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Carbon Footprint of Public Transportation – A Case Study of Religious Tourism to Shri Mata Vaishano Devi Shrine in Katra, Jammu and Kashmir, India.

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Abstract: The rates of increment in GHGs concentrations in the atmosphere are extraordinarily high, far exceeding their natural sequestration rates. Transportation accounts to 19% of the global energy use and 23% of all the CO_2 emissions globally, About 75% of these emissions come from cars and trucks. In India, transportation sector consumes about 17% of total energy and produces 60% of GHG emissions, estimated at around 261 Tg of CO_2, of which 94.5% is contributed by road transport. Travel and tourism, one of the largest industries in the world is a significant contributor to greenhouse gas emissions. Religious tourism in particular, is an important cultural and traditional heritage of India. This paper is a case study to estimate the individual carbon footprints of pilgrims travelling Shri Mata Vaishano Devi Shrine in Katra, Jammu and Kashmir. The analysis considers individual emissions from different modes of transportation *viz.* train, bus, taxi/auto-rickshaw and air travel using equivalent carbon emission factors.

Keywords: Carbon Footprint, CO_2 emission factor, Climate Change, Green House Gases, Tourism

1. INTRODUCTION

Energy-intensive economic development associated with the emissions of large quantities of CO_2 and other greenhouse gases (GHGs) into the atmosphere has prompted the modern problem of global climate change. The rates of increment in GHGs concentrations in the atmosphere are extraordinarily high, far exceeding their natural sequestration (IPCC 2007) rates. The transportation sector accounts to 19% of the global energy use and contributes to 23% of

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all the CO_2 emissions globally, 75% of these emissions come from cars and trucks (IEA, 2009). Indian automotive industry is the second fastest growing in the world, manufacturing about 8 million vehicles annually. In 2005–2006, the transport sector in India consumed about 17% (36.5 mtoe) of the country's total energy (217 Mtoe) generation (Ramachandra and Shwetmala, 2009). The transportation sector in India consumes about 17% of total energy and produces 60% of GHG emissions, estimated at around 261 Tg of CO_2, of which 94.5% is contributed by road transport. Most of the transport-related emissions are concentrated in urban areas which account for the bulk of on-road transport energy consumption and there is little scope of fuel substitution by the renewable transportation fuels (Li, 2011). The total number of registered motor vehicles in India increased from about 0.3 million as on 31st March, 1951 to 159.5 million as on 31st March, 2012 (Vyas, 2014).. The six largest GHG emitting countries/regions in 2012 were: China (29%), the United States (15%), the European Union (11%), India (6%), the Russian Federation (5%) and Japan (4%). Even though India's per capita GHG emissions of 1.6 tonnes are well below the world average of 4.9 tonnes (Olivier et al, 2013).

Travel and tourism, one of the largest industries in the world is a significant contributor to greenhouse gas emissions (UNWTO, 2008). Religious tourism is an important cultural and traditional heritage of India. India is home to many shrines of the world's major religions such as Vaishno Devi temple (Jammu and Kashmir), Golden temple (Punjab), Amaranth (Jammu and Kashmir), Hemkund Sahib (Uttarakhand), Ajmer Sharif (Rajasthan), Velankanni Church (Tamilnadu), Shirdi (Maharashtra), Haridwar (Uttrakhand), Balaji (Andra Pradesh) and many other shrines. Like other industries, tourism also generates GHGs directly when it sells goods and services to tourists and indirectly when it purchases inputs which require energy in their production. Hanandeh (2013) estimated that nearly 3.0 Mt eCO_2 were generated as a result of pilgrim transport, meal provision, lodging and waste management of Hajj pilgrims.

The GHG emissions contributed by an activity/process can be expressed in terms of CO_2 equivalents (eCO_2) also known as carbon footprint. The equivalent means that the footprint is made up of number of green house gases which are converted into equivalent of CO_2 in order to show all the emissions in single term. 'Carbon footprint' has become a widely used term and concept in the public debate on responsibility and abatement action against the threat of global climate change (Wiedmann and Minx 2007). McKercher et al., 2010 suggested that the three major sets of stakeholders are involved in tourism: governmental and global policy bodies, industry, and tourists which must participate to reduce the carbon footprint linked with tourism. The joint United Nations World Tourism Organisation (UNWTO, 2007) declaration also

Table 1 Carbon dioxide equivalent (CO_2e) emission factors (Bhoyar et al., 2014).

