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Carbon footprint from road transport use in Kolkata city

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ABSTRACT

Carbon footprint is intricately related with the consumption and lifestyle pattern of individuals. The transport sector is one of the major sectors that effects lifestyle in a significant way and is the major contributor towards the city emissions. This paper attempts to estimate the carbon footprint arising from household's use of road transport in the city of Kolkata across various income categories. The objective is to see how the footprint changes across income categories and also what factors drive changes in the footprint values across the defined income categories. The study has been based on primary surveys done across the city of Kolkata by choosing about 500 households across various income classes defined. Estimation of carbon footprint shows a clear picture of the relation between people's affluence and the average per capita footprint. It clearly shows that per capita footprint from transport use increases with income. Further results show that income, vehicle ownership and per capita transport expenditure has significant and positive impact on per capita footprint of households from road transport use.

Introduction

The term carbon footprint is a relatively new concept, and can be generally described as the total greenhouse gas emissions associated with any anthropogenic activity. However, in many cases, for simplicity, we consider only carbon-di-oxide emissions, while measuring carbon footprint. Driven by a widespread use in the academic literature, carbon footprint has now become a synonym for the climate change impact of individuals, communities, nations or any specific activity. Carbon footprint is intricately related with the consumption and lifestyle pattern of individuals. This is because the kind of food consumed by the people, the way cooking is done at homes, the transport that is being used, or the kind of appliance ownership at homes, all these activities generate significant energy consumption and emissions. It is not urbanisation per se, that contribute to GHG emissions, but rather the way in which people move around the city, the way in which people use energy at home, that make cities the great consumers of energy and polluters that they are. India is a developing country with huge growth potential. Energy consumption patterns widely vary across different cities and income groups in the country. There is a strong middle-class, growing at a faster pace than the overall population with high consumption aspirations. With changing income distribution pattern and changing socio-economic profile of people, lifestyle pattern of the metropolitan cities of developing countries are changing rapidly. Kolkata is one such city which according to a report by ICLEI South Asia, 2009 is the largest emitter of carbon di-oxide among 41 key main metropolitan cities across India, with total emissions of around 9.3 million tonnes (in absolute terms). The transportation sector is the major contributor towards the city emissions.

As India undergoes fast economic growth, energy consumption and GHG emissions in the transport sector would increase exponentially given the growth in population, changes in income distribution pattern, scale of urban expansion and continued quest of improving living standards. Over the period 1991–2005, energy consumption from urban transport in

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23 major urban areas (million plus cities) in India became more than double, growing from 103 to 209 PJ, and carbon emissions increased from 7.9 to 15.3 Mt (Li Jun, 2011). The city of Kolkata in 2010 registered emissions to the tune of 1.8 million tons from road transport itself, with the maximum emissions coming from diesel operated vehicles (Guttikunda and Jawahar, 2012). According to a CSE report (2011), in Kolkata, the cars and two wheelers together already use up about 40 per cent of the total energy consumption of the city's road transport.

Against this background, this paper attempts to estimate the carbon footprint arising from household's use of road transport in the city of Kolkata across various income categories. The objective is to see how the footprint changes across income categories and also what factors drive changes in the footprint values across the defined income categories.

Literature review

In the past two decades, the role of consumers and their consumption patterns have attracted increasing attention and discussion among researchers. The IPCC (Intergovernmental Panel on Climate Change) report for policymakers, Working Group III has mentioned in its report that *Changes in lifestyles and consumption patterns that emphasize resource conservation can contribute to developing a low-carbon economy that is both equitable and sustainable.* In the late 1980s, some researchers brought the concept of lifestyle into the study of personal energy consumption. Lee Schipper et al. (1989) rightly concluded: "*about 45–55% of total energy use is influenced by consumers' activities for personal transportation, personal services, and homes.*" They argued that significant changes in energy demand will be driven by "*the mix of personal activities and their locations besides energy prices and incomes*". There exists relatively a large body of literature on the developed countries. Weber and Perrels (2000) quantified the impact of lifestyle factors in the 1990s and 2010's energy demand and related emissions in West Germany, France and the Netherlands. Lenzen assessed the energy use and greenhouse gases attributable to consumer activities in Australia (1998). Bin and Dowlatabadi (2005) used the consumer lifestyle approach (CLA) to study the relationship between consumer activities and energy use and related CO_2 emissions. Their results showed that 80% of energy consumption and CO_2 emissions could be attributed to consumer behaviour and related economic activities. The indirect effects of consumer behaviour caused by energy consumption and CO_2 emissions were twice those of direct actions. Here direct action means energy use that is resulting directly from personal travel, or home energy use like lighting, appliances, cooking, space heating and water heating. Indirect impact refers to the energy consumption and CO_2 emission occurred in the preparation of a product or service before its use. Reinders et al. (2003) analysed household energy consumption in 11 European Union countries and found that household energy consumption varied with expenditure. Lenzen et al. (2006) have used input output analysis to evaluate sustainable household consumption from a global perspective. Their results showed that energy needs are quite different across countries and does not support the environmental Kuznets curve. Also there are significant differences in average energy requirements even at equal income levels.

There are few studies on the developing countries. In China, a study by Wei et al. (2007) suggests that approximately 26 per cent of total energy consumption and 30 per cent of CO_2 emissions in the country every year are a consequence of residents' lifestyles, and the economic activities that support these demands. Another study on China by Zhen-Hua Feng et al. (2011) uses the Grey Model to compare the relationship between energy consumption, consumption expenditure and CO_2 emissions for different lifestyles. The results show that direct energy consumption is diverse for urban households and simple for rural households in China. Direct energy consumption and CO_2 emissions are increasing faster for urban than for rural households. Indirect energy consumption and CO_2 emissions for urban households are much greater than the direct consumption values. Reddy and Srinivas (2009) analysed Indian household energy consumption patterns and the factors that influence them. It analyses actor linkages and their impact on the fuel choice mechanism. Apart from carbon footprints, closely related energy requirements of Indian households have been calculated by Pachauri and Spreng (2002) for the years 1983–84, 1989–90 and 1993–94. Based on input–output (IO) analysis, the authors find that household energy requirements have significantly increased over time identifying growing income, population and increasing energy intensity in the food and agricultural sectors as the main drivers. The study also reveals income levels as the main factor determining variation in energy requirements across households. Nicole Grunewald et al., 2012 apply IO energy analysis along with household expenditure survey data from India for the year 2004/05 to calculate the carbon footprint of households by income groups and analyse the respective emission drivers. The authors have also estimated the income elasticities of major consumption subgroups to point to consumption items, which are declared as luxury goods and which exhibit a high carbon intensity. The paper concludes by saying that other than income, fuel types used for cooking have a positive impact on carbon footprint as well as factors like gender, age, employment and religion. The household carbon footprint of the richest quintile is almost five times the carbon footprint of the poorest quintile.

Recently Bhoyar Sankesha et al. (2014) have tried to identify major factors contributing to carbon footprint and understand their relative contribution for people living in rural and urban parts of Mumbai, the wealthiest city of India. Details of the members of households were prepared to estimate the GHG emissions due to electricity, food consumption, cellphone usage, waste generation and transportation. The major findings are that in general the carbon footprint of urban households is larger than that of the rural households. The carbon footprint due to travel and cellphone usage is highest for higher income groups in rural areas. Whereas cooking fuel and food are the major contributors for the low income households. On the other hand travel and electricity are the major contributors to the total carbon footprint in urban areas.

The present study based on Kolkata, is different from the studies conducted earlier, because it tries to capture the carbon footprint arising only from public transport usage in urban Kolkata, and factors that determine variation in footprint values