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Analysis of Ecological Footprint of the Employees of a University: A Case Study of the Islamia University of Bahawalpur, Pakistan

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ABSTRACT

This study has analyzed the ecological footprint of employees' behavior for a sustainable university campus in Pakistan. The study's main objective is to estimate the carbon and ecological footprint of the Islamia University of Bahawalpur (IUB). The primary data for this research is collected by a physical and online survey during 2021-2022, using a proportionate stratified sampling method. The Global Footprint Network's ecological footprint calculator technique is used to estimate. The results have shown that the ecological footprint of the employees of the IUB is 3.47 gha. According to the world's biocapacity, the IUB's employees' biocapacity deficit is -1.87 gha, whereas Pakistan's biocapacity deficit was -3.17 gha in 2021. The main drivers of this high ecological footprint are shelter, food, and transportation. The portion of renewable energy is meager in domestic use, and energy appliances are not energy efficient. Moreover, the faculty at IUB mostly uses processed food and has deficient use of public transport and zero-emission vehicles. The study recommends a complete transformation in lifestyle to deal with ongoing sustainability crises.

1. Introduction

In recent years, debates on the climate crisis have multiplied, involving scientists and activists from around the world. For example, 2019 saw student climate strikes led by the group Fridays for Future, which involved millions of students from around the world. Since Paul Crutzen suggested the word "Anthropocene" to express the human duty to change the existing ecological imbalance, the scientific community has acknowledged the crucial role played by humans in the climatic problem. (Steffen et al. (2011). Other scientific studies, like the Intergovernmental Panel on Climate Change (IPCC), have expressed the dire need to reduce global energy, materials, and food consumption of earth's biocapacity (IPCC 2020).

A growing number of scientists made it clear that the significance of individual behaviors, lifestyle choices, and habits matter a lot in determining atmospheric changes. (Castellani et al., 2019; Sala & amp; Castellani, 2019; Vanham. 2019, 2019 Sala and Castellani 2019, Vanham and co. 2019) The atmospheric changes significantly impact the current economic, social and environmental crises. The broader character of this crisis is also evident in the context of 17 Sustainable Development Goals (SDGs), which were adopted in 2015 by the United Nations (UN) including the critical role of the environment. (Baranzelli et al., 2019; Colglazier, 2015).

The attainment of the SDGs and mission-driven strategies to mitigate their immediate effects on the environment and instigate change at the urban scale depend on higher education institutions (HEIs) (Leal Filho et al., 2018; Patrizia Lombardi & amp; Sonetti, 2017). Numerous academics have noted that the new role of the university is to draw on a community of learning on climate change risks awareness, solutions, and mitigation rather than continue to be a location-based center for research and teaching (Genta and co. 2019, 2019; Mulder et al., 2015; Tejedor et al., 2019).

Universities have played a critical role in disseminating knowledge about higher education. There is very little possibility of producing great researchers without a university education. Hence, higher education is indispensable for social, economic and scientific development. However, as universities are getting larger and larger with more students, the academic activities require frequent use of transportation, high-level usage of papers, and continuous consumption of electricity, water usage and food. These activities may involve serious consequences for the sustainability of the university.

Large universities function in the same manner as small towns do, with significant local environmental repercussions. Therefore, it has become a key issue in research to evaluate the ecological impact of large public sector universities and their contribution to fostering sustainable values by “practicing what they preach” (Sonetti et al., 2016, 2020).

The Ecological Footprint (EF) technique is currently being utilized globally in a variety of organizations, including private, public, and non-governmental organizations, to evaluate the environmental implications of human activities. (Kitzes et al., 2009). EF represents the human consumption of the biosphere in a unique number that can be compared with the biocapacity of the organization (Goldfinger et al., 2014).

The Islamia University of Bahawalpur (IUB) is a large public university in Bahawalpur, Punjab, Pakistan. The university was established in 1925 as a Catholic institution and was transformed and allowed international students in 1975. The university has a big campus with almost a 40000 population and a total area of 508 hectares. Bhawalpur city, IUB has three campuses Baghdad, Abasia and Railway. In the last few years, IUB has started many initiatives to become a sustainable and green university such as the Green Campus Project and Consortium of the national and international universities on climate change (IUB Website). This study attempts to calculate and assess the ecological footprint of the teaching and non-teaching faculty of The Islamia University of Bahawalpur.

