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POLICY BRIEF - 53

Household Carbon Footprint of India:
A Comprehensive Assessment and Prospecting for Emission Reduction Pathways

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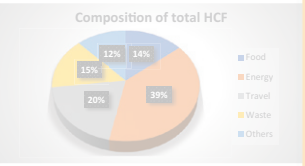

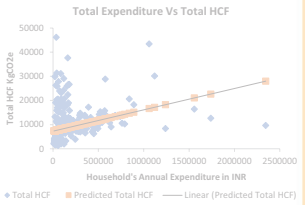

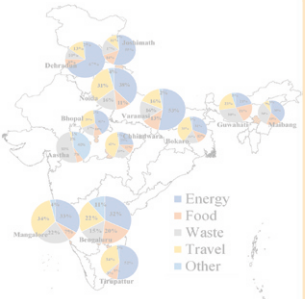

Background

As a significant emitter of greenhouse gases, India is expected to play a critical role in global climate change mitigation. However, being a developing country starting from a low emissions base, India needs to balance the perception of an energy-deficient climate deal-breaker. It is essential for India to look into effective pathways for emission reduction without compromising on development. Keeping the development agenda in the forefront, together with eradicating poverty and commitment to follow a low carbon path to progress, India's National Development Council has communicated three numeric targets for 2030. India's goal is to reduce overall emission intensity and improve the energy efficiency of its economy over time, and at the same time protect the vulnerable sectors of the economy and segments of society. Carbon footprint is considered a benchmark for the quantification of a total set of greenhouse gases emitted from different sources that aid global climate change, which makes it significant to know how much is contributed by a person or a product or any activity.

The calculation of carbon footprints for the lifecycle of products, industries, cities, countries as well as households is attaining increased attention with an intent to identify action points for reducing greenhouse gas emissions at various levels. Previous estimates show that household consumption contributes 65%-72% of greenhouse gas (GHG) emissions worldwide (Ivanova et al., 2016; Hertwich et.al. 2009). For the past few decades, the transition to a sustainable lifestyle is a central point of the debate in the arena of global sustainable policy (Koide et al. 2019). It has also been noted that sustainable lifestyles within the capacity of the ecosystem are only evident among the poorest population of the least-developed countries of the world (Moore and Rees, 2013).

The most recent studies in India regarding the estimation of carbon footprint (Lee et al., 2021; Green et al., 2018) are very elaborative and data extensive research, based on secondary data from NSSO and IMS. Within this study, Lee et al. (2021) calculated and compared the household carbon footprints (HCF) in 623 districts in India, based on micro-consumption data from 203,313 households and explain their variation by economic, cultural and demographic factors. The results show that eradication of extreme poverty does not conflict with ambitious climate change mitigation in India. The basic food items consumed in India are largely produced in India, except pulses and cooking oil where 17.5% and 59.3% respectively are imported (Green et al., 2018). This implies a comparatively lower carbon footprint of basic food required for attaining nutritional security from a balanced diet. Previous studies based on household expenditures reported that private transport, electricity use, and services demand in India accounts for a smaller proportion of individuals' carbon footprints, whereas food accounts for a slightly higher share as compared to developing countries (Lee et al., 2021). It is evident from existing literature that there is no comprehensive assessment of household GHG emissions calculated based on primary consumption data. It was felt essential that the identification of effective emission reduction strategies should have a strong underpinning of emission patterns and apportionment of emissions across socioeconomic classes as well as variations across ecological and climatic zones India.

Objectives

1. To calculate the carbon footprint of Indian households based on primary consumption data.
2. To assess the variations of HCF across socioeconomic classes and agro-ecological regions in India.
3. To understand the factors influencing HCF with respect to urban, peri-urban and rural set-ups.
4. To identify pathways for sustainable lifestyles for reducing GHG emissions from different types of Indian households.

Study area

The selection of study areas for collecting data on households' consumption and willingness has been done to cover the agro-climatic diversity of the country. It is expected to help in developing place-specific knowledge of emission reduction pathways and decision-making. The survey was carried out in thirteen different locations (Dehradun, Joshimath, Noida, Bengaluru, Mangalore, Tirupattur, Varanasi, Bokaro, Guwahati, Maibang, Astha, Chhindwara and Bhopal) from nine agro-climatic regions of India (Figure 1).

