Department of Environmental Economics
Working Paper No. 13

Analysis of Ecological Footprint of Rural-Urban Households in Islamabad

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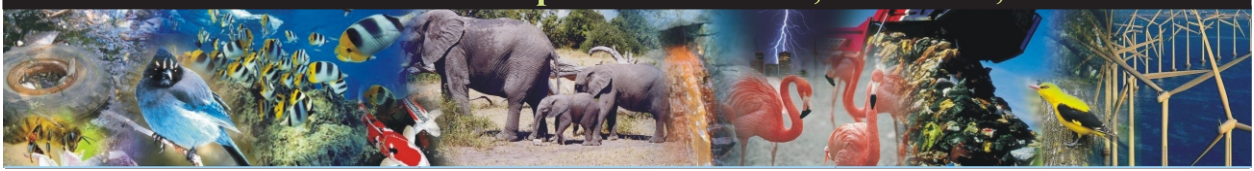

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C O N T E N T S

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ABSTRACT

Pakistan is among the ecological deficit countries which means we are consuming more than what we actually have. Change in the demands of households and lifestyles put pressure on the resources and ultimately on environment. Exploring the pattern of consumption and wastage of resources at household level is the need of the day. The present study aims to estimate Ecological footprints for urban and rural household in Islamabad taking into account the components of food, transportation, housing and consumer goods & services. Further, the impact of various influencing factors on the ecological footprint in urban and rural areas was also estimated. For this purpose, primary data had been collected from 600 households through questionnaires from sampled urban and rural areas of Islamabad. The findings revealed that the average ecological footprint of Islamabad is 4.5 Gha and households of Islamabad require on average 2.5 planets to live with current living standard and pattern with an average of 9.2 tonnes of CO_2 emissions. The sectors with high level of income, high standard of living and high quality of life have high ecological footprint. Households with high ecological footprints are generating more amount of waste. The major influencing factors of the ecological footprint were monthly income, family size, education, job type, business, house story, energy efficient appliances, gaseous appliances, farm production, commercially packed products, public transport, gas fuel for heating, electricity for heating, volume of waste and car ownership. Based on the findings, it is recommended that the household ecological footprint of Islamabad needs to be reduced to lessen the pressure on the consumption of resources and also to reduce the emission level for sustainable development of the city. This can be done through awareness, supporting environment friendly products by the authorities.

Keywords: Ecological Footprint, Consumptions, Global Hectares, Planets, Emissions

1. INTRODUCTION

1.1. Introduction

The term 'Ecological footprint' EF is defined as "the land area that would be needed to meet the consumption of a population and to absorb all their waste" [Mathis Wackernagel and Rees (1998)]. We all know that human activities are responsible for the environmental problems which affect their lives and future generations in the form of pollution, global warming, melting of ice, GHG's emissions and sea level rise etc. The United Nations report entitled *Our Common Future* [WCED (1987)] highlighted that humans are facing serious issues of natural resource depletion, more air pollution and poverty for which something needs to be done. If no actions/steps are taken for improvement in these problems, the Planet earth will be in serious danger not only for the present and future generations but also the nature itself will also be destroyed [Holden (2004)].

Why it is necessary to measure human use of the environment and nature? In 1992 after the Rio Earth summit ended, the world global population was facing the challenges to reduce anthropogenic impacts on nature and earth. Today we are living in more dangerous world with more consumption, increasing poverty and scarcity of resources, biodiversity, fresh water, forest area followed by more wastes. We all know that humanity is far away from the sustainability but how much and how far? We can't manage if we can't measure how far we are. We should know where we are standing now and how much efforts will be required for making sustainability a reality in future [Malthis Wackernagel (1997)].

"Sustainability, or satisfying lives for all within the means of nature, depends on making sure people do not use more ecological services than nature can regenerate. As human pressure is already exceeding the globe's ecological capacity, the sustainability challenge becomes how to reduce overall human pressure. Certainly, we cannot succeed with this challenge if we do not reduce the pressure in a way that is fair to all" [Malthis Wackernagel (2001)].