This is the first study in Pakistan to quantify university personnel's ecological and carbon footprints to examine how they use environmental resources. Pakistan is a developing nation,

and resource scarcity necessitates efficient use of limited resources, hence this study is crucial. Additionally, Pakistan is in dire condition as a result of climate change and global warming, so the nation must adopt environmentally responsible consumption practices. Additionally, recommendations for policies apply to all expansive universities in emerging countries. Last but not least, the policy suggestions also apply to cities and small towns.

2. Literature Review

Since many studies have shown that large public universities are major emitters of greenhouse gases, the sustainability of these institutions has become a global concern. These research studies also recommended ways to lessen these institutions' ecological footprints.

Abolarin et al. (2013) investigated a group strategy to cut carbon dioxide emissions from four halls of residence at the Universities of Lagos. According to Moore, Kissnger, and Rees (2013) analysis of Metro Vancouver's urban metabolism and ecological footprint, each person had an ecological footprint of 4.76 hectares, which was three times their individual global biocapacity. The Carbon Footprint of an NTNU University was examined by Larsen, Pettersen, Solli, and Hertwich (2013), who found that the university had a significant CF of 4.6 tonnes per student. Adams (2013) recommended universities incorporate social, environmental, and economic sustainability.

Other studies have shown that universities, business schools, small towns and cities are now reporting ecological footprints to assess the sustainability of higher education institutions and small towns and cities. Some of these studies are Sepasi, Rahdari, and Rexhepi (2018) for higher education institutions, including The University of California. Świąder et al. (2020) for European cities. Galli et al. (2020) for Portuguese towns.

Previous studies discussed ecological footprint and biocapacity for developed countries, such as Galli et al. (2020), Sepasi, Rahdari, and Rexhepi (2018), An, Davey, and Harun (2017), Gamage and Sciulli (29017), Bice and Coates (2016), Li, Tan, and Rackes (2015) and del Mar Alonso-Almeida, Marimon, Casani, and Rodriguez-Pomeda (2015) on University level. The main determinants of ecological footprint are food, transport, energy, and housing which are used by different studies such as An, Davey, and Harun (2017), Gamage and Sciulli (2017), Bice and Coates (2016), Li, Tan, and Rackes (2015) Moore, Kissinger, and Rees (2013)Venetoulis and Talberth (2008).

This area of research is totally ignored or neglected in developing countries, especially in the context of Pakistan and Pakistan's universities. In this study, we are going to fulfill this gap concerning the Baghdad-Ul-Jadeed campus of The Islamia University of Bahawalpur, Pakistan, by analyzing the ecological footprint of the employees and how it is contributing to the environmental problem of the Islamia University of Bahawalpur and whether it crosses the biocapacity limit of the Islamia University of Bahawalpur.

3. Methodology

This study collected data from the employees of Islamia University Bahawalpur in the reference year 2021-2022. The data has been collected from 12 strata of professors, Associate professors, assistant professors, Lecturers, Deputy Registrar, Assistant Registrar senior clerk, junior clerk, Directors, Deputy Directors, Assistant Directors and Library Assistants for ecological footprint

analysis. The available population frame's size was 1390, and 310 samples were collected following the Krejcie and Morgan's table. The information was collected through both online and physical surveys. 16.9 % sample responded through the online survey while the remaining responded physically. The following information is collected from the respondents to analyze their ecological footprint (EF).

- How often do you eat animal products?
- How much eat food unprocessed, unpackaged, or locally grown?
- Which type of home respondent is residing in?
- What material is used for house construction?
- How many people live in a household?
- What is the size of the home?
- How energy efficient is your home?
- How much percentage of homes' electricity is used from renewable sources?
- How much trash do you generate as compared to neighbors?
- How far (kilometers) do you travel by car or/and motorcycle each week?
- What is the fuel economy of the vehicle? Car Liters? /100 km. Motorcycle Liters? /100 km.
- When you travel by car, how often do you carpool? 0% to 100%?
- How far do you travel on public transportation each week? (bus, train, etc.)
- How many hours do you fly each year?

The calculation process of ecological footprint (EF), biocapacity, and deficit biocapacity of an institution has been derived from the Global Footprint Network, http://data.footprintnetwork.org.

It is based on (Rees, Wackernagel, & Testemale, 1996) methodology. This approach estimates the area required to satisfy our daily production and consumption needs. Cropland footprints, grazing land footprints, forest footprints, fishing grounds footprints, carbon footprints, and built-up land footprints are described in detail. Each of these divisions has its biocapacity, estimated in global hectares, and an annual average of world land productivity. To evaluate the EF, many components of the material are used and waste emissions are computed (Moran, Wackernagel, Kitzes, Goldfinger, & Boutaud, 2008).

