



## Calculation of carbon footprints in semi urban areas of Jammu, J&K (India)

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### Abstract

In present study an attempt has been made to assess the carbon footprints of Sunjwan (A residential and semi urban area of Jammu district in the state of J&k). The study area is a village about 12-15 kms from General bus stand Jammu. The Carbon footprints analysis is based on the cumulative consumption of electricity, diesel/petrol, firewood and LPG. The per capita emission of CO<sub>2</sub> in study area was found out to be 1.08 tonnes per year and 5.46 tonnes per household per year. The major contributor to carbon emissions is Diesel and petrol the reason for which being the rapid and large scale construction work in the progressively developing area. Another important contributor to Carbon emissions is the burning of fuel wood mainly used by the local bakers who use traditional clay ovens.

**Key Words:** Carbon footprints; greenhouse gases; CO<sub>2</sub>e; carbon emissions; global warming.

### Introduction

Every country's environmental concerns are related to the level of its economic development, the availability of natural resources and the standard of lifestyle of its population. In India, fast growth of population, poverty, urbanization, industrialization and several other related factors are very much responsible for the fast degradation of the environment. Environmental problems have become very serious in many parts of the country, and hence cannot be ignored. In the recent past, scientists and researchers have become much more concerned with regards to global warming due to human impact on the climate system, through the enhancement of natural greenhouse effect. It is a natural process that warms the surface of Earth. The process is called the greenhouse effect because the exchange of incoming and outgoing rays of the sun that warms the planet works in a similar way to that of a greenhouse. The radiations of sun penetrate through the Earth's atmosphere and the earth's surface warms up. Some of the Sun's energy is reflected directly back to the outer space, the rest is absorbed by land, ocean, and the atmosphere. The greenhouse gases in the atmosphere trap the long wave terrestrial radiations radiating from the Earth toward space. The energy radiated from the sun is absorbed by the gases making the lower part of

atmosphere warm, called as greenhouse effect which is critical to occurrence of life on earth but in recent decades these energy trapping gases have increased alarmingly, increasing the temperature of earth and the surface temperature of earth is expected to increase by 2<sup>0</sup> to 6<sup>0</sup> Celsius by end of twenty first century (Riebeek, 2010). Greenhouse gas emissions from humans have increased by a worrying 70% between 1970 and 2004. (IPCC, 2007). Important greenhouse gases are Water vapor (H<sub>2</sub>O), Carbon dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>), Nitrous oxide (N<sub>2</sub>O) Ozone (O<sub>3</sub>), Chlorofluorocarbons (CFCs) Hydrofluorocarbons (incl. HCFCs and HFCs). Over the years the concentration of greenhouse gases in our atmosphere has increased at a very fast rate due to anthropogenic activities resulting in a very significant increase in the temperature of the earth causing the dreaded global warming. Amongst the greenhouse gases, CO<sub>2</sub> is the most dominant gas causing global warming that accounts for nearly 77% of the total global CO<sub>2</sub> equivalent greenhouse gaseous emission. Though the global warming potential of CO<sub>2</sub> is comparatively less being (01) as compared to (16300) of Sulphur hexafluoride (SF<sub>6</sub>)(UNFCCC [unfccc.int/ghg\\_data](http://unfccc.int/ghg_data)) but it is the largest contributor to global warming due to large emissions of CO<sub>2</sub>. Directly or indirectly all human activities cause the carbon dioxide emissions by using electricity generated from fossil fuel power stations, burning gas for heating, driving or

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travelling in a diesel or petrol car. Furthermore, every product or service which humans consume directly or indirectly creates carbon dioxide emissions because energy is required for their manufacturing, transport and even disposal. These products and services may also cause emissions of other kinds of greenhouse gases. Combustion of fossil fuels for energy is the major contributor to carbon dioxide in our atmosphere. Understanding and addressing the full range of our impact is very crucial for the effect of climate change to be minimised.