S. No	Source	gCO_2e per L of fuel
1	Petrol	2207
2	Diesel	2650
S. No	Source	gCO_2e per km of distance travelled
1	Air travel (domestic)	195.18
2	Air travel (international)	96.35
3	Travel by Train (long distance)	41.5

encourages tourists to reduce their carbon footprints or offset their emissions, opt for environment friendly activities that contribute to the preservation of the natural environment and cultural heritage and consider the climatic, economic, societal and environmental impacts of their travel options.

The carbon footprint is defined as a measure of the greenhouse gas emissions that are directly and indirectly caused by an activity or are accumulated over the life stages of a product or service, expressed in carbon dioxide equivalents (Chaurasia et al., 2012). In the present study, we calculated the carbon footprint associated with travelling of the pilgrims visiting Shri Mata Vaishno Devi Shrine in Jammu and Kashmir. The Vaishno Devi Shrine is located in the famous Trikuta hills near Katra town at an altitude of 5200 ft above the sea level.Thousands of devotees throng to the hilly shrine every day to seek the blessings of goddess Vaishno Devi. The yatra that stood at 13.96 lakh devotees in 1986, increased to 93.24 lakhs in 2013. The increase in the number of devotees to the hilly shrine has been an issue of debate among the conservationists as due to certain serious ecological and environmental associated.

2. RESEARCH METHODOLOGY

A thorough questionnaire was designed to collect the relevant information regarding the mode of transport and the total distance covered to and fro by pilgrims from their hometown during their visit to the holy Shrine. In this connection, a total number of 110 samples were collected randomly from various places in the Katra town. Each respondent was personally interviewed, the questions in the questionnaire were conveyed to the respondents in the simplest of the way. To get an estimate of the combined impact of emissions from different greenhouse gases, the mass non-CO_2 greenhouse gases emissions are converted into the CO_2 equivalent emissions using their Global Warming

Table 2: Average distance travelled by respondants through various modes of transportation and their equivalent CO_2 emissions.

		Average Distance Travelled				Average Carbon Emissions (in gCO2e)			
Category	**Distance (in kms)**	**Air**	**Train**	**Bus**	**Auto /Car**	**Air**	**Train**	**Bus**	**Auto /Car**
1	**0-500**	0.0	207.0	107.2	1.3	0.0	11.8	10.7	0.3
2	**500-1000**	0.0	606.2	99.8	11.8	0.0	34.6	10.0	2.2
3	**1000-1500**	240.1	899.4	89.6	14.7	61.2	51.3	9.0	2.8
4	**1500-2000**	77.4	1580.9	90.7	9.8	32.7	90.1	9.1	1.9
5	**2000-2500**	1211.5	958.2	86.1	30.5	226.0	54.6	8.6	5.8
6	**2500-3000**	0.0	2784.3	89.9	10.6	0.0	158.7	9.0	2.0
7	**3000-3500**	1105.6	2054.5	98.0	18.4	206.2	117.1	9.8	3.5
8	**3500-4000**	580.7	3072.0	84.9	26.7	108.3	175.1	8.5	5.1
9	**4000-4500**	0.0	4394.4	101.6	9.4	0.0	250.5	10.2	1.8

Table 3: Percentage distance travelled by respondants through various modes of transportation and their equivalent CO_2 emissions (%age).

		%age distance travelled				%age Carbon Emissions			
Category	**Distance (in kms)**	**Air**	**Train**	**Bus**	**Auto /Car**	**Air**	**Train**	**Bus**	**Auto /Car**
1	**0-500**	0.0	64.1	35.4	0.4	0.0	53.9	44.9	1.1
2	**500-1000**	0.0	83.4	15.2	1.4	0.0	73.1	23.1	3.8
3	**1000-1500**	20.2	71.3	7.2	1.2	22.0	66.2	10.1	1.7
4	**1500-2000**	5.3	88.9	5.2	0.6	7.2	83.4	7.9	1.5
5	**2000-2500**	51.8	43.1	3.8	1.3	52.5	41.2	4.4	1.9
6	**2500-3000**	0.0	96.5	3.1	0.4	0.0	93.5	5.3	1.1
7	**3000-3500**	33.7	62.7	3.0	0.6	36.6	58.4	3.9	1.1
8	**3500-4000**	16.2	80.9	2.2	0.7	16.2	78.7	3.7	1.4
9	**4000-4500**	0.0	97.5	2.3	0.2	0.0	95.4	3.9	0.7

Potential GWP (Bhoyar et al., 2014). The CO_2 equivalent emission factors (Bhoyar et al., 2014) for the various sources are provided in Table 1. For the vehicles (bus, car, auto-rickshaw) where the direct CO_2 emission factors were not available, in those cases the emission factor were estimated based on the average mileage and the average occupancy of vehicles.