The ingredients needed to calculate the EF in the first step of the analysis are direct energy, water, mobility, waste, food, and infrastructure. The information about these material uses is gathered through a questionnaire as detailed above to evaluate the EF of a person. The study's reference units are the employees of the Islamia University of Bahawalpur, Pakistan campus in the reference year 2021.

In addition to the ecological footprint (EF), the carbon footprint (CF) also has been calculated to examine its share in total EF. The quantitative component of resource usage by a population of a region or a nation is included in estimating how much of the environment is necessary to support a given ecological footprint, emphasizing the link between the people's living standards and the supply of the environment (Deegan & Blomquist, 2006). The principal equation is of the calculation of EF given below.

$$EF = \frac{T_i}{Y_w} \times EQF_i \quad (1)$$

T_i= the annual tonnage of each product *i* consumed in the country/region.

Y_w= the world-average yearly yield for producing each product *i*.

EQFi = the equivalency factor for each development *i*.

The ecological footprint determines how much humans are dependent on natural resources due to their lifestyle. It compares the demand for natural resources to the supply of natural resources. It is also defined as a population's capacity to maintain itself in the present without risking its ability to do so in the future. It can be termed ecologically sustainable when a person can live a specific lifestyle while satisfying the demands imposed on the environment. Environmental sustainability is associated with producing a level of pollution that the ecosystem can sustain. The variables used in this analysis are derived from a global footprint calculator developed by the Global Footprint Network (Rees, Wackernagel, & Testemale, 1996).

4. Results and Discussion

This section contains the results of the estimates. In this case study, the ecological footprint is calculated using an online ecological footprint calculator for the Ecological footprint analysis of employees' behavior for a sustainable university campus in Pakistan. All results relevant to the study are written in table 1, table 2, and table 3.

Table 1: Some Comparative Stats

Region	year	Ecological footprint gha	Biocapacity gha	Biocapacity deficit gha
World	2017	2.8	1.6	-1.2
Pakistan	2017	0.9	0.3	-0.6
IUB	2021`	3.47	0.013	-3.45

Table 2: Ecological Footprint of IUB

Employees BJC's IUB	Students BJC's IUB	Total population of BJC's IUB	Area gha BJC IUB	EF BJ's IUB	Require hectors to BJ IUB	How many times larger areas need BJ IUB	CO_2 emissions tons per year
4031	34937	38968	508	3.47	135219	266.17	6.02

The world's ecological footprint is 2.8 gha, the world's biocapacity is 1.6 gha, and the biocapacity deficit was -1.2 gha in 2017. The ecological footprint of Pakistan is 0.9 gha, the biocapacity of Pakistan is 0.3 gha, and the biocapacity deficit was -0.6 gha in 2017. The ecological footprint of the employees of the IUB is 3.47 gha, and biocapacity of the IUB is 0.013 and the biocapacity deficit of the employees of the IUB is -3.45, and the biocapacity deficit of the employees of the IUB is -1.87 gha, according to the world's biocapacity. The biocapacity deficit is -3.17 gha according to Pakistan's biocapacity in 2021. According to the estimates, the IUB requires around 135219 gha. IUB requires an area 266 times greater than the actual area occupied by the institution, approximately 508 hectares. The average carbon footprint or CO_2 emissions is 6.02 tons per year.

