Carbon Dioxide Emissions from Motor Vehicles in Bangalore City

[1]Habibulla, [2]Prof. SampatKumar, [3]Dr. C.S Bhaskar Dixit

[1]PhD Scholar, Jain University, Bengaluru, India
[1]habibulla.m@gmail.com
[2]Prof & HOD, Department of Civil Engineering, BMS College of Engineering, Bengaluru, India
[2]sampathmc61@gmail.com
[3]Professor, Centre for Disaster mitigation, Jain University, Bengaluru, India
[3]bhaskar.dixit@gmail.com

ABSTRACT

Rapid Urbanization has caused a significant reduction in the number of water bodies, the extent of green cover while there is a steep increase in the built-up area in the city. Along with urbanization happening at a rapid pace, the city is witnessing an unprecedented population growth and to cater the needs of this population with respect to transportation, there is an alarming rise in the production and manufacture of sophisticated vehicles. This rise can be attributed to the current air quality status of the city. Of all the emissions released into the atmosphere by vehicular movement, carbon dioxide is of concern because it is one of the major contributors to global warming. In this study an attempt has been made to determine the carbon dioxide levels in the atmosphere due to vehicular emissions. Along with this, the impact of increasing CO2 levels on the existing green cover has also been carried out.

Keywords/ Index Term— Vehicle Exhaust, Land use, Carbon Dioxide, Health, Oil extraction, Green cover.

1. INTRODUCTION

Metropolitan cities like Bangalore city are witnessing rapid urbanization, industrialization in order to cater the needs of the increasing population. Owing to the development in the field of information Technology, industrial growth, sophisticated lifestyle, health care, educational facilities etc., the city has witnessed an unprecedented growth in the population due to migration of people from the rural towards the urban side.

Due to rapid urbanization there is sharp reduction in the number of water bodies, green cover while there is steep increase in the built-up area. Haphazard distribution of population in urban areas resulting in an erratic increase in the consumption pattern and unplanned infrastructure and industrial development are contributing to the increase in air pollution levels. Also, to cater the transportation needs of the growing population, there is a substantial increase in the manufacture and production of motor vehicles having sophisticated design and high-performance efficiency. Motor vehicles contribute a major share of significant pollutants into the air atmosphere. The increase in air pollution faced by the city in the recent years can be attributed to the steep increase in the vehicular growth. Vehicular emissions are of prime concern because they seem to have a major health impact on the general population as the emissions contain various harmful elements like carbon di oxide, carbon monoxide, particulate matter, oxides of Sulphur and nitrogen, particulate matter, trace metals etc., of which carbon dioxide is of major concern in this study because they are a major contributor to global warming. In this study, an attempt has been made to statistically determine the approximate amount of carbon dioxide emission contribution from road traffic, their health impacts on human beings and also their consequences on the green cover i.e., to statistically analyze the amount of carbon di oxide sequestered by the existing green cover of the city [1].

2. DESCRIPTION OF STUDY AREA

Bangalore is the principal administrative, cultural, commercial, and industrial and knowledge capital of Karnataka. Bangalore is one among the rapidly growing metros in the state of Karnataka. It is situated at 920 m above the mean sea level and has an area of 741 Sq. Km. The city is divided into 8 major zones and 198 municipal wards under the limits of Bruhat Bengaluru Mahanagara Palike. As per 2011 census, the city has 198 wards under the limits of and has a population of 84, 00,000 and currently the city has a population of approximately 1, 25, 96, 719.

Given the technological advancements in the field of information and technology, the city is called as the "Silicon Valley of India" and "Garden city of India". Along with this, the city also houses several small and large-scale industries, in which some of industries are highly hazardous in nature. Also, the city is a home to numerous prestigious educational and research institutions, aerospace, defense organizations, Pharmaceuticals industries, automotive industries, Heavy engineering industries [2].

3. URBANIZATION AND ITS IMPACTS

Bangalore is witnessing urbanization at an alarming rate. Along with this there is an unprecedented growth in population. There is subsequent pressure on infrastructure development, utilization of natural resources etc., to cater the needs of the growing population. Due to this, serious threats such as climate change, global warming, greenhouse emissions etc. Also, there is a constant pressure on the city planners and developers to sustainably manage the available natural resources and devise ways to mitigate serious issues like traffic congestion, habitat management etc. Spatial Temporal remote sensing data has been analyzed to understand the variation in urbanization trend and pattern.

3.1 Land Use and Land Cover Analysis

Variation in the trend and pattern of urbanization in Bangalore city, Spatial temporal remote sensing data is analyzed [3].

Class	Urban		Vegetation		Water		Others	
Year	Ha	%	Ha	%	Ha	%	Ha	%
1973	5448	7.97	46639	68.27	2324	3.4	13903	20.35
1992	18650	27.3	31579	46.22	1790	2.6	16303	23.86
1999	24163	35.37	31272	45.77	1542	2.26	11346	16.61
2006	29535	43.23	19696	28.83	1073	1.57	18017	26.37
2012	41570	58.33	16569	23.25	665	0.93	12468	17.49

Table-1: Variation of Land use and land cover pattern in Bangalore city from 1973 to 2012.

