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District Wise CO_2 Emission for Maharashtra State Using AADMI Approach

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ABSTRACT

Fuel and electricity consumption pattern has been rising over the last several years in most of the districts of Maharashtra due to rise in per capita income. High fuel consumption leads to deterioration of environment, in terms of increasing CO_2 concentration, which is highly responsible for global warming and have impacted the state in terms of change in rainfall pattern and drought prone conditions. To minimize the associated impacts of global warming, steps are required to be taken to measure or estimate the concentration of CO_2 in atmosphere. With the help of emission inventory, one can quantify the concentration of CO_2 emissions. Emission inventory is a tool which accounts the amount of pollutants emitted into the atmosphere by various anthropogenic activities. Inventory consists of quantification of GHGs (CO_2, CH_4, N_2O) which are emitted from the consumption of fossil fuels and electricity. A macro level study was carried out using secondary data. Estimates were made for major hotspots of Maharashtra state based on fuel & electricity consumption, (data available for the year 2014). Secondary data was obtained from various districts reports & literature survey.CO_2 emissions were calculated district wise to identify cases for urgency i.e. the districts, which rank high in terms of CO_2 emission and require appropriate and urgent environmental management plans (EMPs) in terms of fuel use choice or land-use planning etc.

Keywords : Emission Inventory, District Wise CO_2 Emissions, Emission Factor, Maharashtra State

I. INTRODUCTION

Carbon dioxide (CO_2) gas exists in earth's atmosphere in small concentrations but is vital for sustaining life for all living organisms. CO_2 is also known as a Greenhouse gas (GHG) which absorbs and emits thermal radiations, creating the 'greenhouse effect' (Hannah Ritchie and Max Roser, 2018). Since, the industrial revolution, fossil fuel consumption has led to a rapid increase in GHG's emissions prominently CO_2 gas, disrupting the global carbon cycle and leading to a global warming impact. Among the GHG's, carbon dioxide is the most dominant gas causing global warming which accounts for nearly 77% of global total CO_2 equivalent greenhouse gas emissions (IPCC 2007c). The global average atmospheric carbon dioxide in 2016 was 402.9 parts per million (*ppm* for short), with a range of uncertainty of ± 0.1 ppm. Past few decades, fossil fuel consumption in India has subsequently raised to fulfil country's need and to achieve developed position in the world. Increased fuel consumption has led to significant rise in CO_2 emissions up to 2.47 billion tonnes in 2015, which was 5.1% more as compared to 2014 (Trends in Global CO_2 Emissions, report,2016. Emission inventory is a tool which helps to quantify the GHG's emissions from various fuel anthropogenic activities. The increasing interest in quantification of greenhouse gas emissions has been growing because of public awareness on global warming. Quantifying the GHG's emissions is an important step towards making quantifiable emission reductions (Sridevi et al.,2014). Many global metropolitan cities and organizations are estimating their greenhouse gas emissions and developing strategies to reduce their emissions. Many researchers have estimated Indian emission inventories of different gases from various sources and for different years (Mitra 1991, ADB 1994, Parashant et al., 1994, 1997, ALGAS 1998, Gupta et al., 1999, Garg, Bhattacharya and Shukla., 2001a, Mitra A P et al., 2004, Sridevi H et al.,2014). This study deals with the quantification of CO_2 emissions from most populated districts of Maharashtra state. Maharashtra is the second largest State in India in terms of population and 3rd largest State as per geographical area (3.08 lakh sq.km) of the country. The state contributes about 9.28 % of total population of India (Census2011). Rapid urbanization and industrialization, has significantly increased state's electricity and fuel consumption. Being one of the developed and wealthiest state of India, state contributes significantly to the maximum amount of greenhouse gas emissions (GHGs) through its high electricity and fuel consumption. Quantification of GHG emissions is desirable to understand its associated environmental impact; quantification through emission inventory proves to be effective tool in mitigating the impacts of global warming. Secondary data based on electricity and fuel consumption for CO_2 emissions has been used. Analysis of Acquired Data, Modulation, and Interpretation **(AADMMI)** approach has been framed to quantify the district wise CO_2 emissions from most populated districts of state.

II. STUDY AREA

Maharashtra state is located on the western part of country comprising 36 districts and is the third largest state in India. Being developed and civilized most of the districts are urbanized and have city specific industrial hub attracting most of the population across the country. This study has identified the most populated districts in Maharashtra state based on census 2011.