Graph 1: Environmental Decay: World Versus Pakistan

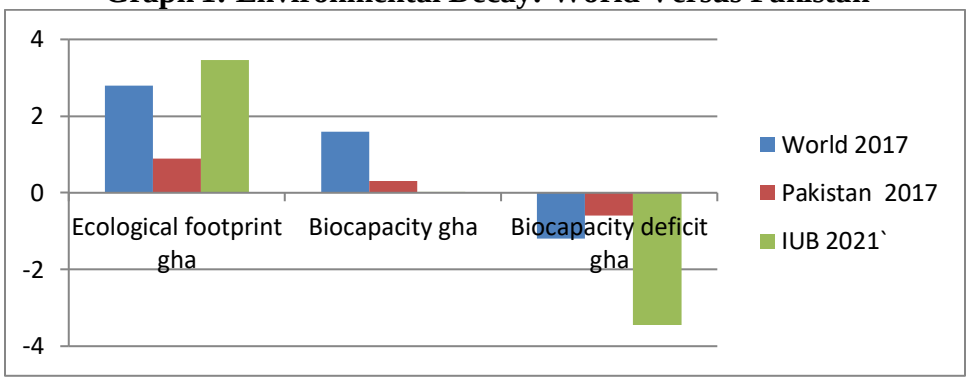


Table 3: Ecological Footprint of the Faculty

Designation	Average EF (global hectares or gha)	Biocapacity (BC) deficit of employees according to World BC 1.6 gha	Biocapacity (BC) deficit of employees according to Pakistan 0.3 BC gha	Biocapacity (BC) deficit of employees according to IUB 0.013 BC gha	Average Carbon Footprint (CO2 emissions in tonnes per year)	If everyone lived like you (Average), we would need Earth	Average Earth Overshoot Day is
Professor	4.23	-2.63	-3.93	-4.217	7.7	2.52	3-May
Associate Professor	4.14	-2.54	-3.84	-4.127	7.57	2.45	21-May
Assistant Professor	3.55	-1.95	-3.25	-3.537	6.33	2.16	10-Jun
Associate Lecturer	3.42	-1.82	-3.12	-3.407	5.84	2.05	14-Jun
Lecturer	3.77	-2.17	-3.47	-3.757	6.86	2.25	31-May
Assistant Registrar	2.8	-1.2	-2.5	-2.787	4.6	1.72	6-Aug
Assistant	3.57	-1.97	-3.27	-3.557	6.39	1.96	11-Jun
senior clerk	3.12	-1.52	-2.82	-3.107	5.43	1.89	22-Jun
junior clerk	3.26	-1.66	-2.96	-3.247	5.54	1.97	5-Jul
Assistant Director	2.46	-0.86	-2.16	-2.447	3.78	1.44	30-Jul
Library Assistant	3.84	-2.24	-3.54	-3.827	6.18	2.28	17-May

Each strata's results are different from other strata.

Graph 2: Stratified Contribution of University To Environmental Decay

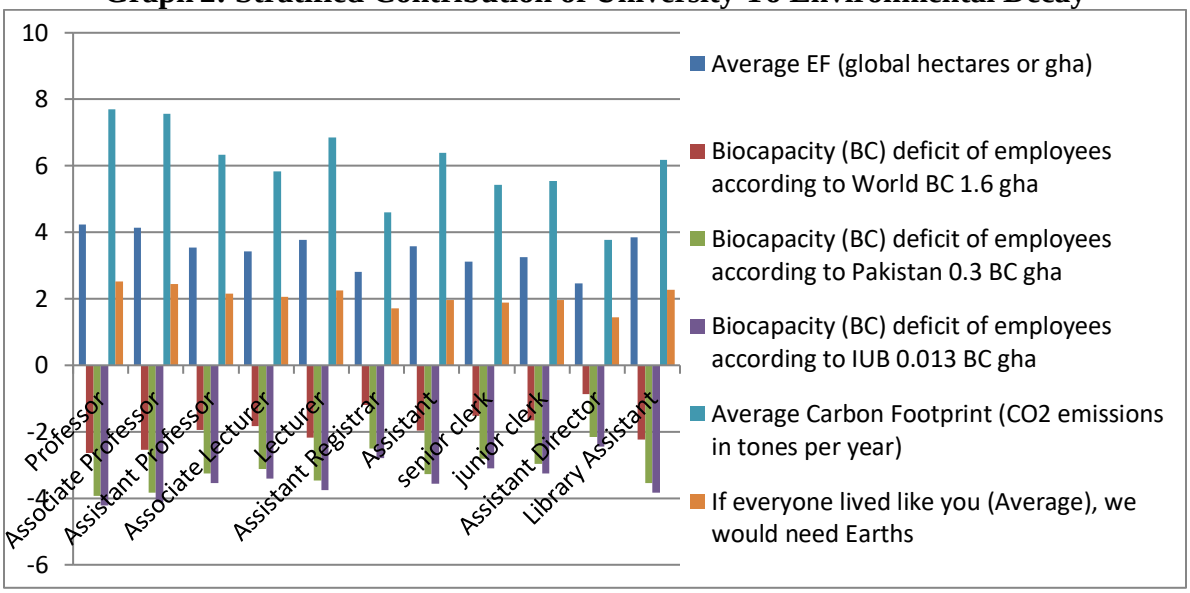
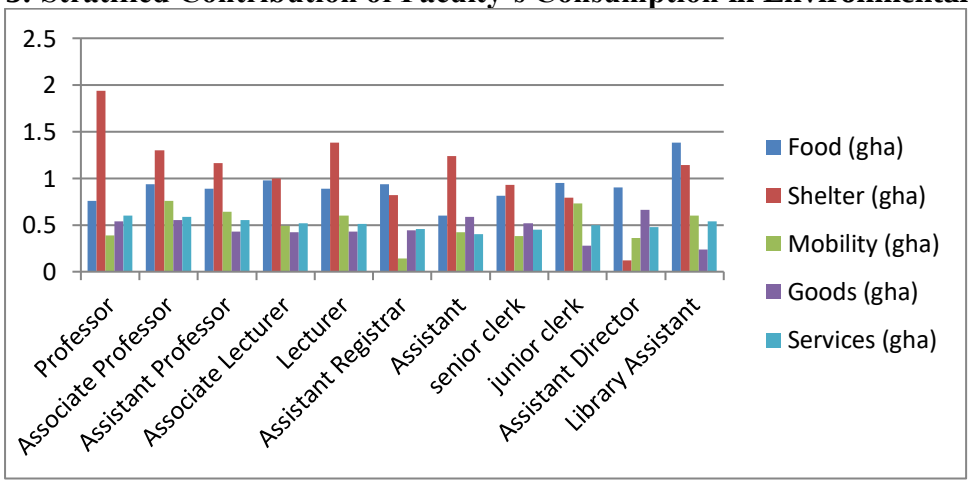


