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Trends of CO2 Emissions in India, Linkages with Energy Consumption, Transport and Economic Growth

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Abstract
Air pollution is a burning issue in all over the world. Due to increase industrialization, urbanization, transportation and housing activities, India's air pollution is continuously rising. As a result of air pollution related many health problems are faced by the society such as a respiratory and cardiovascular disease. Today, energy consumption is the best indicator for economic growth in any developing country, especially in BRICS nations which are totally focused on the development as well as they are ignoring the environmental quality which is affected by the development process. Energy consumption in terms of fossil fuel is highly responsible for increasing Greenhouse Gas Emissions specifically Co_2 emissions in India. This paper is trying to analysis the relationship between transport development, energy consumption, economic growth and CO_2 emission scenario in India.

Keywords: Economic Growth, Energy Consumption and CO_2 Emissions

Introduction

Today, sustainable development is the burning issue at world level. It includes many approaches such as economic, social and environmental (IPCC). After economic reform, India's process of industrialization, transportation and urbanization is continuously increased. As a result environmental quality of India has been felt and create pollution problem in the atmosphere. Therefore, it is linked between economic development and the environment. India is the fastest growing country of the world as well as air pollution is also rising day by day. People are facing many health problems related to the air pollution. This paper is focusing on the economic development, energy consumption and co_2 emission of India.

Energy is the main key to the economic development to any country. It also improves socioeconomic development, such as living of standard, improved productivity, effective transportation of goods etc (Akpan, U.F and Akpan, G.E 2012) [1]. The transport system is playing an important role of human life and it gives the conveyance of goods and the motor mobility of people across the country. The transport system depends on the energy consumption.

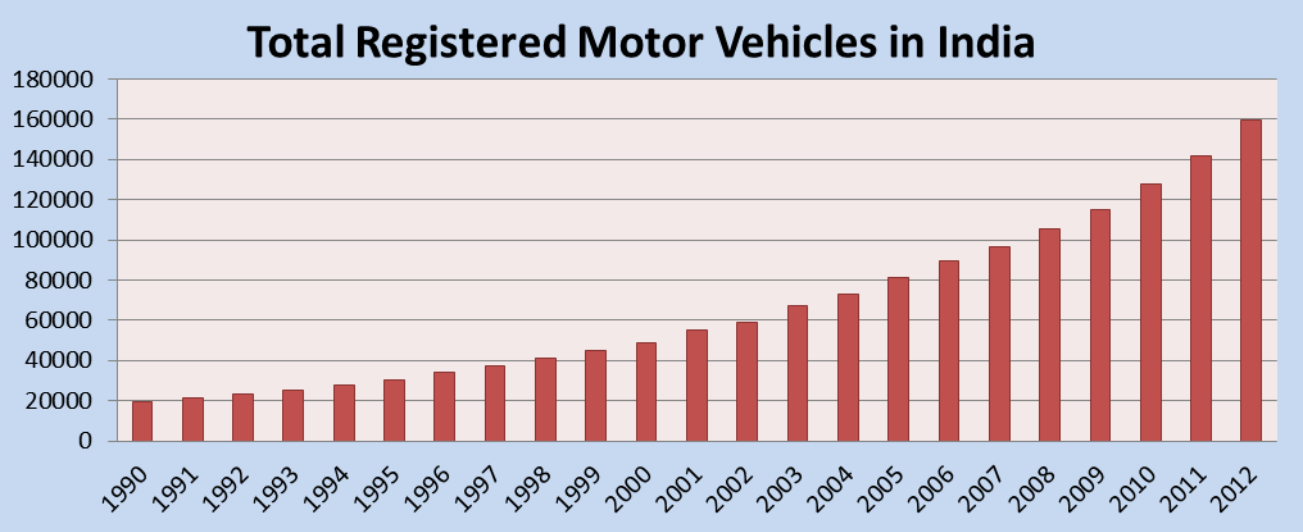
Basically, due to increasing road transport, air pollution is spreading in urban areas (colvile *et al.*, 2001; Pison & Menut, 2004) [3, 9]. Continuously increasing population is also responsible factor for the air pollution. Increase the demand of vehicle ownership and shortage of public transport by the people is rising of the air pollution. Lack of maintenance of vehicles is a serious challenge for the policy maker and government agencies which is responsible for maintaining air quality. Therefore, it is found that the growing population, vehicle ownership and emissions are a threat for the future (Selden & Song, 1994).