Methodology

Both primary and secondary data sources have been used throughout the study. The primary data was collected through an extensive household survey questionnaire with predetermined variables to capture the consumption needs of households. As the data for comparison for basic level

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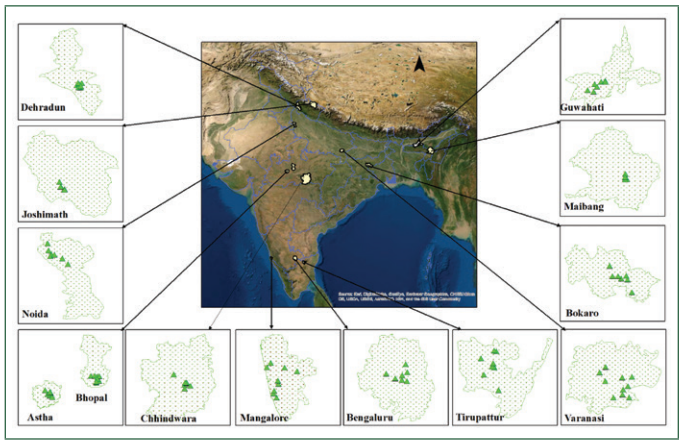
Figure 1: Map showing selected study locations



analysis is either unavailable or obsolete, it enables us to conduct per-capita, zone and state-wise estimation analysis and eventually use national estimates for total valuation. The secondary sources include per capita consumption of energy, food, and other resources for consideration, but majorly the conversion factors were used to estimate emissions from household consumption of energy, food, transport, and waste among other variables. Each area was scientifically selected based on its geo-climatic location, and agricultural, ecological, social and economic settings to develop an inclusive sample, representative of diversity of India. The weightage of 150 households from rural/peri-urban/urban areas was evenly distributed for each location.

Within the study, we have included 1950 households from nine agro-ecological zones. The assessment is solely based on the input from the residents where we enumerate the emissions from the consumption of total household energy, waste, transport, food and consumer products. From the expenditure standpoint, carbon footprint estimations are based on health & medicine, education, clothes, textiles and shoes, furniture and other manufactured goods. The governing factors for the carbon footprint of households have been divided broadly into zone and income categories. The study has employed a carbon assessment study wherein the household's expenditure and consumption have been integrated from the personal data through a survey questionnaire and also an attempt has been made to compare the first-hand obtained data with nationally available data sets. The analysis does not include any carbon emissions related to government and industrial sectors.

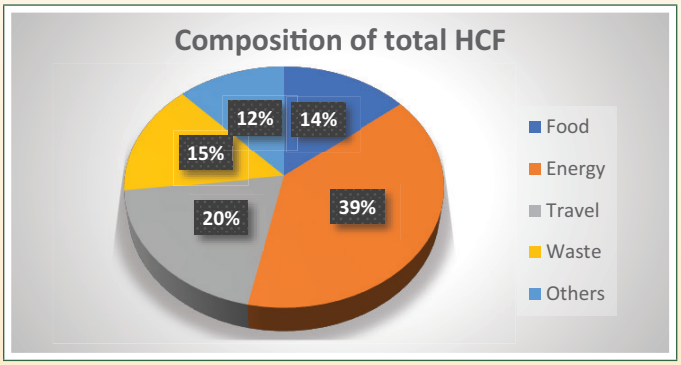
The emissions factors obtained from the Intergovernmental Panel for Climate Change (IPCC) and other official sources have been applied for the calculation of selected items. The time period of units consumed for distinctive variables was estimated and converted in yearly terms by extrapolating the average use. Categorization of sector-wise consumption and aggregate expenditure from the survey data was administered while covering the different product categories was done which was linked with the NSSO dataset for the comparison. As the required data was not entirely available, we took the data which was in consonance with primary data.

Key Findings

1. The average HCF of Indian households is estimated around 6505 $KgCO_2e$ per household per year with a corresponding per capita carbon footprint of 1472 $KgCO_2e$ per year. While only basic HCF is calculated excluding the items that are non-prevalent among the lower income groups, the average HCF was calculated to be 5625 $KgCO_2e$ per year, whereas the per capita emission is 1273 $KgCO_2e$ per year. The shares of different sectors in the HCF of an Indian household are presented in figure 2.