3. RESULTS AND DISCUSSIONS

Based on the total distance travelled the pilgrims visiting shrine, data was grouped into nine categories and the averages of the analysed parameters are provided in the table 2 and 3. As evident, the general indication is that majority of the pilgrims preferred railway over the other travel options, the pilgrims from nearby towns also showed their preference of bus or through cars. Percentage of air travel remained low for the passesngers coming from nearby towns and cities. However in the air travel percentage peaked in the category 3, which is probably due to the fact more number of tourists from New Delhi and surrounding areas fall into this category. Similarly, air travel showed a great increase with the distance in the categories 5, 7 and 8 to 51.8%, 33.7% and 16.2% respectively. Being costlier, air travel is only afforded by the well-off families; people coming from urban areas generally show preference towards air travel. Moreover air travel is not accessible as majority of the small towns in India are not connected by the airports as evident from the category 4, 6 and 9 showing nil or low preference to air travel. Railway being comfortable and relatively cheaper mode of travel remained the most preferred travelling option. This is quite evident from the percentage travel preferences shown by pilgrims i.e. 64.1% (category 1), 83.4% (category 2), 71.3% (category 3), 88.9% (category 4), 43.1% (category 5), 96.5% (category 6), 62.7% (category 7), 80.9% (category 8), 97.5% (category 9). Relatively the passengers gave lower preference to bus travel except for the pilgrims coming from the closer by towns within the state and out of the state as indicated in categories 1 (35.4%) and 2 (15.2%). Most of the nearby areas within the state are not connected by railway, therefore buses and cars are the most preferred option. A number of passengers boarded buses for local travel to to reach Katra town from Jammu railway station, as rail service to Katra town has been started very recently. Similarly, the percentage travel by auto-rickshaw is also very low. However, these are the most preferred mode for local travel.

An average CO_2 emissions in gCO2e reported in the categories1, 2, 3, 4, 5, 6, 7, 8, 9 are 22.8, 46.8, 124.2, 133.7, 295.0, 169.7, 336.6, 297.0, 262.4 respectively, which shows that CO_2 emissions increased with the distance travelled. Very high CO_2 emission in the category 5, 6 & 8 are due to higher percentage of air travel. Air travel has higher emission factors of CO2 emission. Lee et al., (2009) reported that the relative contribution of other GHG gases from the aviation sector and estimate the total radiative forcing from aviation to be 3.5% of total anthropogenic forcing excluding the effect of clouds. Hanandeh (2013) estimated that long haul air travel accounts to 60% global warming potential (GWP) of the hajj, food and lodging combined for 31% while all other activities contribute around 9%, emissions from infrastructure provision accounts for 11% of the total GHG emissions during the Hajj.

The percentage CO_2 emission from Railway is highest owing to the distance travelled, however quite lower than the corresponding percentage of distance travelled. In contrast, the percent CO_2 contribution of buses and auto rickshaw/ cars was higher in terms of their percent contribution to distance travelled during the journey. The passenger travelling same distance but chose to travel by air/bus/car emitted more CO_2 than those travelled by train which is more evident in the category 3, 7 and 8 and also in category 1 of the respondants.

CONCLUSIONS

With no doubt, it is evident from this paper that railways are more eco-friendly mode for travel. Due to lower emission factors railways produce lesser emissions. Interestingly, railways are the most preferred mode of travel too, this may be due to the comfort associated and the cost too. However, with economic growth of the country and increase in per capita GDP, air travel and personal convience is now affordable for a vast section of the country. this increase can offset the plan to lower the CO_2 emissions associated with transport. To keep a check on the rising carbon emissions assocaiated with pilgrimage, authorities must run more train directly to Katra, night train will be more preferred as would save the time for the passengers and also cut short the local travel. The non-availability of the seats is the major issue prompting passenger to follow bus ot air route which must be addressed by running new trains. The completion of railway track upto Katra town and the introduction of few new trains is a good step forward in this context.

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