The total amount of greenhouse gases produced from any locality, area, population, factory, installation or unit to directly or indirectly support human activities, are usually expressed in equivalent tons of carbon dioxide CO<sub>2</sub> (eCO<sub>2</sub>) and is called as the Carbon footprint. Carbon footprints can be defined as a measure of the total amount of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) emissions of a defined population, system or activity, considering all pertinent sources, sinks and storage within the spatial and temporal boundary of that population, system or activity of interest. Carbon footprint is measured in Kg or tons of CO<sub>2</sub> e (e=Greenhouse gas equivalent to CO<sub>2</sub>). Carbon footprint is measured in terms of carbon dioxide emissions because out of all six greenhouse gases present in atmosphere, carbon dioxide is the most abundant. Therefore, though all the greenhouse gases are measured while measuring the carbon footprints, they are converted to their Carbon Dioxide equivalent while presenting the final result of emissions. This is the reason we write a small "e" at the end of CO<sub>2</sub> while we mention the unit of carbon footprints. It is a measure of the exclusive total amount of carbon dioxide emission that is directly and indirectly caused by an activity or is accumulated over the life stages of any product (Wiedmann and Minx, 2008). Carbon footprint, being a quantitative expression of GHG emission from an activity helps in emission management and evaluation of mitigation measures (Carbon Trust, 2007). Having quantified the emissions, the important source of emission can be identified and area of emission reductions and increasing efficiencies can be prioritised. This provides the opportunity for environmental efficiencies and cost reductions. Carbon footprint has been used as an indicator of the impact of lifestyle of a citizen of a

country on carbon emissions. The UNDP (2007) and Edgar and Peters (2009) published country wise per capita footprint, a convenient way to compare contributions of countries, cities and sectors towards global warming. Carbon footprints are now used as an important indicator of event management (London 2012, Sustainability plan 2007). The study was conducted with the following objectives:

1. Measuring and analyzing the carbon footprints of the study area based on the energy consumption
2. Finding out about the awareness amongst the residents of the study area with regards to the environment
3. To identify the main sources of CO<sub>2</sub> emissions and suggest alternatives.
4. To calculate and analyze house hold and per capita carbon foot print of study area when compared to the global carbon foot prints.

### Materials and Methods

**Study area:** To the northern most part of India is located the state of J&K. The state has three provinces namely Jammu, Kashmir and Ladakh. The province of Jammu is situated on a sub hilly area between 32<sup>0</sup>17' and 37<sup>0</sup>5' N and 74<sup>0</sup>40' and 80<sup>0</sup>30' E at an altitude of 400 m above mean sea level. The present study is confined to village Sunjwan of district Jammu,(J&K). The present study regarding assessment of Carbon footprints, has been undertaken in Jallalabad, area of village Sunjwan dist. Jammu, J&K, India. Sunjwan, situated at an altitude of 336 m above the sea level and (32.69<sup>0</sup>) N and (74.90<sup>0</sup>) E are the respective latitude and longitudes of the study area.

**Collection of data:** The selected area was visited and the respondents were made aware of the study. A total of 506 individuals and 100 households interviewed as sample to carry out the questionnaire based detailed survey and Statistical surveys of current conditions to assess the carbon footprints in the study area. The answers of the respondents to the best of their knowledge and usage patterns were recorded. The total usage of Electricity units, LPG, Petrol and Diesel consumption, other fuels like wood etc. were noted for each household. The



energy and fuel consumption of different households was noted.

**Electricity:** Number of power units (one unit = 1KWh of electricity) consumed in home was recorded and verified from the monthly electricity bills issued by State Electricity Board. The average monthly units consumed were then multiplied by 12 to calculate the annual consumption.

**Petrol/Diesel:** Number of litres of petrol/ diesel consumed during a month was recorded from each household. The annual consumption of petrol/diesel is calculated accordingly.

**LPG:** Normally, one LPG cylinder has 14 kg of gas. From the number of cylinders consumed, the per month consumption of LPG cylinder is recorded in Kg and the resultant value is then multiplied with 12 to get the annual consumption.

**Wood:** The quantity of firewood burnt in a month is noted down which is then multiplied by 12 to get annual consumption. The values calculated for different variables (electricity, petrol, diesel, LPG and wood) are now multiplied with their respective emission factor as given in *Table 1* to get the carbon dioxide emission in Kg (Kg CO<sub>2</sub>). Value is divided by 1000 to get carbon dioxide emission in tons (tCO<sub>2</sub>). To get the final carbon footprint of the study area the Carbon dioxide emission values of each of the above given variables are added.