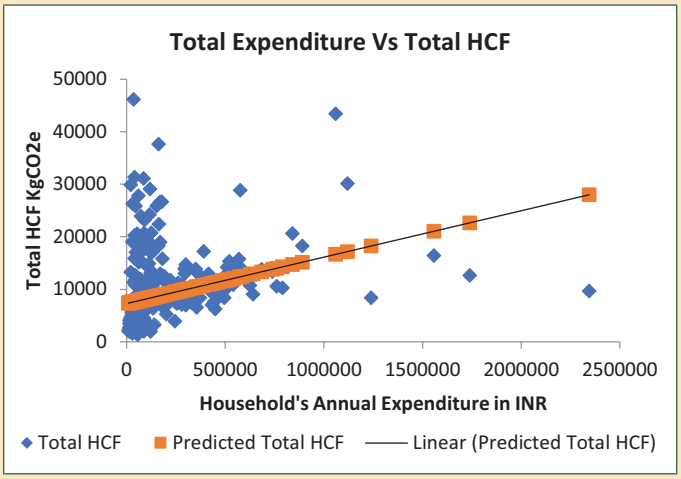
2. Contrary to other estimates stating a higher share of food carbon footprint in total HCF, the share of food groups has been found to be just a little above 14% of the total HCF.The value of footprint increases 14% from IC-1 to IC-2; however, a major leap in emission is noticed from IC-4 to IC-5, where the increase in emission is almost 40% from one income class to the next. The impact of economic well-being on carbon emission is evident from the upward trend of increasing footprint with respect to increasing household annual income. IC-1 (<1Lakh annual household income) has a per capita CF of 1158 $KgCO_2e$, whereas the per capita CF of IC-6 (>30Lakhs annual household income) is 4768 $KgCO_2e$.

Figure 2: Total HCF composition



3. The impact of household expenditure on emission was found statistically significant (Figure 3), where an increase in households' annual expenditure by Rs 1000 results in an increase in 8.83 $KgCO_2e$ of total HCF. The rate of increase in travel HCF is 3.49 $KgCO_2e$, followed by energy HCF of 2.72 $KgCO_2e$ and food with 1.93 $KgCO_2e$. Results of multivariate regression analysis reveal that household income is the highest-ranked determinant of HCF influencing most of the emission heads, followed by landholding size and types of occupation.

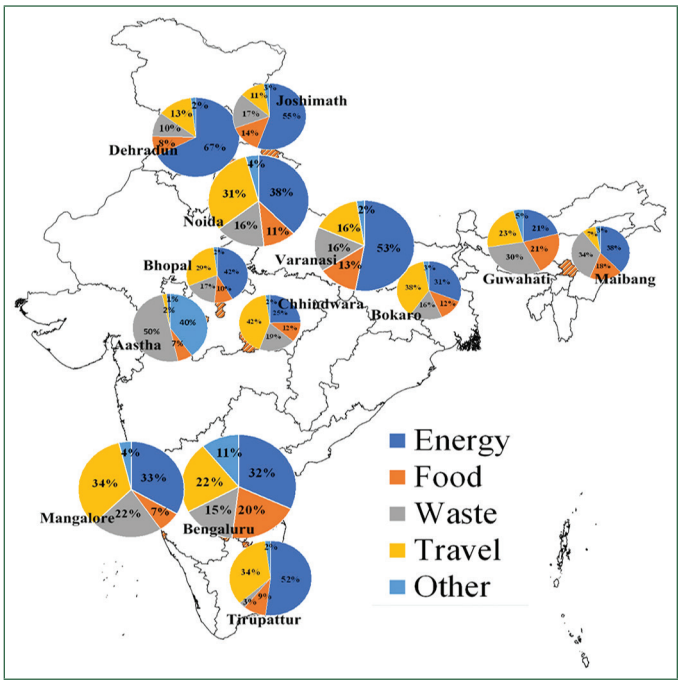
Figure 3: Total expenditure vs total HCF



4. Respondents mostly believe that environmental concerns are overstated. Motivation to shift towards low carbon alternatives or reduction of HCF is largely guided by the well-being of the family, mainly, the reduction of health risks due to climate change. The majority of the surveyed households may consider adopting low-carbon alternatives if they do not have to compromise with the cost and quality of the existing item or practice. Government policies and subsidies have been given equal importance by the rural population. However, the affluent section of the society stated that increased ease of access to available technology/alternatives and awareness should be the primary strategies for HCF reduction.

