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Case Study on Consumption of Carbon and its Importance

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Abstract: Carbon consumption places a vital role in human life as well as animal life. Humans are utilizing and consuming excesses of utilities comparatively requisite. Key consumption areas like food, medicines, clothing, cleaning products, beauty products, ornaments, housing, transport, mobility and each and every aspects human activities and behaviors are responsible for increasing of greenhouse gases and its consequences are responsible for global warming and climatic changes. This is due to high consumption of carbon and its impacts on humans and other biotic components health and life span. To overcome the above said call for proper planning and methodology to mitigate the consequence of global warming and climatic changes.

Keywords: Carbon consumption, Food, Medicine, Clothing, Mobility, Greenhouse gases, Global warming, Biotic components

I. INTRODUCTION

As indicated by the International Energy Agency, India is the fourth largest producer of global greenhouse gas emissions contributing about 5% of total emissions [1]. It is a third of the world's deprived and exists a large gap in the living circumstances and lifestyles of people in the rural and urban India. Based on geographical location and lifestyle, an individual's contribution to the global carbon footprint has been projected in this work. Data on consumption of goods and services resulting in greenhouse gas emissions was collected at the household level through a door to door survey from few localities in Hyderabad and rural areas within 80 km of boundary.

Activities such as urban transport, solid waste disposal, domestic fuel use, industrial activities and power generation for meeting the energy requirements of the cities generate a considerable amount of GHGs along with other air pollutants [2,3]. In the rural areas the use of traditional fuels, like wood, animal waste and crop residues, has local environmental impacts due to significant emissions of pollutants such as SO_2, NO_x, etc. along with emissions of GHGs like CO_2, CH_4 and N_2O. Carbon footprint is used as an indicator to measure and compare the impact due to such activities across Hyderabad. Carbon footprint is the overall amount of CO_2 and other greenhouse gases emissions expressed as CO_2 equivalent associated with a product, along its supply-chain and sometimes including emissions from use and end-of-life recovery and disposal.

The present study is focused on the estimation of the Domestic (household) carbon footprint for a variety of people living in and around Hyderabad. Hyderabad is the capital of the southern Indian state of Telangana and de jure capital of Andhra Pradesh. Occupying 650 square kilometres (250 sq mi) along the banks of the Musi river, it has a population of about 6.7 million and a Metropolitan population of about 10.25 million, making it the fourth most populous city and sixth most populous urban agglomeration in India. At an average altitude of 542 metres (1,778 ft), much of Hyderabad is situated on hilly terrain around artificial lakes, including Hussain Sagar-predating the city's founding-north of the city centre.

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Equivalent Carbon emanation factors were used to estimate the carbon footprint from major sources like power, transportation, cooking fuel consumption, food and medicines, clothing, cleaning products, beauty products, ornaments, and housing for these areas. The average annual per capita carbon footprint was estimated to be 2.7 tons CO_2e in the urban area and 0.45 tons CO_2e in the rural area. For each of the areas (rural and urban), significant variation in carbon footprint has been observed from corner to corner different socio-economic classes. Limitations: Indirect emissions, emissions related to work and public place were not considered. This study looked at the sectoral contribution (activity-wise, e.g. cooking, transportation etc.) as well as the rural-urban disproportion in the individual carbon footprint; which was done in the first time at Hyderabad, Telangana in India.

II. METHODOLOGY

Data Collection

In the present study, domestic level data on consumption of goods and services resulting in greenhouse gases emissions was gathered through door to door interviews. A questionnaire including the personal details of the members of every household was prepared to estimate the greenhouse gases emissions due to Key consumption areas like food, medicines, clothing, cleaning products, beauty products, ornaments, housing, transport, mobility, electricity, cell phone usage, waste generation. In order to cover the diversity in living habitats, two types of location were chosen: rural (villages about 80 km from Hyderabad) and urban (parts of Hyderabad city). A total of 100 household were survey.

