested traffic condition of pavement, acceleration, idle or deceleration of vehicle, capability of driver and traffic management systems.

Region specific emission factors of road transport, based on the type of vehicle compiled from various literatures including regulatory agencies are listed in Table 2.

Table -2: Emission factor for the different category of Vehicles

Category / Pollutant	CO2	CO	NOx	CH4	SO2	HC	PM
Two wheeler	26.6	2.2	0.19	0.2	0.013	1.42	0.05
Three wheeler	62.41	1.37	0.2	0.2	0.03	2.53	0.045
Goods Auto	131.61	0.41	0.51	0.09	1.4	0.14	0.091
Car/Jeep	223.6	1.98	0.2	0.2	0.05	0.25	0.03
LCV	333.31	3	2.48	0.09	1.4	1.28	0.655
BUS	515.2	3.6	12	0.09	1.4	0.9	0.6
Truck/ Trailor	515.2	3.6	6.3	0.09	1.4	0.87	0.3
Others	343.9	3.9	3.9	0.1	1.9	0.2	0.5
Reference	Mittal and Sharma, 2003	CPCB, 2007	CPCB, 2007	EEA, 2001	Kanithkar and Ramachandran, 2000	CPCB, 2007	CPCB, 2007

3. RESULTS AND DISCUSSIONS

The secondary data was collected for districts like Thrissur, Malappuram, and Kozhikode. The data collected included the ambient air quality data for a period of 2005-2015 which was collected from the Kerala State Pollution Control Board and the categorized number of registered vehicle for a period of 1980 to 2015 that was collected from motor vehicle department.

3.1 Ambient air quality data

The State Pollution Control Board has collected ambient air quality data for the three districts. It consists of the monthly average of pollutants such as oxides of sulphur, oxides of Nitrogen, respirable suspended particulate matter and suspended particulate matter. CO was not measured by KSPCB. In Thrissur and Malappuram, one station each has been selected as the monitoring station by KSPCB and in Kozhikode two stations were selected. From the ambient air quality data, the concentration of various pollutants in the three districts was identified for the years 2005-2015. Using this data, the air pollution index is calculated. The API values for the selected study areas have been listed below.

Table -3. Air Pollution index for PCB sampling station Poonkunnam, Thrissur

Year	API Value	Air Pollution Index
2010	25.98	Light air pollution
2011	30.10	Light air pollution
2012	54.06	Moderate air pollution
2013	36.30	Light air pollution
2014	42.43	Light air pollution
2015	35.79	Light air pollution

Table -4. Air Pollution index for PCB sampling station Kakkanchery, Malappuram

Year	API	Air Pollution Index
2010	11.328	Clean air
2011	24.139	Clean air
2012	25.600	Light air pollution
2013	26.203	Light air pollution
2014	35.106	Light air pollution
2015	36.439	Light air pollution

Table -5. Air Pollution index for PCB sampling station KSRTC Stand, Kozhikode

Year	API	Air Pollution Index
2005	33.580	Light air pollution
2006	31.784	Light air pollution
2007	27.997	Light air pollution
2008	37.070	Light air pollution
2009	31.767	Light air pollution
2010	38.791	Light air pollution
2011	34.224	Light air pollution
2012	39.800	Light air pollution
2013	46.025	Light air pollution
2014	48.439	Light air pollution
2015	52.528	Moderate air pollution

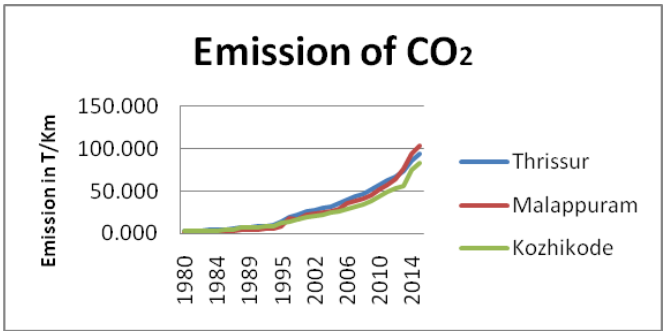
Table -6. Air Pollution index for PCB sampling station Nallalam, Kozhikode