Here the concept of ecological footprint is used for assessment of sustainable development of the nations. Sustainability requires an equitable and decent use of natural resources and living and staying within the limits of nature and exceeding the ecological limits not living within them will destroy one and only home for humanity. Insufficient and inadequate availability of natural

resources and living in an inequitable and outside the ecological limits, will cause conflicts and degrade the environment. So there is an urgent need to get knowledge about whether the people's standard of living and quality of life has improved over the time. We should start monitoring and observing that whether we know our ecological limits and living within boundaries of environment and how fast humans are depleting the earth's biosphere. We must ask how much nature a human, a household or a country requires for sustaining them. Humans are important part of nature and they are dependent on it for basic needs of life like energy, food, water, fibre and ecological sinks for waste absorption. Human has some impact and influence on the planet and nature, because human consume and utilise the different products & services of the nature. The amount of nature everybody occupies to keep them going corresponds to their ecological impact [Malthis Wackernagel (1997)].

Ecological footprint (EF) calculations are made to link the sustainable development and consumption of humans [Holden (2004)]. EF calculation is based and builds on two main facts one is that we can track and keep record of resources consumed and waste generated and other is conversion of these resources and wastes to biologically productive area, thus ecological footprint shows how much nations use the nature. Thus, ecological footprint doesn't tell us how bad the things are instead it tells us how they are and what we can do about them. Abstract sustainability can be ultimately put to its concrete terms by this kind of simple and easy tool [Malthis Wackernagel (1997)]. The rationale behind the calculation of ecological footprint is the challenge faced for sustainable development and living productively within the limits of the planets and protecting it from degradation by taking care for the future generations [Oloruntegbe, Oluwatelure, and Agbayewa (2013)].

The amount of earth available for the human activities is illustrated beautifully by a teacher to his students: "We take an apple to represent the Earth and cut it into four pieces. Our earth surface comprises 75 percent of oceans so we set aside the three pieces considering them as oceans. We will slice the remaining earth part into two equal parts. Now again we throw the one piece that would represent different land areas that are inhospitable such as deserts. Now we are left with one-eighth of the apple. However, this one-eighth is still not the available land to the mankind. Further we will cut this remaining piece into four parts and set aside the three of them these three pieces represents the areas which are too rocky, too steep or too cold to produce food. We are now with the 1/32 sized part of the whole apple. Now we peel away the skin of that remaining piece and dispose of the rest. This very small amount of skin peeled represents the Earth's crust, the enough topsoil area to produce the food on which all the mankind depends. On average the topsoil of Earth is five feet deep and relatively fixed amount of food is produced from it. Every year billions of tons of topsoil are taken away because of over-farming and erosion. It takes 100 years, on average for each inch of topsoil to form" [Oloruntegbe, *et al*. (2013)].

According to Ewing, Reed, Galli, Kitzes, and Wackernagel (2010); Malthis Wackernagel, Monfreda, and Deumling (2002), the Global Ecological Footprint of humanity and accounting of biocapacity is based on the following six fundamental assumptions:

(1) Most of the consumption of resources by humans' and the waste generated by humanity can possibly be tracked and quantified.
(2) Biological productive area can be scaled in proportion to its usable biomass productivity and theses productive areas can be expressed in standardised global hectares. Gha, a common unit for measurement. The global hectare unit is used for footprint and biocapacity both.
(3) To maintain the necessary and certain resources and wastage flow majority of these flows can be measured in terms of biologically productive area.
(4) Because these productive areas are for exclusive mutual uses, the unit global hectares' demand represents for a given year the same amount of usable biomass productivity, that can be summed up to obtain a total represented as the aggregate demand of the humanity or Ecological footprint.
(5) Natural supply of ecological services can also be expressed as biologically productive space in global hectare.
(6) Area which is demanded can exceed the area available and supplied. For example, if area demanded exceeds the regenerative capacity of a particular ecosystem, then this phenomenon is said to be an 'ecological overshoot'.