Table 4: Stratified Contribution of Faculty's Consumption in Environmental Decay

Designation	Food (gha)	Shelter (gha)	Mobility (gha)	Goods (gha)	Services (gha)
Professor	0.76	1.94	0.39	0.54	0.6
Associate Professor	0.94	1.3	0.76	0.55	0.59
Assistant Professor	0.89	1.16	0.64	0.43	0.55
Associate Lecturer	0.98	1	0.49	0.42	0.52
Lecturer	0.89	1.38	0.6	0.43	0.51
Assistant Registrar	0.94	0.82	0.14	0.44	0.46
Assistant	0.6	1.24	0.42	0.59	0.4
senior clerk	0.81	0.93	0.38	0.52	0.45
junior clerk	0.95	0.79	0.73	0.28	0.5
Assistant Director	0.9	0.12	0.36	0.66	0.48
Library Assistant	1.38	1.14	0.6	0.24	0.54

Graph 3: Stratified Contribution of Faculty's Consumption in Environmental Decay



A detailed overview of all the strata is given below.

Ecological footprints are 4.23 gha, 4.14 gha, 3.55 gha, 3.42, 3.77 gha for professors, associate professors, assistant professors, associate lecturers and lecturers, which is higher than Earth's biocapacity for every person and also exceed IUB's and Pakistan's biocapacity for every person. Those in the higher teaching ranks behave more irresponsibly than their juniors. The figures for food and shelter consumptions are 18% (0.76 gha) and 46% (1.94 gha) for professors, 23% (0.94 gha) and 32% (1.3 gha) for associate professors, 24% (0.89 gha) and 32% (1.16 gha) for assistant professors, 29% (0.98 gha), and 29% (1 gha) for associate lecturers and 23% (0.89 gha) and 36% (1.38 gha) for lecturers. Professors have the least ecological footprint in terms of food consumption but the highest in shelter consumption. Assistant professors have the highest contribution to the ecological footprint through food consumption.

The average carbon footprint or CO_2 emissions are 7.7 tons per year for the professor, 7.57 tons per year for associate professors, 6.33 tons per year for assistant professors, 5.84 tons per year for associate lecturers, and 6.86 tons per year for lecturers. Hence, the average carbon footprint or CO_2 emissions are highest for professors and associate professors. It seems that those on the highest ladders are consuming resources and ignoring the needs of the hour.

Ecological footprints are 2.8 gha, 3.57 gha, 3.12 gha, 3.26 gha, 2.46 gha, and 3.84 gha for the assistant registrars, assistants, senior clerks, junior clerks, assistant directors and library assistants. These digits are higher than Earth's biocapacity for every person and exceed Pakistan's biocapacity. Assistants and senior clerks have the highest ecological footprints compared to other non-teaching staff. The figures for food and shelter consumptions are 34% (0.94 gha) and 29% (0.82 gha) for assistant registrars, 19% (0.6 gha) and 38% (1.24 gha) for assistants, 26% (0.81 gha) and 30% (0.93 gha) for senior clerks, 29% (0.95 gha) and 24% (0.79 gha) for junior clerks; 36% (0.9 gha) and 26% (0.66 gha) for associate directors, 35% (1.38 gha) and 29% (1.14 gha) for library assistants. Associate directors have the highest ecological footprint in food consumption; the second-highest figure is the assistant registrar. Assistants and library assistants contribute the most to the ecological footprint through shelter consumption.