III. METHODOLOGY

An Analysis of Acquired Data, Modulation and Interpretation(AADMI) approach has been carried out on the basis of data mining, data analysis, data modulation and data interpretation to quantify the CO_2 emissions from electricity and fuel consumption. In present study, secondary data on electricity and fuel consumption of top ten districts having higher population was collected from statistical reports of Maharashtra state and Indian Petroleum and Natural Gas Statistics for the year 2014-2015. CO_2 emissions are calculated based on fuel and electricity consumption. Units were normalized as per emission factor unit. Following equation has been used to quantify CO_2 emissions *(IPCC-2006).*

Emissions = Activity × Emission Factor (EF)

Where,

Emissions = amount of CO_2 emitted;
Activity=Electricity or Fuel consumption;
EF =IPCC based emission factors.

- **District wise Consumption Pattern**

Total electricity and fuel consumption was calculated using district per capita electricity and fuel consumption with the help of district population based on secondary data.

Table 1. District Wise Electricity & Fuel consumption

Most Populated Districts	Per Capita Electricity consumption *(kWh/yr.)*	Total Electricity Consumption *(kWh/yr.)*	Per Capita Fuel Consumption *(kg/yr.)*	Total Fuel Consumption *(kg/yr.)*
Ahmednagar	884.82	4019877946	144.7	657395107.3
Aurangabad	915.13	3387154197	149.66	553933864.1
Jalgaon	768.42	3250352821	125.67	531573669.4
Kolhapur	976.25	3783945976	159.66	618842319.7
Mumbai	1,317.64	16394568360	215.49	2681206958
Nagpur	871.53	4055725862	142.53	663273332.1
Nashik	906.26	5534699291	148.21	905146185.3
Pune	1,445.99	13634829674	236.48	2229866404
Solapur	992.01	4283257130	162.23	700469555.9
Thane	1,508.16	16680472808	246.64	2727874903

- **Common Emission Factor**

Fuel specific emission factors were obtained from Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report, 2007, while Electricity emission factor was obtained from GHG Inventory Report,2009. Table 1.2 shows common emission factors used for the present study.

Table 2. Common Emission Factors

Fuel Type	Emission Factor's (kgCO_2/gallon)	Fuel Type	Emission Factor's (kgCO_2/gallon)
LPG	5.68	MS petrol	8.78
Fuel oil	10.21	Lubes	10.69
Kerosene	10.15	Bitumen	10.29
Diesel	11.09	Other	10.59
LDO	10.21	LSHS	10.21
Naphtha	8.50	Electricity	1.29 (Kg CO2/kWh)
ATF	8.31		

- **Quantification of CO_2 Emissions**

1) For Electricity: District wise CO_2 emission from electricity consumption is calculated using below formula,

CO_2 emission = Electricity consumption × Emission factor

CO_2 emissions = Million tonnes CO_2 equivalent per year, Electricity consumption = District electricity consumption in KWh/year, Emission Factor = State specific Emission Factor.

2) For Fuel: District wise CO_2 emission from fuel consumption is calculated using below formula,

CO_2 emission = Fuel consumption × Emission factor

CO_2 emissions = Million tonnes CO_2 equivalent per year,

Fuel consumption = District fuel consumption in kg/year,

Emission Factor = Fuel specific emission factors were used from IPCC,2014.

3) Total CO_2 Emissions: Total CO_2 emissions includes emissions from both district wise electricity and fuel consumptions in Million tonnes CO_2 equivalent per year.

Total CO_2 emissions = Electricity emissions + Fuel emission

IV. RESULTS

In the present study, the per capita electricity consumption of thane and Mumbai district was found to be more. The electricity consumption includes sectors like domestic, industrial, transportation, commercial and other. It has been observed that Thane district shows 21.01 million tonnes of CO_2 emissions followed by Mumbai 20.72 million tonnes per year. Aurangabad and Jalgaon district shows lowest CO_2 emissions of 4.26 and 4.09 respectively.

District wise share of CO_2 emissions through fuel consumption by most populated districts is computed in figure-1. Highest CO_2 emissions is observed in Thane district 8.19 million tonnes of CO_2e/year followed by Mumbai and Pune districts comprising 8.08 and 6.70 million tonnes of CO_2e/year respectively; while the Lowest share of 1.60 million tonnes of CO_2e/year is observed in Jalgaon district as shown in figure -2.