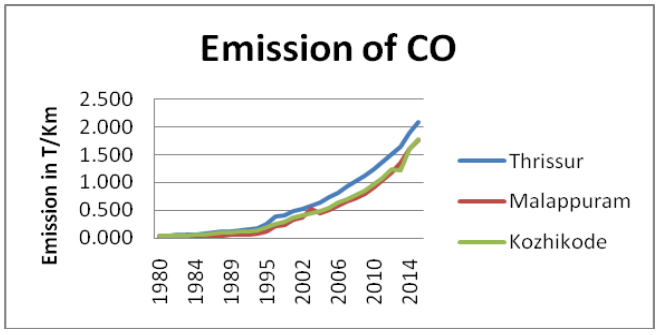
Year	API	Air Pollution Index
2005	25.195	Light air pollution
2006	35.728	Light air pollution
2007	23.566	Clean air
2008	28.418	Light air pollution
2009	30.126	Light air pollution
2010	35.267	Light air pollution
2011	38.994	Light air pollution
2012	37.661	Light air pollution
2013	37.983	Light air pollution
2014	37.300	Light air pollution
2015	39.028	Light air pollution

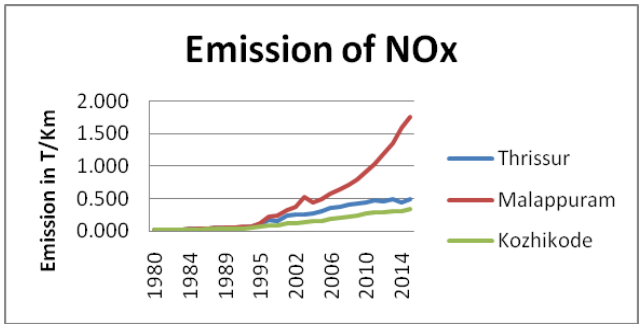
3.2 Categorised vehicle volume data

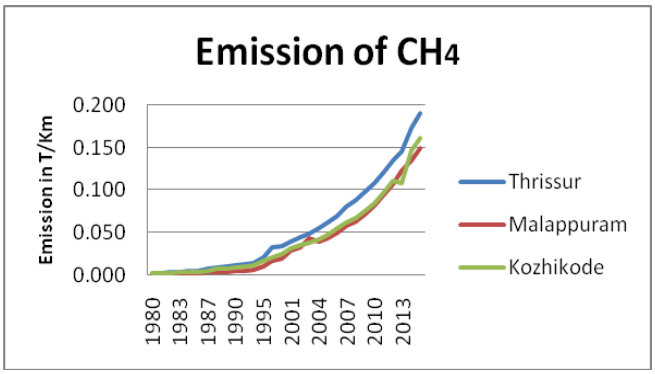
From the motor vehicle department, the categorized vehicle volume data is collected. The data collected included the number of vehicles under various categories. The emission of various pollutants from these vehicles is calculated using the emission factor method. Each vehicle is characterized with its own emission factors that vary with respect to various pollutants. The emission of various pollutants is calculated for the three districts for a period of 1980-2015.Most of them showed an increasing trend for every year.

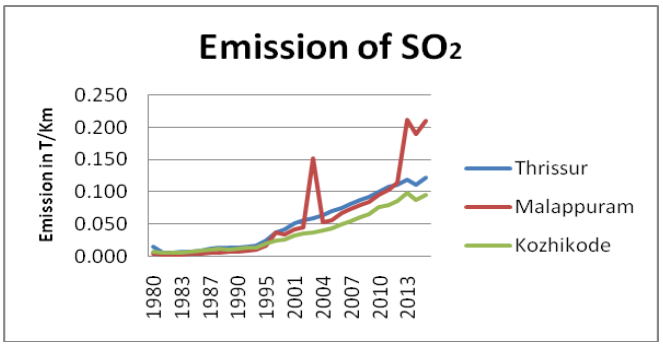
Fig -2: Emission of pollutants in Thrissur, Malappuram and Kozhikode districts