In the world level, transport sector was highly responsible for 23 percent of the world energy which is related to the greenhouse gas emissions in 2004. During the last few years, GHGs emissions is continuously rising with the faster rate. It will be strongly increase due to using energy in transport activity over the next several decades (Kamalakar, 1991) [7].

According to trends in global CO_2 emissions report 2016 that 2015 is the hottest year since began in1880. The Intergovernmental Panel on Climate Change (IPCC) has been shown the various reports on the linkage between global warming and greenhouse gases (GHG). It is found that combustion of fossil fuels is the main source for increasing CO_2 emissions and also contributes to increase global warming at a world level (Ghosh S, 2010) [5].

Transport Scenario in India

In India, more than 6.3 million vehicles were playing in the mega cities during the year 2000. Mumbai has been covering the highest vehicles compared to other mega cities. There are various pollutants emitted from the motor vehicles such as nitric-oxide, carbon monoxide, carbon dioxide and many organic compounds which are responsible for the decline the environmental quality in India (Tahir M, et.al, 2015) [13]. In 2011, India was the fifth largest motor vehicle manufacturer in the world level. There were 14.82 million motor vehicles have been recorded in 2010 and approximately 3.54 million cars has been founded.



***Source*:** Ministry of Road Transport and Highway, 2017

Fig 1: Total Registered Motor Vehicles in India from 2001 to 2012 (In thousand)

Figure 1 shows the total registered motor vehicles in India from 1990 to 2012. During the 1990 the total registered vehicles were only 19152 thousand vehicles registered in India. In 2001, there are 54991 thousand motor vehicle recorded in India. It is continuously increasing due to rising urbanization, education, Income, production and demonstration effect (related to consumption where one person consumes something by seeing another person).

Table 1: Growth Rate of the Total Registered Motor Vehicles in India from (1990 to 2012)

Year	Growth Rate
1990	-
1991	11.60
1992	9.98
1993	7.82
1994	9.13
1995	9.53
1996	11.52
1997	10.50
1998	10.81
1999	8.48
2000	8.87
2001	12.56
2002	7.15
2003	13.72
2004	8.52
2005	12.08
2006	9.96
2007	7.91
2008	8.94
2009	9.11
2010	11.13
2011	11.05
2012	12.42

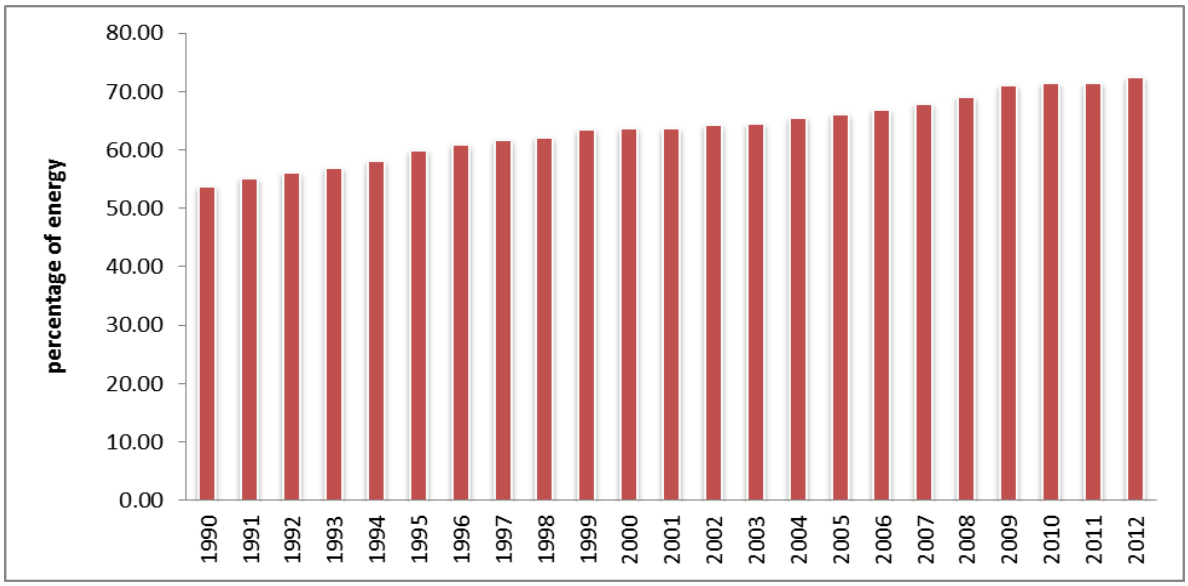
Table 1 shows that the growth rate of total registered motor vehicle of India from 1990 to 2012. In 1991 the growth rates of registered motor vehicles were at 9.98 percent and it was creating the ups and down condition and increase with the fluctuating rate. Before 2000 this growth rate was higher in 1999 8.48 percent. But, in 2002 the growth rate was 7.15 percent, which is lowest in that duration and in it was highest in 2013 which was 13.72 percent due to the industrialization growth of India. But after 2007 it had been continuously increasing and in 2012 is was 12.45 percent. The transport sector in India consumes about 16.9 percent and energy consumption is also varied with the modes of transportation and transport system has least an average energy consumption and passengers and per kilometer (Singh, 2006) [12].