## Results and Discussion

The need to measure greenhouse gas emission has given rise to carbon footprint analysis. It has become a new area of research, yet different enough to spawn a new approach. This is a basic micro unit of the nation which can play an important role in protecting environment by curbing the emission of carbon dioxide. Since the various household action commands to perform various roles in the household by different family members, their correct and proper practices will reduce the emission of carbon dioxide, if the household are made aware about it. The consumption patterns of energy and fuel (electricity, petrol, diesel, LPG and wood) are found to be different in different areas. More precisely, the consumption as well as emission patterns are different at household level and individual level.

In the study area, the maximum carbon dioxide emission is mainly due to the consumption of fuel used in transportation. Petrol (92.22L) being the major fuel used followed by Diesel (88.81L). The annual consumption of fuel (petrol and diesel) per capita is 181.03 Litre whereas the national average is 175.3L (<http://world.bymap.org/OilConsumption.html>, 2014).

In the present study, the second major contributing factor to carbon dioxide emissions is the consumption of electricity. The annual per capita electricity consumption in the study area is observed to be 320 KWh whereas the national average is 1075KWh (2015-16 Report Ministry of Power Central Electricity Authority New Delhi, Government of India Power Sector). The variation is observed because in our study only the household electricity consumption pattern is considered. In our study, wood is found to be the third major contributor, with the consumption of 116.69Kg/capita/year while the net national per capita fuel wood consumption was estimated at about 194 kg/capita/year. Wood is followed by LPG having the consumption of 34.58Kg/capita/year; on the other hand the national average is 22.8Kg/capita/year (Chandrasekhar and Pandey, 2012). In the study area as well as at national level the consumption of wood is much higher than the LPG consumption, the reason for more consumption of wood as compared to LPG is its easy availability and comparatively less monetary value. In the study area, wood is used on a large scale by local rural population for traditional cooking practices. Therefore, in this particular study, the fuel consumed in the transportation sector is found to be the major contributor of carbon dioxide emissions. Rise in carbon emissions can be correlated with increasing direct and indirect energy requirements of household and depend on economic growth, which has increased the consumption of energy (Sridevi *et al.*, 2014). However, in contrast to our study, the study done by Parikh *et al.*, (2009) on carbon dioxide emissions of India by producing sectors and due to household fuel consumption, show that the highest direct emissions were due to electricity sector followed by manufacturing, steel and road transportation. The difference of our study from the

**Table 1: Different emission factors used to calculate the carbon dioxide emissions in Kg.**

SN	Emission source	Emission factor	Source
1	Electricity (in KWh/Yr)	0.85 kg CO <sub>2</sub> per KWh	CEA(Govt. of India ) <a href="http://www.cea.nic.in/reports/planning/cdm_CO2/cdm_CO2.htm">http://www.cea.nic.in/reports/planning/cdm_CO2/cdm_CO2.htm</a>
2	Petrol( in litres/Yr)×	2.296 kg CO <sub>2</sub> per litre	<a href="http://www.ghgprotocol.org/calculation-tools/alltools">http://www.ghgprotocol.org/calculation-tools/alltools</a>
3	Diesel( in litres/Yr)×	2.653kg CO <sub>2</sub> per litre	“
4	LPG	2.983kg CO <sub>2</sub> per kg	“
5	Wood	1.8kg CO <sub>2</sub> per kg	“

**Table 2: Energy and fuel consumption in tons.**

Emission source	Consumption/100HH/m	Consumption/100 HH/y	Consumption/HH/month	Consumption/HH/year	Consumption/capita/m	Consumption/capita/y
Electricity	13550 KWh	16260000 KWh	135.5 KWh	1626 KWh	26.67 KWh	320 KWh
Petrol	3904 litres	46848	39.04	468.48	7.68	92.22
Diesel	3760 litres	45120	37.6	451.2	7.40	88.81
LPG	1464 Kg	17568	14.64	175.68	2.88	34.58
Wood	4940 Kg	59280	49.4	592.8	9.72	116.69