Total CO_2 emissions comprising electricity and fuel consumption shows Thane district with highest emissions of 29.2 million tonnes per year, followed by Mumbai 28.8 million tonnes. Lowest emissions were observed in Jalgaon and Aurangabad district comprising 10.5 million tonnes of CO_2 emissions as shown in figure 3.

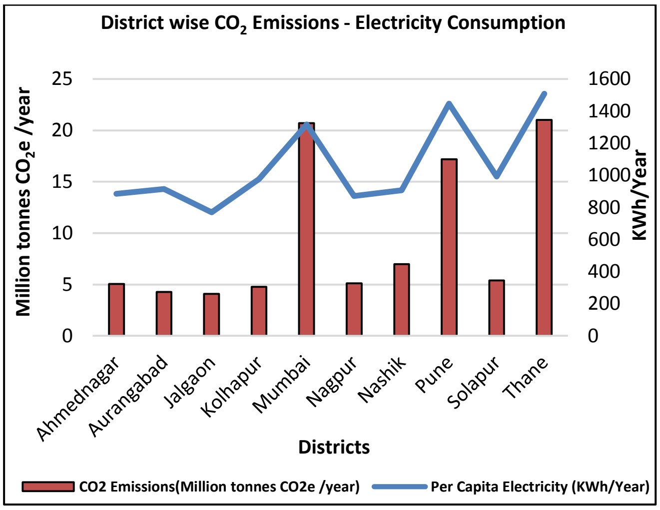

Figure 1. District wise CO_2 emission from electricity consumption

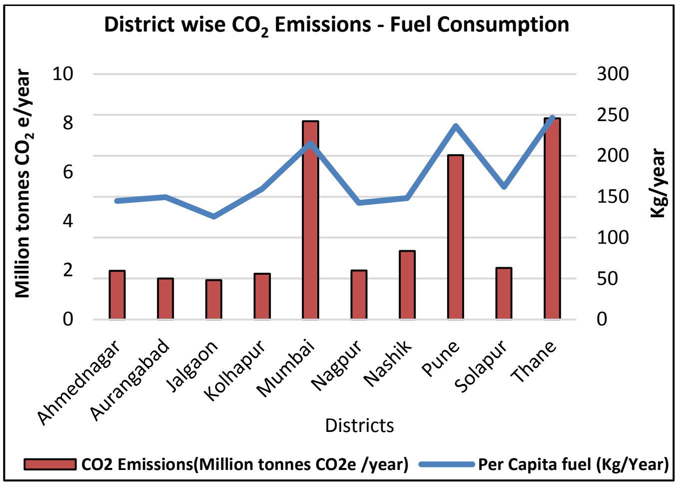

Figure 2. District wise CO_2 emission from fuel consumption

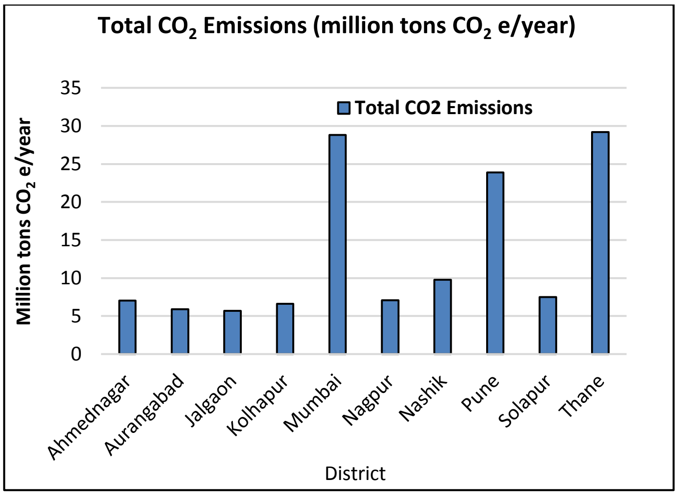

Figure 3. District wise total CO_2 emission

V. CONCLUSIONS

Quantifying the CO_2 emissions district wise helps to identify the districts with their emission level. This study shows that about 62 % of CO_2 emissions are being released by the Mumbai, Thane, and Pune district because of high consumption pattern in electricity and fuel. Levels of CO_2 Emissions are directly proportional to consumption pattern of fuel and electricity. Identifying the CO_2 level district wise will help to frame policies in reducing CO_2 levels, helps to build up mitigating strategies like change in fuel and electricity, consumption pattern, within the district, as districts have more potential than cities in reducing CO_2 level.

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