2.2 CO_2 equivalent emission factors: In order to estimate the combined impact of emissions of all of the different greenhouse gases, mass emissions of the non-CO_2 greenhouse gases are converted into the CO_2 equivalent emissions using their Global Warming Potential (GWP). The CO_2 equivalent emission factors for the various sources are given in Table 1.

Table 1. Distribution of households in India by type of fuel used for cooking.

Cooking fuel	Total	Percent	Rural	Percent	Urban	Percent
Fire-wood	100,842,651	52.5	88,635,032	64.1	12,207,619	22.7
Crop residue	19,254,851	10	18,115,410	13.1	1 1,139,441	2.1
Cow dung cake	18,758,885	9.8	17,694,317	12.8	1,064,568	2
Coal	3,932,730	2	1,475,498	1.1	2,457,232	4.6
lignite	12,528,916	6.5	2,240,227	1.6	10,288,689	19.2
charcoal	33,596, 798	17.5	7,845,161	5.7	25,751,637	48
Kerosene	338,054	0.2	173,042	0.1	165,012	0.3
L.P.G	849,098	0.4	647,927	0.5	201,171	0.4
Electricity	1,231,727	0.6	1,135,083	0.8	96,644	0.2
Biogas/ Any other	630,225	0.3	309,862	0.2	320,363	0.6
No cooking	-	-	-	-	-	-
Total number of household	191,963,935	100	138,271,559	100	53,692,376	100

III. RESULTS AND DISCUSSION

Rural Carbon Footprints

In all 60 households from 6 villages (Khadthal, Pochampalli, Bata singaram, Ghatkesar, Ibrahimpatnam, Ramachandrapuram) about 80 kms from Hyderabad, were surveyed as part of this study. The average number of members in these households ranging from 2 to 8. From the survey, it was observed that the electricity consumption (per month) for rural areas ranges from 30 kWh to 70 kWh per capita depending on the household income. People in villages use motorized vehicles, some of them are farmers who own land in the same village and some commute to nearby towns and cities daily for work purpose. Thus the range of distance travelled (per year) is vast, from 430 km to 13,450 km per capita. The diet of rural people mainly consists of rice, jowar; fruits and vegetables are only consumed in rich families in villages. Wood and kerosene are used for cooking by few families; maximum number of families is using LPG.

This section compiles all the results obtained from rural area across the various income groups. Based on the annual income of each household they were divided in 3 groups:

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1. < INR 50,000
2. INR 50,000 to INR 100,000
3. > INR 100,000

Fig. 1 gives the relative contribution of the various sources to the total carbon footprint across the 3 income groups.

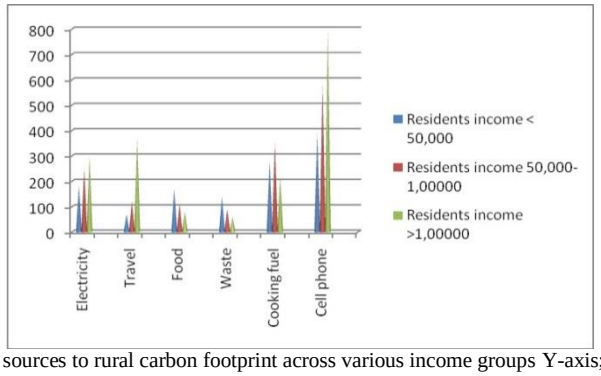

Fig. 1. Contribution of various sources to rural carbon footprint across various income groups Y-axis; kg of CO_2 per capita per year.

Urban Carbon Footprint

In all, 50 households from various localities (Chaitanyapuri, Saidhabad, Balnagar, Ameerpate koti) in Hyderabad city were surveyed as part of this study. The average number of members in these households was 4, ranging from 2 to 8. From the survey done in the urban areas, it was observed that the electricity consumption (per month) in urban area ranges from 30 kWh to 450 kWh per capita depending on the income of the family and in summer season more electricity consumption is observed. Most of the people have personal vehicles and a large number of them use public transport as well for commuting to their work places (Fig. 2).