**Table 3: Energy and fuel emissions of CO<sub>2</sub> in tons.**

Emission source	CO <sub>2</sub> emission/100 HH/m	CO <sub>2</sub> emission/100 HH/y	CO <sub>2</sub> emission/HH/m	CO <sub>2</sub> emission/HH/y	CO <sub>2</sub> emission/capita/m	CO <sub>2</sub> emission/capita/y
Electricity	11.8 KWh	141.6 KWh	0.118 KWh	1.42 KWh	0.023 KWh	0.28 KWh
Petrol	8.96	107.4	0.090	1.08	0.017	0.21
Diesel	11.2	134.6	0.117	1.40	0.023	0.28
LPG	4.36	52.4	0.042	0.50	0.008	0.10
Wood	8.88	106.6	0.088	1.06	0.016	0.21

**Table 4: Final Carbon footprints of sunjwan**

Carbon footprints.	CO <sub>2</sub> emissions in tonnes per year				
	Electricity	Fuel (Petrol+ Diesel)	Wood	LPG	Total
Per household	1.42	2.48	1.06	0.50	5.46 tonnes
Per capita	0.28	0.49	0.21	0.10	1.08 tonnes





Fig (A-F): Construction work at area of study and use of heavy trucks and load carriers.

study conducted by Parikh *et al.* (2009) can be justified because of the following reasons:

1. Most of the population is higher middle class, who can easily afford private mode of transportation. Sunjwan being a semi-urban area is away from the city and residents have to travel every day to go to work, school, colleges, for medical facilities etc. As a result of which there is a considerable amount of carbon footprint due to fuel consumption.
2. The area is undergoing construction work, for which heavily loaded trucks are at work adding to the fuel consumption.(Fig A-F). Some of the locals own such construction trucks and machines and use it locally adding to the carbon emissions.
3. The study area does not have any industry, factory or heavy machinery operations undergoing, therefore there is no load on electricity. Also the population of study area are an average income group and do not own numerous heavy appliances. This is the reason

why the carbon footprint due to electricity consumption is not alarming.

### Conclusion

In the present study, the CO<sub>2</sub> emissions because of electricity consumption are 0.27tonnes/capita/year. Interestingly it is observed that even though the consumption of petroleum is more than diesel but the CO<sub>2</sub> emissions caused by diesel are observed to be more than petrol. This is because the emission factor of diesel (2.653) is higher than petrol (2.296), which means that for every litre of fuel consumed, more CO<sub>2</sub> is released in case of diesel as compared to petrol. The CO<sub>2</sub> emission caused by wood is 0.21tonnes/capita/year and the CO<sub>2</sub> emissions caused by LPG consumption are 0.10tonnes/capita/year. The total annual per capita carbon emissions of the study area is 1.08 tonnes (Table 4). The total per capita emissions obtained from the study area are quite less when compared with the household carbon footprint for Virgin Islands of United States where the average carbon

footprint in the territory is found to be 13 CO<sub>2</sub>e per year per capita (Shirley et al. 2012). Rise in carbon emissions can be correlated with increasing direct and indirect energy requirements of household and depend on economic growth, which has increased the consumption of energy (Sridevi *et al.*, 2014).

Suggestions:

- 1) Locals must be made aware of the harmful effects of the greenhouse gases, global warming and the direct health effects of their emissions. Discourage the use of wood as fuel by banning it.
- 2) Fuel efficient, eco-friendly and hybrid cars should be preferred. Old heavy trucks and load carriers should be abandoned.
- 3) Use of labels for products that show the carbon footprint value of the product. Increased energy efficiency standards for new housing which include energy efficiency rating in the sale of domestic properties.
- 4) Promote public transportation, fuel efficient vehicles, hybrid cars, raise awareness among public about the health benefits of walking and cycling. Spread environment awareness and ensure peoples participation through training and extension programmers and by mass media.
- 5) Plantation on community and waste lands will ensure the rate of natural sequestration of carbon dioxide emitted from the fossil fuels.
- 6) Discourage the use of fire-wood and go for alternative fuels.
- 7) Introduce the concept of green buildings to decrease energy consumption and switch to eco-friendly life practices.

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