Earlier Bangalore was attributed as the garden city given its dense vegetation cover. However, over the years, there is a significant decrease in the extent of vegetation. The number of water bodies in the city has been reduced over the years and this can be attributed to the illegal encroachment of water bodies in the name of infrastructure development by builders and developers. Water bodies have reduced from 3.4% in 1973 to less than 1% in 2012. Vegetative cover has reduced from 68.27% in 1973 to less than 23% in 2012. There is steep rise in the built-up area from 8% in 1973 to more than 50% in 2012 [4].

4. POLLUTION AND HEALTH

4.1 Oil Extraction

In India, unscientific and age-old methods of oil refining practices can be attributed to the poor fuel quality subsequently causing harmful vehicular emissions. Crude oil basically consists of large quantities refined products, including liquefied petroleum gas, gasoline, kerosene, diesel fuel, lubricants etc. The extraction and transportation activity of crude oil also contribute to air pollution. During extraction, chances of crude oil being evaporated from the oil pits to form vapors which might contain harmful elements in high concentrations. Other than this, gas flaring activity contributes to the formation of soot that usually gets deposited in the environment.

4.2 Vehicle Exhaust

Vehicular exhaust contributes some of the significant pollutants into the atmosphere. They emissions include major elements like particulate matter, carbon dioxide, carbon monoxide, oxides of Sulphur and nitrogen, hydrocarbons, trace metals etc.

The two and four-wheeler vehicles use petrol and petrol/diesel as fuel respectively. The 3 wheelers i.e., autos make use of CNG as a fuel. Combustion of Natural gas emits pollutants such as oxides of Sulphur and nitrogen, carbon dioxide, particulates etc., in negligible quantities. However, on combustion, it emits a large quantity of methane and negligible quantity of carbon dioxide into the atmosphere [5][6].

4.3 Health effects

These emissions are of concern because they are considered as a serious threat to human health. Long term exposure to such pollutants affects the morbidity and mortality rates. They could cause serious health issues like respiratory disorders and cardiovascular issues.

5. MATERIALS AND METHODOLOGY

Since 1990, there is an increase of almost 90% in the number of vehicles of all categories. As per the data collected from the regional transport office, Bangalore, currently i.e., as of December 2017 there are 47.31 lakh 2 wheelers, 1.73 lakh 3 wheelers, 15.80 lakh 4 wheelers, 0.92 lakh buses, 1.72 lakh goods vehicles and 0.84 lakh of other vehicles [7].

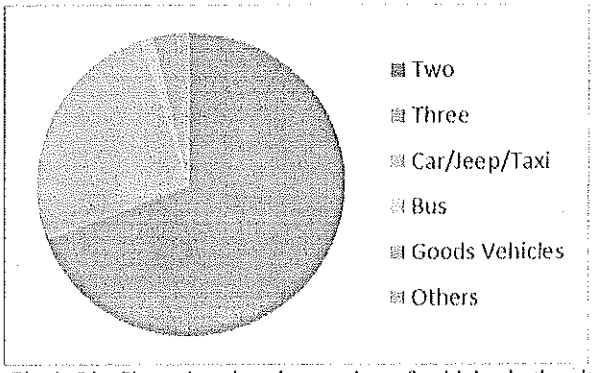

Fig-1: Pie Chart showing the number of vehicles in the city as per 2016-17.

5.1 Carbon dioxide emissions in the city and their impact on green cover

Given the constant surge in the number of vehicles in the city, often the city faces problems of traffic congestion and therefore it is difficult to achieve high speed and fuel efficiency within the city limits. Due to traffic congestion, vehicles are stopped often thus increasing fuel consumption and emissions thus deteriorating the air quality.

The emission factors for petrol and diesel are calculated by assuming complete combustion of the fuel, the quantity of carbon dioxide emitted from the combustion of one liter of fuel is calculated. The characteristics of petrol and diesel are as follows [8] [9].

Type of Fuel	Default Carbon content (kg/GJ)	Oxidation Factor	Net Calorific Value (Tj/Gg)	Carbon Molecule mass ratio	Fuel Density (kg/L)	Emission Factor (kg/L)
Diesel	20.2	1	43	44/12	0.845	2.691
Petrol	18.9	1	44.3	44/12	0.775	2.379

Table-2: Emission factors of CO2 for Diesel and Petrol.

Given the consequences of rapid urbanization, the green cover or the lung spaces of the city i.e., parks, playgrounds, forest reserves, national parks etc., have been reducing at an alarming rate and as per 2017, the city has approximately 4603 hectares of green cover i.e., 6.46% of the total area of Bangalore city [10]. Field census and remote sensing data of the study area reveals that currently, 1.5 million trees i.e., one tree per seven people exist in the city. Reduction in the green cover due to cutting of trees is extensively contributing to the increased air pollution in the form of dust accumulation in the air environment [11].