The assistant registrar's average carbon footprint or CO_2 emissions is 4.6 tons per year. The assistants' average carbon footprint or CO_2 emissions is 6.39 tons annually. The senior clerks' average carbon footprint or CO_2 emissions is 5.43 tons annually. The junior clerks' average carbon footprint or CO_2 emissions is 5.54 tons annually. The associate directors' average carbon footprint or CO_2 emissions is 3.78 tons annually. The library assistants' average carbon footprint or CO_2 emissions is 6.18 tons annually. The assistants and library assistants have the highest average carbon footprint, while senior and junior clerks also maintain high figures in terms of average carbon footprint.

The results of this paper show that teaching staff in higher positions are more responsible for leaving strong ecological footprints than their juniors. However, the results for non-teaching staff are a mix. The ecological footprints of assistants and library assistants are the highest. The ecological footprints of associate directors and assistant registrars are highest for food consumption, while assistants and library assistants have the strongest ecological footprints for shelter consumption.

5. Conclusion

Using an ecological footprint calculator, this study analyzed the ecological footprint of employees' behavior for a sustainable university campus in Pakistan. It is a case study of the Islamia University of Bahawalpur. The study's main objective is to estimate the carbon and ecological footprint of the Islamia University of Bahawalpur employees. Primary data was used in this study, and data had collected through a physical and online survey. The ecological footprint calculator technique is used for calculation created by the Global Footprint Network. It is based on (Rees, Wackernagel, & Testemale, 1996) and a Proportionate stratified sample used for data collection.

According to the results, the university campus is unsustainable due to employees' lifestyles. Employees use more foods that are not locally farmed, processed or packaged, and meat-based food. They do not use renewable energy, only a few employees use very low levels of renewable energy, and most employees use old or inefficient appliances, mainly because their home sizes are enormous. Some reasons for high EF and CO_2 emissions on the campus of IUB are that employees are not using a bicycle, or public transport, and carpooling. The vehicle's average fuel economy is also often. Hence, the average carbon footprint or CO_2 emission is 6.02 tons per year which is a high CO_2 emission.

On the bases of the findings, the study suggests the following recommendations. The analysis revealed your ecological footprint and the potential environmental impact of your lifestyle choices on the world. The supply and demand of the world's resources are influenced by our diet, how we move, the size of our houses, and our waste and recycling methods.

Transportation is the primary source of greenhouse gas emissions into the environment, with automobiles accounting for most of the problem. One reason for high EF on the campus of IUB is not using a bicycle, public transport, and carpooling. If you can walk or ride your bicycle to your destination, do so! It is a massive victory with 0% carbon emissions and even a little exercise. If at all possible, take public transportation whenever and wherever possible. Because you will also be sharing carbon emissions with multiple other individuals, it will significantly influence your ecological footprint. The next best choice is carpooling. Start carpooling with your coworkers or university buddies if they live near your traveling route.

Start "reduce meat base food" or replace dairy items with alternate choices like vegan foods. Start buying at your neighborhood farmer's markets; I consider this a more cost-effective alternative than buying products from big shops. Food packaging that is not essential is not just inefficient but also expensive in terms of resources. Choose recyclable items wherever possible. Processed foods consume a considerable amount of resources during preparation and transportation and are also not the healthiest alternatives. Schedule your weekly meals and purchase what you will need; this will help you avoid wasting food.

When analyzing your ecological footprint, the nature of the home you stay in is considered. A larger home will necessitate higher energy use than a small one. If you live with roommates, then you may reduce your electricity consumption. Lighting, fans, TVs, and so forth, turn them off when they are not in use. You also must turn off these gadgets at the power outlet. Minimize the time you take the shower. Also, remember to turn the off flow while cleaning your teeth. Whatever you put in your junk can goes directly to the dump. Recycle whatever you can, and do

not waste what could be used anymore. On a personal level, minimizing your EF by following the above suggestions would be an excellent place to start.

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