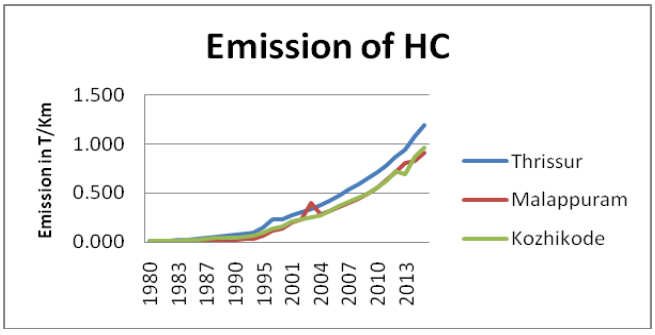


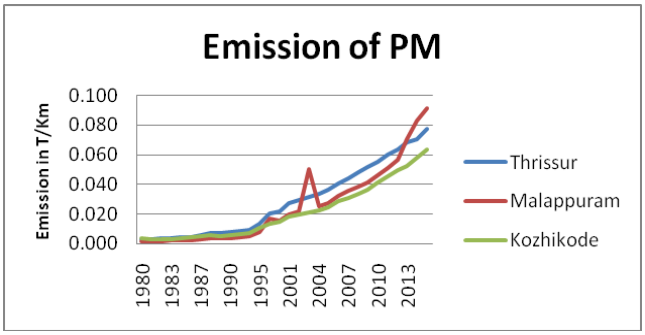












3.3 Projection of API and emission

The value of Air Pollution index for the years 2010-2015 are already known. Using these values, the API values and the corresponding indices can be projected for the future years. For suggesting proper remedial measures the air quality status of an area is to be foreseen. To facilitate this, the concentration of various pollutants as well as corresponding API value is projected to desired years. Projection is done by trend line method. The results obtained are tabulated below in Table 7.

Similarly the emission values obtained between the years 1980 to 2015 were projected to obtain the emission in the future year 2025 at that particular station. Here also trend line method is used for projection. The results obtained are tabulated and shown below in Table 8. While projection it is assumed that the fuel system remains the same as that for the year from which it is being projected.

Table -7 Projection of pollutant concentration and API Values in Thrissur, Malappuram, Kozhikode

Place	API Value		Air Pollution index
	2015	2025	
Thrissur	35.786	54	Moderate Air Pollution
Malappuram	36.439	68	Moderate Air Pollution
Kozhikode (KSRTC)	52.528	82	Heavy Air Pollution
Kozhikode(Nallalam)	39.028	62	Moderate Air Pollution

Table -8 Projection of emission of pollutants at Thrissur, Malappuram, Kozhikode district in 2025.

Place	CO_2	CO	NOx	CH_4	SO_2	HC	PM
Thrissur	170	3.92	0.95	0.338	0.24	2.25	0.148
Malappuram	188	3.32	1.3	0.29	0.38	1.8	0.16
Kozhikode	137	3.22	0.65	0.292	0.188	1.82	0.118

4. CONCLUSIONS

From the projected data it is clear that there is an increasing trend in the concentration of pollutants. It also gives an idea of the future air quality status of the stations selected for the study. By analyzing the data it is clear that by 2025, the KSRTC stand, Kozhikode seems to be having higher API value of about 82. Also, the vehicular emission is showing an increasing trend. This needs further attention. The station where air pollution is more is identified and proper preventive measures are taken to avoid such a hazardous situation.

5. PREVENTIVE MEASURES

Air pollution is one of the serious threats that we are facing now a days. The main causes of the air pollution are the industrial as well as the automobile exhaust. Since the vehicular emissions is the major cause for deterioration of urban ambient air quality, it is necessary to prevent it for the future days. Some of the improvement methods include upgradation of automobile technology, improvement in fuel quality, expansion of urban public transport systems and promotion of integrated traffic management systems. Promotion of the Ethanol Blended Petrol and Bio-diesel has been taken up in some of the places. Also Ethanol Blended Petrol has been introduced as a new pollution limiting fuel that is suggested by the Ministry of Petroleum and Natural Gas.

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