According to Kitzes, Peller, Goldfinger, and Wackernagel (2007); Malthis Wackernagel, *et al*. (2002); Wilson and Anielski (2005), the EF accounting is the total sum of six components and these demand and supply components are summed up together which give an aggregate ecological footprint:

(1) Crop Land: the area for growing crops for individual's consumption.
(2) Carbon Land: the forest area required to sequester and absorb carbon dioxide emissions for individual's personal consumption of energy.
(3) Grazing Land: the area of grazing land for necessary animal goods production.
(4) Fishing Grounds: the required area under sea for marine and fisheries products.
(5) Forest Land: The forest area required for production of wood and paper products.
(6) Built-up Land: The built-up area for housing, infrastructure, transportation and industrial production.

Consumption is component of ecological footprint and main aspect of the economy and this consumption marginally contribute to environmental degradation. Figure 1 shows the ecological footprint components of consumption, divided into four categories, to help focus on where to take action to reduce environmental impacts [Abd'razack, Ludin, and Umaru (2013)]. According to Abd'razack, *et al*. (2013); Zuzana Hudeková (2007) these are:

(1) Food: What we eat.
(2) Shelter/Housing: The type of house we live in.
(3) Mobility/Transport: How and how far we travel.
(4) Goods & Services: How many goods and services we use.

1.2. World and Pakistan Footprint

The ecological footprint of global world was 18.1 billion global hectares or 2.5 global hectares per capita while the total biocapacity of planet Earth was 12 billion global hectares or 1.7 global hectares per capita in the year 2010. Globally, 3 percent of the humanity's ecological footprint decrease was observed between the years 2008 and 2009 which was because of decline and reduction in demand of fossil fuels and forest products. However, the latest 2010. For over half a century humanity demand on earth has exceeded what it regenerates.

Concept of ecological footprint is getting more advanced in developed countries like USA, Canada and UK but it has yet to find presence in developing countries like Pakistan where the problem of sustainable development is still need to be addressed. The ecological footprint of Pakistan in 2012 was 0.8 global hectares per capita and biocapacity 0.4 global hectares per capita.

1.3. Motivation of the Study

In South Asia Pakistan is an urbanised country. The population of Pakistan was 188.0 million in 2014 and in 2015 it is estimated to be almost 191.71 million. In the year 2015 the urban Population grew up to 75.19 million from 72.50 million in the year 2014 and the population of rural areas increased in 2015 to 116.5 million from 115.5 million of 2014. Pakistan is ranked among few of the most environmentally vulnerable countries in the world. The geographical location of Pakistan and socio-economic fragility had made it the most vulnerable countries to the economic, environmental and social effects of climate change.

For this purpose, the ecological footprint research at an individual household level was necessary to make the individual persons aware about the consumption and wastage of the resources. We all have some impact on earth in the form of usage of resources, change in demand of households and lifestyles which are the factors affect the consumption of resources which have an effect on environment.

Many of the previous studies have been done about the sustainable development in Pakistan, but my focus of study was towards the sustainable development through using the ecological footprint analysis. I accounted for the individual household's consumption and their waste generated activities through calculating ecological footprint in global hectares.

As per Global Footprint Network (2016) statistics, Pakistan is among the ecological deficit countries which means we are consuming more than what we actually have i.e. 0.4 Gha ecological deficit. So, there is dire need of the calculation of ecological footprint at household level in Pakistan. The research will also help to know the impact of various influencing factors of ecological footprint in Pakistan. The study will also help us to understand the consumption level and wastage of the resources and conservation of the resources for future generation. This sort of work has not been performed before for the city of Islamabad. The research questions of study were which ecological footprint component impacts total ecological footprint more as compared to other influencing factors? And is the ecological footprint of urban households more as compared to rural households? And the objectives of the study were:

- To calculate ecological footprints at household level in Islamabad city taking into account the components of food, transportation, housing and consumer goods and services.
- To estimate the impact of various influencing factors on the ecological footprint in urban and rural areas.

2. DATA AND METHODOLOGY

2.1. Introduction

This chapter provides details about description of study site, nature and source of data, sampling design, justification of variables and estimation techniques. These are given in subsequent sections.