Basically, rapid increasing vehicular population and falling air quality are the by-product of speedy growth of population in India. This is found that for the growth of a nation's economy, the transport sector is playing a significant role in the overall development. But due to evaluation of this sector, air pollution proportion is continuously substantially growing. Many causes responsible for the air pollution, such as the urban development, industrialization, energy, and demand of transport are leading to a vicious cycle of pollution (Tahir Mary, Hussain Tahir, et.al, 2015) [13]. Intergovernmental Panel on Climate Change (IPCC) has been analyzed that the main sources of emissions are energy (26%), transport (18%), industry (19%) and building (10%) responsible.

Trend Energy Growth in India

Energy has been made a vital to economic development for any country. It is also important for the achieving the goals of the sustainable development. For improved the living of standard, enhanced productivity, transportation of goods to the point of need and input arrangement in the wide range of the economic production activities, energy is required for the socioeconomic development (Akpan,U.F and Akpan,G.E 2012) [1]. During the last three centuries, it has been seen that mankind's substantial dependence upon an ever-growing us of fossil fuels (coal, oil and gas) for industrialization and urbanization (Cao, 2003, Reddish and Rand, 1996) [2, 10]. Basically, coal consumption increased by 64 % from 2000 to 2014 at a world level and it is the faster faster growing fuel in absolute number in this period. 50% Global coal demand

covers by the China and India's coal consumption is growing with the increasing rate. In the developed such as USA is closing or replacing coal with the gas in power plants (World Energy Resources, 2016) [15].