6. RESULTS AND DISCUSSIONS

Given the total number of vehicles in the city and an average commute of 50 Kilo meter per day, the calculated amount of

carbon dioxide is approximately 3100 tons of CO2 has been released by vehicular emissions alone in the year 2016-2017. The level of CO2 in the atmosphere has witnessed a sharp increase given there was only 272 tons of CO2 emissions from vehicular movement in the year 1990 [12].

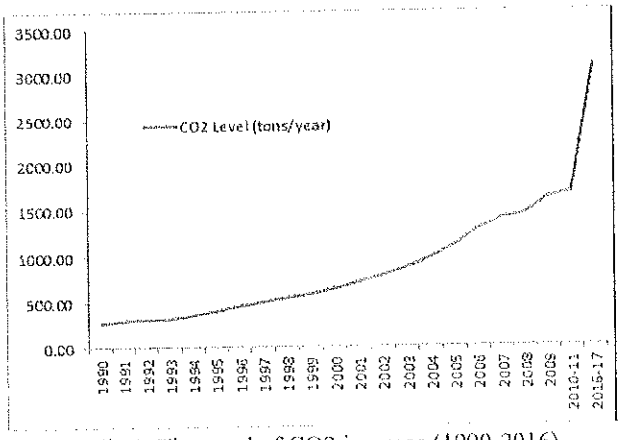

Fig 2: The trend of CO2 increase (1990-2016)

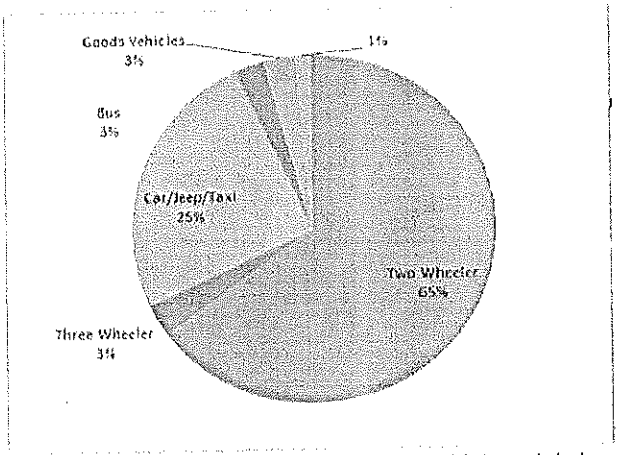

Fig 3: Pie Chart showing the type of vehicle and their contribution towards CO2 emissions in the year 2016-17.

It can be seen from the graph that, two and four-wheeler vehicles are the major contributors of CO2 emissions, while, the contribution of buses, goods vehicles and autos are comparatively negligible.

According to WHO, 6 tons of carbon can be sequestered by 1 Ha of forest i.e., the atmospheric carbon dioxide is utilized as energy by the plants and oxygen is in turn released into the environment. Based on stoichiometric calculation, the ratio of carbon dioxide to carbon is approximately 3.66. Therefore, to sequester 3100 tons of CO2, approximately 140 ha of green cover is required [13].

7. MITIGATION MEASURES

The emissions from the vehicles can be reduced by, (i) restricting the introduction of new vehicles to reduce fuel consumption (ii) improving the vehicular design and operation mechanism (ii) Ensuring proper maintenance of vehicles to reduce wear and tear (iii) use of cleaner fuels and promoting the use of alternate fuels like bio diesel, ethanol gasoline blends [14] (iv) encouraging and improving public transport (v) setting stringent permissible emission standards for all the vehicles (vi) implementing end of pipe technologies (vii) replacement of unpaved roads by paved roads (viii) Promoting the use of electric vehicles (ix) making emission test mandatory for all vehicles (x) putting a ban on commercial vehicles that are more than 15 years old etc.

Apart from this, the Indian government has passed some stringent norms to control vehicular emissions. These norms regulate the output of air pollutants from motor vehicles. Under these stringent standards that are like European regulations, all the new vehicles manufactured should be in compliance with the regulations. However, these norms don't give standards for Carbon-di-oxide emissions from vehicular movement [15].

8. CONCLUSIONS

Rapid Urbanization had caused a significant reduction in the number of water bodies, the extent of green cover while there is a steep increase in the built-up area in the city. Along with urbanization happening at a rapid pace, the city is witnessing an unprecedented population growth and to cater the needs of this population with respect to transportation, there is an alarming rise in the production and manufacture of sophisticated vehicles. This rise can be attributed to the current air quality status of the city. Of all the emissions released into the atmosphere by vehicular movement, carbon dioxide is of concern because it is one of the major contributors to global warming. From statistical calculations, it was observed that, around 3100 tons of CO2 has been released in the year 2016-17. Therefore, in order to regulate and monitor the vehicular emissions, stringent norms should be laid out by the government. Along with this, other measures such as maintenance of vehicles, use of alternate fuel, use of public transport etc., should be followed by the citizens.

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