5. The findings revealed that there is no need to curtail emissions from any of the consumption heads of households belonging to low and medium-income groups (<10 Lakhs annual household income). Rather food HCFs of low-income groups are found to be very low in most of the locations (less than half of the required balanced diet); for those households, predominantly located in rural and peri-urban regions, development opportunities can be formulated for future food and nutritional security with the lowest possible level of carbonization.

Figure 4: Share of different contributing sectors of HCF across study areas



6. The variations in HCF across 13 study sites in nine agro-ecological regions of India and contributions from different sectors are presented in figure 4. Among the studied regions, Upper/Trans and Middle Gangetic Plains are the highest contributors to increasing emissions in terms of energy use, travel & transport and consumption of animal-based products, which is attributed to urbanization and population density. The Western Himalayan Region falls second in the line, as it was found through the analysis that the traditional form of energy usage is still prevalent across the region and is the most highly attributed factor related to emissions in Western Himalayas. The Central Plateau Region is catching up fast in the emissions race with an increase in amenities, access to technology and standard of living.

7. The rural-urban divide in emission is also visible with a clear impact of urbanization on consumption behaviour; here the per capita basic emission in rural, peri-urban and urban areas are estimated as 1275 $KgCO_2e$, 1331 $KgCO_2e$ and 1656 $KgCO_2e$ respectively. Urban zones in all the study locations have shown increased consumption of milk and meat products whereas the rural zones are still dependent on biomass as a fuel type for cooking and heating purposes due to its easy accessibility. The results show that the factors responsible for high electricity emissions in the rural areas were, surprisingly, more household members, cultural habits, and repetitive use of machinery and production purposes with a lack of information on conservation methods.

Policy Recommendations

There are other top-down policies aiming at achieving a low carbon progressing economy of India. Policies aligned with people's aspirations and needs should be formulated with detailed understanding of the types of consumers about who, what, where and how much. The findings of the study are intended to suggest that concerned authorities identify the scope to curtail GHG emissions considering the demand side behaviour and suggest strategies for attaining sustainable development with minimized carbon intensification. The parallel increase in consumption patterns along the income has to be understood for strategizing emission reduction. Discussion on a few specific policy recommendations follows.

Reducing HCF of urban households

The rich urban households contribute 4768 $KgCO_2e$ per capita per year. In urban areas, the economically privileged section of society will be willing to shift to greener fuels and energy sources if accessibility and ease of transition are provided. Further, a city-specific approach should be developed for reducing the energy footprint of households considering the growth pattern of the city, terrain, climate and building density. Incentives for green building as well as regulatory norms for high-end residential developers to develop energy-efficient infrastructure will aid low-energy urban households. For new developments in cities getting good amounts of solar radiation, in-built solar PVs must be made mandatory. Decentralized but integrated urban energy systems based on wind and solar energy (based on climate and topography) for the cities with rapid future growth should be planned. Although sustainable energy is a well-known target for all policymakers, regulation and planning are required at the municipality level for making households take up carbon-friendly alternatives. In cities like Bengaluru, both metro and AC buses are well appreciated by the city dwellers (both middle and high-income); however, they are reluctant to use public transport because of low connectivity. Comfortable and well-connected (last mile travel) public transport in cities will be instrumental for a modal shift in transport. A shift is needed to advanced biofuels or waste-to-energy fuels by setting up decentralized units for continuing internal combustion engine cars but with reduced travel footprint of households, where bottom-up planning and execution will play a key role. In this regard, integrated development of peri-urban areas should be considered in terms of providing space and resources, and managing waste. Policies should focus on targeting the financial motivation and environmental responsibility of richer urban households for strong diffusion of electric vehicles to be run by energy from renewable sources and charging facilities at public places.

Urban development policies and schemes should be linked to promote sustainable consumption. Emission from household energy consumption is a factor of income and climate where very limited reduction opportunity exists. Decentralized renewable energy sources and urban greening along with rational use of appliances (energy efficient appliances) can be the major touchpoints in this regard. The Bureau of Energy Efficiency can take up more consumer-facing product labelling and pricing to encourage the use of more energy-efficient products. At city-level planning, waste management rule and land use planning must look into the aspects of waste taxation on an augmented slab basis where stringent bottom-up planning and monitoring is essential. The National Mission on Sustainable Habitat can be one of the prime policies in mission mode to implement sustainable consumption in cities, emphasizing more on behavioural economics of urban households. Climate Smart Cities Assessment Framework can take it further to achieve sustained behavioural change at household levels. GRIHA and AMRUT are two other policies where emission reduction strategies can be aggressively executed. In terms of commitments within the country, state-level action plans should explore equitable burden-sharing among socioeconomic classes. Separate labelling of a carbon tax for consumables showing shares of taxes for transport, packaging and process would be helpful in behavioural change, where the Eco-mark Scheme of BIS and Ministry of Consumers Affairs may play a crucial role.