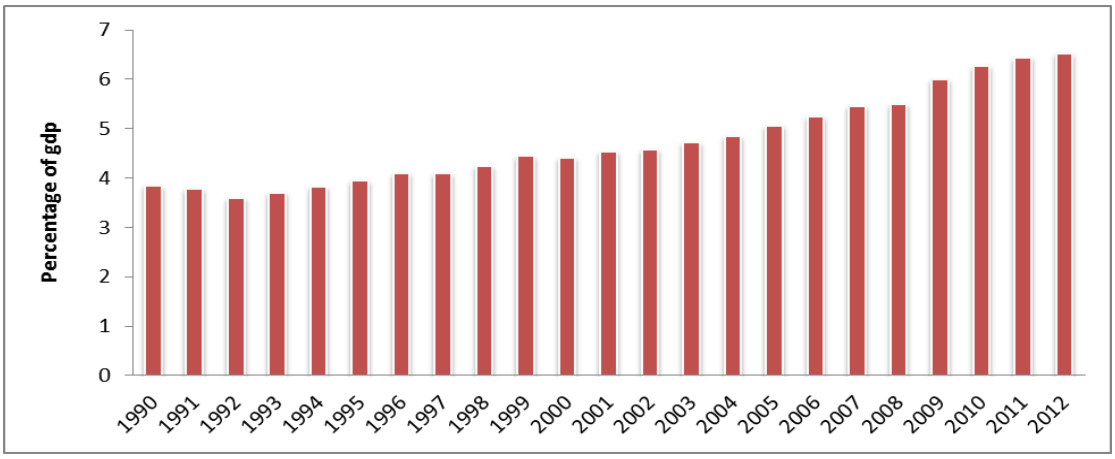
***Source*:** World Bank, 2017

Fig 2: Energy Consumption from Fossil Fuel (% of total) from 1990-2012

Figure- 2 shows the energy consumption from fossil fuel in percentage of India from 1990 to 2012. Energy consumption based on the coal, oil, petroleum and natural gas production. The figure shows the fluctuation condition with the increase rate. In 1990 the energy consumption percentage was 53.67 % and in 2000 it was 63.73 % and it is continuously rising. It was highest in 2012 which was 73.42 percent of the total. This is increasing due to the rising demand of vehicles and production of goods. In recent years, India's energy sector has been tremendously grown. Some reasons are mostly responsible for the continued rapid expansion in demand of the energy in India, which are economic growth and population growth, allied to the structural trends such as the nature of envisioned industrialization and urbanization (IEA, 2015). At a global level, it has estimated that coal combustion was responsible for about 46 percent of CO_2 emissions from fossil fuel combustion and approximately 31 percent emitted from coal-fired power plants. Coal-fired power plants are the largest contributor to share in national CO_2 emissions and top four emitting countries of coal-fired are 48 percent for China, 31 percent for the United State, 28 percent for the European Union and 47 percent for India which is also higher (Trend of Global CO_2 emissions Report, 2016).

Trend of Economic Growth in India

India is one of the fastest growing or emerging economy of the world. This paper analyzes the data of linkage carbon dioxide from transport, energy from fossil fuel and GDP growth in India. Basically, transport and energy are closely related and both are contributing to rising GDP growth of India. Transport is a major determinant of energy demand, which has been already defined (European Business and Technology Center, 2013) [4].



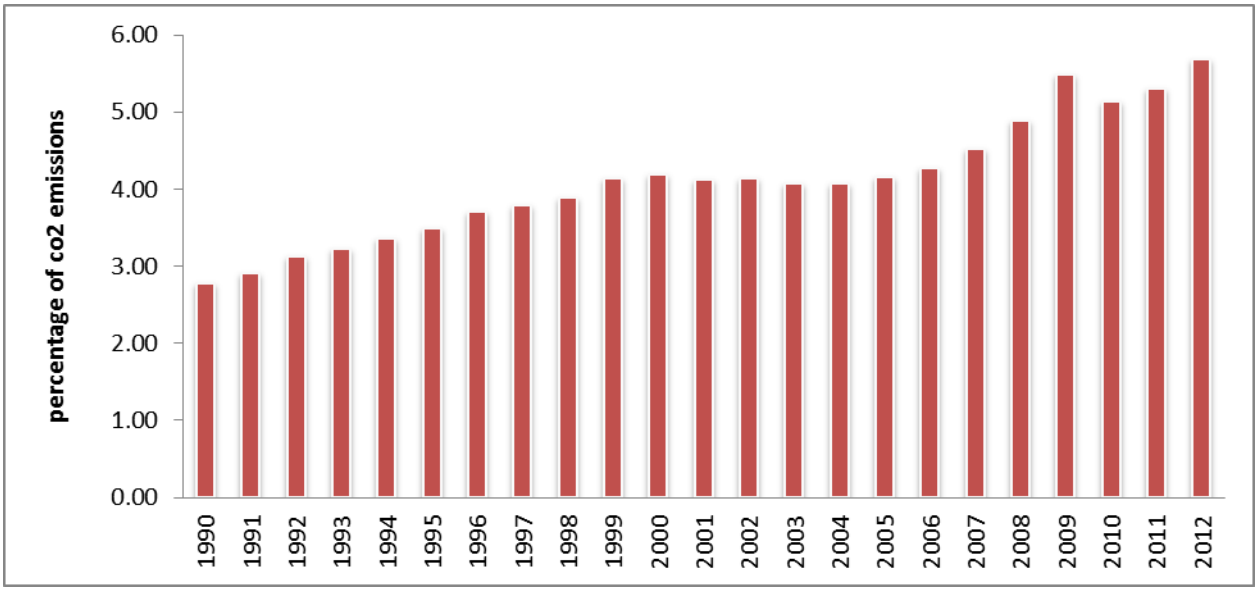
Source: RBI, 2014

Fig 3: Trend of GDP Growth of purchasing power parity in India from (1990-2012)

Figure3 shows the GDP growth of India at a World level, which based on the purchasing power parity and share of total world percentage. During the pre-liberalization period, the GDP growth rate was sluggish at 3 percent per year. Figure 3 shows that in 1990-1991 the GDP growth rate was 3.8 % of the total and this was continuously increasing with the fluctuating rate. However, during the post liberalization (1991-2005) phase, the growth rate was higher which recorded 6.09 percent was and it was rising continuously. Figure 3 shows that in 2012 the GDP growth rate was 6.53 percent which was also higher. But with the rising GDP environmental condition was continuously decreasing and climate change has been made a burning issue in India. Greenhouse gas (GHGs) is continuously emitting due the burning of fossil fuels and especially CO_2 emissions have been the most important causes of climate change because CO_2 emissions is playing an important role in rising global warming and ozone depletion in the world (Tiwari. A.k. 2011) [14].