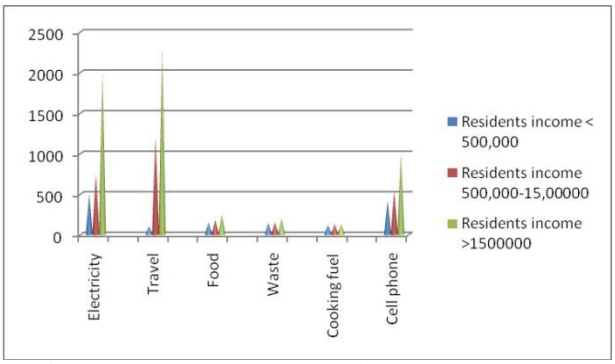

Fig. 2. Variation in the contribution of various sources to the total carbon footprint across the 3 income groups for the urban households.

Fig. 2. shows the variation in the contribution of various sources to the total carbon footprint across the 3 income groups for the urban households. Interestingly, contribution from of cooking fuel is very small (12.66%) and is almost same for all the income groups whereas for rural areas the cooking fuel is the highest contributor towards total emissions with a share of 28.33%.

The distance travelled is also significantly longer than that by the rural population. Significantly more travel by trains and airplanes has also been reported. Thus, the range of distance travelled (per year) varies from 200 km to 45500 km per capita. The diet of the urban people consists of much larger variety than that of rural people. LPG is the major cooking fuel. Cellphone usage per day varies from 10 minutes to 120 minutes per capita. There is more variability in the socio-economic statuses in urban area compared to rural area because of wide distribution of income among the

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population. The income varies from as less as INR 50,000 to millions of Indian Rupees per annum. Based on the annual income of each household, they were divided into 3 groups:

1. < INR 500,000
2. INR. 500,000 to INR 1,500,000
3. > INR 1,500,000

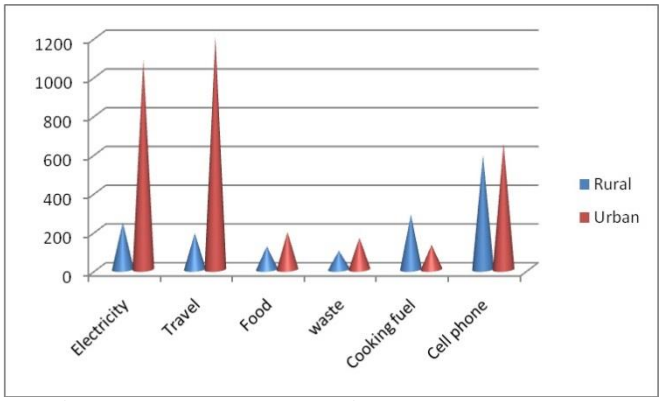

Fig. 3. Contribution of various sources to urban carbon footprint (per capita) across various income groups.

Comparison of Carbon Footprint Between Rural and Urban Area

From Fig. 3 and Table 2, we can clearly see that the carbon footprint due to electricity, travel, cellphone and waste are much higher for urban areas. This is a clear reflection of the urban lifestyle that depends on electricity as the lifeline. Also, mobility and connectivity (through mobile phones) have become essential services in the urban areas. On other hand, carbon footprint due to the cooking fuels and food are higher in rural areas. This can be easily explained by the fact that the usage of less efficient cook-stoves with wood for cooking purpose is very common in rural areas whereas, it is negligible for urban areas. The food pattern on other hand can be explained by the lifestyle followed in these areas. The diet of rural people mainly consists of rice which has a high CO_2e emission factor compared to other food items. Whereas in urban areas people eat variety of food reducing the amount of rice consumed compared to rural areas. It should be noted that the emissions related to the food miles have not been accounted for in this analysis.