Research and validation

Ministries, specifically Ministry of Environment, Forest and Climate Change (MoEFCC), should facilitate more research on carbon emission estimates with proper apportionment of sources for identifying sources and sectors that need attention. Only this can effectively support the building and re-orientation of relevant policies on carbon trading and carbon pricing. Awareness programmes should be prioritized in the policy domain. The framework adopted in this study or an improvised version of the same should be validated and proposed to determine consumption-based carbon emission (methodology to identify emission hotspots, sectoral emission hotspots, consumer awareness etc.) The framework should be based on consumption data collection, on actual quantity rather than the existing approaches based on consumption expenditure. It is also essential to leverage the income-consumption relationship to formulate the targeted decarbonization and carbonization strategy. There is a need to encourage more research on emission calculation for the number of consumables (where emission factors are unavailable), segregating production and consumption side emissions.

Interventions in rural and peri-urban agriculture

Dependency on conventional sources of energy in household as well as agriculture has to be reviewed for alternative green arrangements. Initiatives have to be taken for reducing carbon emissions from cereals, pulses and to set up policies for encouraging traditional practices and agri-based products for local consumption. Encouragement for peri-urban agriculture to reduce food miles and local self-sufficiency through optimum use of local resources should be prioritized. The organic concept of a circular economy in rural India needs to be revived with further expansion of those practices in urban and peri-urban India for carbon-friendly management of wastes.

Awareness building for behavioural change

Policy for encouraging carbon handprint understanding the behavioural aspects of people from different strata is necessary. The under-consuming sections need attention and can be allowed to intensify their emission for achieving developmental goals. The results from behavioural analysis of the current study reveal that the section of people that needs to cut down their household energy use is the most aware section of society with commendable knowledge on climate change and the need for household carbon emission reduction. The barriers seen in this process of adoption is low ease of access to consider the adoption of green energy (e.g. solar) or lack of motivation to shift towards energy-efficient appliances. About 46% of middle and high-income urban households will consider shifting to solar energy, and half of them are ready to invest in the transition, whereas the other half will opt for it if subsidized.

Innovations in awareness, widespread and intense dialogues among citizens, concerned authorities, academia and urban local bodies may be key in this regard. The structured role of media, both mainstream and social media, through a government institutionalized mechanism, will be essential.

A policy to educate, sensitize and incentivize consumers on both organic and inorganic waste reduction at the household level (including e-waste, vehicle etc.), and most important tactical moves like “Swachh Bharat” will certainly result in emission reduction. Policy to leapfrog the implementation of green and sustainable mobility, building and construction, electrical appliances etc. are other opportunities to consider in the policy domain for reducing household energy and travel HCF.

Retaining low-carbon pathways for rural households

To retain the low emission of rural households, future energy transition should be taken care of, where a shift from biomass to other renewable sources of energy has to be ensured. In the rural development sector, economic upliftment of farming communities through sustainable production and consumption can be achieved through the proper implementation of schemes such as the Remunerative Approach For Agriculture and Allied sector Rejuvenation (RKVY-RAFTAAR), National Mission for Sustainable Agriculture (NMSA), Paramparagat Krishi Vikas Yojana (PKVY) etc. Landscape-specific revisions may be incorporated wherever necessary. Mahatma Gandhi National Rural Livelihood Missions, being a mission with widespread reach, can be one of the instruments to promote sustainable development in rural areas with low-carbon activities, providing social and economic upliftment. It is well realised that considering climate and topography, eradication of biomass for energy is not an option for rural India. Sub-Mission on Agroforestry (SMAF) and National Agroforestry Policy can be suggested for sustainable harvest and use of biomass for household energy use. In rural India, imbibing carbon-friendly behaviour through Panchayati Raj institutions can control the gradual transition of rural India’s consumption pattern towards that of urban India. National Urban Mission can focus on sustainable landscape development including sustainable households as one of their core areas of action in peri-urban landscapes.

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