Trend of CO_2 emissions in India

Today, increasing threat of global warming and climate change totally links with the economic growth, energy consumption and environmental pollution. The present cause of global warming is the atmosphere of so-called greenhouse gases, which captivate thermal radiation coming from the earth that would otherwise dissipate into space (David N. Weil, 2013). The shares of gases in global GHGs emission are as follows: methane is 14 percent; nitrous oxide is 8 percent and carbon dioxide (CO_2) is 57 percent use of fossil fuel (IPCC, 2007). Carbon dioxide is one of the major contributors in GHGs for increasing global surface temperatures. Therefore, it may happen that CO_2 emissions are rapidly increasing due to energy supply, industrial process forestry, agriculture and transport.



Source: World Bank, 2017

Fig 4: Trend of CO_2 Emissions in India (In Kilotons)

Figure-4 shows the trend of CO_2 emissions in India from 1990 to 2012 at the world level. It is increasing with the fluctuating rate. It was 2.7 % in 1990 and 4.1% in 2000 and higher in 2012 which was 5.69 percent. The main objective of Kyoto protocol of 1997 that reducing GHGs emissions to 5.2 percent lower than the levels of 1990 during the period of 2008 to 2012. But in developing countries, environmental degradation is rising due to the economic growth through the use of energy and other resources. Approximately 7.3 percent rise in coal consumption was the main cause for increase in India's emissions, which accounted for 59 percent of India's total fossil fuel primary energy consumption and this 59 percent share of coal is smaller than in China and Africa (Maryam. J. et.al. 2017) [8].

Data and Methodology

This paper shows the relationship between CO_2 emissions (kt), economic growth and energy consumption of India. GDP data, based on the purchasing power parity share of total world percentage, are used for economic growth and fossil fuel energy consumption percentage of the whole world is used for energy consumption. Carbon dioxide emissions from the burning of fossil fuels and the manufacture of cement are used for the CO_2 emissions (kt). Annual data have been included for the period 1990-2012 and these data of CO_2 and energy consumption obtain form World Bank data, 2017 and GDP data taken by the Reserve Bank of India 2014. In this analysis, the dependent variable is CO_2 emissions and the independent variables include GDP and energy consumption in percentage of total. A simple regression model is used for the analysis of this model.

$$CO2_t = \alpha + \beta 1 gdp_t + \beta 2 energy_t + \beta 3 year + \mu i$$

Where CO2t is carbon dioxide emissions in kilotons, with time and α is the value of the constant. $\beta 1 gdp_t$ is the Gross Domestic Production at a time. $\beta 2 energy_t$ is showing the energy consumption from fossil fuel in India. β3year is

showing the time duration form 1990-2012. μi is representing the error term. A simple regression method estimates the model.

Table 2: Results of Regression for Carbon Dioxide Emissions and GDP, Energy Consumption

Variable	Coefficient	t-value	Level of significance	
α	-10.38201	-5.28	0.000	R^2= 0.9769
$\beta 1 gdp_t$	0.3842020	3.37	0.003	
$\beta 2 energy_t$	0.2198817	6.21	0.000	
β3time	0.1124025	-3.46	0.003	

Table 2 shows the results for Carbon Dioxide Emissions and GDP, energy Consumption with the time period. All data variables are significant at the 1 percent level of significance. The constant coefficient value is -10.38201 which also significant at the 1 percent level of significance. The model is also significant at the 1 percent level of significance where the value is 0.0000 which is the probability value (P). Therefore, the model shows that the carbon dioxide emissions is highly effected by energy consumption and economic growth in India.

Conclusion

Environmental pollution, especially carbon dioxide is not controlling as well as climate change problems increase continuously in India. India has been made a largest GHG emitter at the global level. It is found that vehicles are highly responsible for increasing CO_2 emission in India. The vehicular growth rate continuously fluctuates and showing the ups and down condition. The percentage of energy consumption from fossil fuel is also rising with the time as a result the economic growth rate is also fluctuating with the increasing rate. During the period 1990 to 2012, with the economic growth, CO_2 emissions are also changing. The result is showing a positive relationship among all variables and significant at the 1 percent level of significance. Therefore, India's rate of economic growth will have a significant for the CO_2 emissions and climate change.

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