Table 2: Annual average per capita carbon footprint for urban and rural areas

	Rural	**Urban**
Electricity	243	1083
Travel	187	1200
Food	120	193.3
waste	96.6	163.3
Cooking fuel	283	126.6
Cell phone	590	651

Sources

Annual average Carbon Footprint in rural household (kg CO_{2e} per capita per year). Table 3 shows the variation of the carbon footprint observed across different socio-economic classes in both the rural and the urban areas. This is attributed to the fact that the cut-offs for the income groups are different and dependent on the area and there is a growing influence of urban lifestyle on affluent rural population (Fig. 4).

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Table 3: Comparison of carbon footprint across different socio-economic statuses for rural and urban areas (kg of CO_{2e} per capitaper year).

	Rural	Urban
Low income group	205	221
Middle income group	250	468.3
High income group	305	946.6

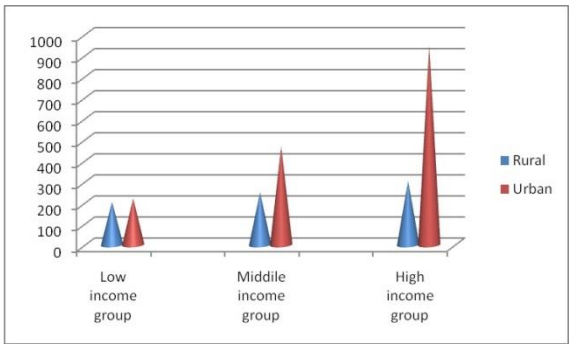

Fig. 4. Contribution of various sources to carbon footprint in rural and urban areas.

IV. CONCLUSION

Conclusion

As it can be clearly seen, the carbon footprint of urban individuals is higher than that of the rural individuals. The average carbon footprint in rural areas is estimated to be 25.33 tones CO_2e per capita per year and in urban areas it is 54.53 tones CO_2e per capita per year. Among all the sources, cooking fuel (85%) is the biggest contributor to the rural carbon footprint whereas in the urban areas, electricity (32.5%) and travel (36.0%) are the major contributors. Long distance travel (including Air Travel) and high percentage of personal vehicle usage in the urban areas result in much higher carbon footprint as compared to the rural areas. The cooking fuel in rural areas is mostly wood which is inefficiently used in the traditional cook-stoves. So, cooking fuel is the single largest contributor to carbon footprint in rural areas whereas, it is less in the urban carbon footprint. The carbon footprint per capita due to the cell-phone usage is much higher in urban areas and thus it forms a significant part of the carbon footprint in case of the urban areas as compared to the rural areas where the cell-phone usage is limited.

Solutions

It is a well-known fact that India's carbon footprint has rose significantly over the past few years owing to the economic growth of the country. The huge population of the country though has kept the per capita carbon footprint within respected limits.

From this it is evident that people placed at the lower rung of the socio economic pyramid are helping in reducing the adverse impact on the nation's overall carbon emissions by those higher up.

This can be solved in five ways:

1. Take on more sustainable ways of living in urban areas for example greater use of public transport, travelling when necessary, avoiding wastage of electricity etc.
2. Take on energy efficient ways of cooking in rural areas which leads to reduced burning of wood etc.

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3. Focusing on energy generation from renewable energy and then distributing it locally where possible, this will have a huge impact on meeting the needs of rural area in an environment friendly manner. This will lead to economic growth in rural areas and thus reduce the burden on urban areas to support the growth owing to less environmental utilization in the urban areas.
4. Adopting more energy efficient devices like better fuel economy vehicles, led based electronic equipments etc.
5. India's per capita income (nominal) is close to 2500 USD. There needs to be a greater focus on innovation and developing highly energy efficient technologies or renewable energy based products which can be used by the masses without affecting their way of living.
6. Proper management of waste in urban and rural areas also reduce carbon footprint.
7. Behavioral attitude of people must change to reduce carbon footprint.
8. Media and advertisements influence the consumerism of the people it in turn effects carbon emissions.

Future Scope

This study can be useful in designing a transparent carbon calculator which will be specific for Indian situations and locations. Also for better results, the sample size of the survey could be increased by covering more number of households in various socio economic classes and also extending to covering more villages and cities.

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