2.2. Study Area

Islamabad, the Capital of Pakistan is located 14 km north east of Rawalpindi at the Potohar plateau. The Map Projections of the city are Northern Latitude 33º49´ and Longitudes 72º24´east of Greenwich. The area of Islamabad is 906.50 square kilometres of which urban area is 220.12 square kilometre and the rural area is 466.20 square kilometres and Islamabad Parks 220.15 sq.km. It is divided into five different zones from Zone-I to Zone-V. It has humid subtropical climate with hot summer followed by monsoon and then winter season. It is the most developed and planned city of the country with lush greenery in whole the city [Capital Development Authority (2015)].

The major problems which are resulting from rapid urbanisation and population growth in capital city include inadequate waste management, pollution, traffic congestion and destruction of the ecosystem. Earlier researchers showed the destructive effects on human life on particulate matter such as respiratory and other diseases. So, due to massive increase in the population and urbanisation rate, this study selected Islamabad for the analysis.

2.3. Nature of Data and Its Collection

Primary data was used for the analysis which was collected through questionnaire from the households of Islamabad city including rural areas including Bara kahau and other rural sectors of Islamabad. The questionnaire of the bioregional.com was used (see Appendix-A). The questionnaire was composed of four parts food, travel, home and stuff. In the category of food different questions related to the "consumption, packing, purchasing of food, number of meals in a day, growing of own vegetables were included". In the travel, different inquiries were there related to "type of car, travelling by bus and train, distance of travelling and travelling by air". In the portion of home, "the type of house, structure of house, number of bed rooms, size of family, gardens, home appliances, energy efficiency and about the stories of the house whether it is single or a double storey were asked". In the stuff people were asked about "the goods they used and purchased in the year like mobile phones, television, Washing machine, clothes, decoration of rooms". Alongside this questionnaire, additional information such as household's income, education family size, number of vehicles, more of transportation, fuels used for heating and waste generated by the households etc. was also collected.

2.4. Sampling Design

By using population calculator http://www.metamorphosisalpha.com/ias/population.php we projected the current population of Islamabad by taking growth rate 1.92 from *Pakistan Economic Survey* (2015) and 1998 as starting period taking population as 805235 from Pakistan Bureau of Statistics (2016) we projected the 2015 population as 1,112,583. According to *Pakistan Economic Survey* (2015) the projected population of Islamabad city in the year 2015 was 1479000. On the basis of this we divided population as per the zones of the cities in rural urban zones and then we selected the sample size from these zones depending on the population of the city. The sample consists of rural and urban population of Islamabad. A sample of size 600 households was used, estimated through sample size calculator, keeping the confidence level as 95 percent while confidence interval as 4 percent. Depending on the urbanisation of the city almost 70 percent of the households were collected from urban areas

and 30 percent from the rural areas. The respondents were selected randomly from the urban and rural areas of Islamabad. From the total sample of 600, the 70 percent of the urban sample were 420 which were collected among 49998 households of urban areas and remaining 180 were collected from the 18514 rural households.

2.5. Analytical Tools

Ecological footprint was calculated by using online calculator http://calculator.bioregional.com/ for which the primary data collected through questionnaires was used. The calculator gives the results in global hectares (Gha) and it is a one planet living framework by Bioregional and modelled by the Stockholm Environment Institute (SEI). Besides, for the analysis of data both descriptive statistics and regression analysis have been used.

2.6. Econometric Modelling

To estimate the impact of various influencing factors (determinants) of household ecological footprint, the following econometric model has been estimated using WLS (weighted by the explanatory variable Household Monthly Income).

$$HEF^* = \alpha^* + \beta_1 HY^* + \beta_2 HS^* + \beta_3 ED^* + \beta_4 HFD_1^* + \beta_5 EUD_2^* + \beta_6 EUD_3^* + \beta_7 FUD_4^* + \beta_8 FUD_5^* + \beta_9 MTD_6^* + \beta_{10} MTD_7^* + \beta_{11} OCD_8^* + \beta_{12} OCD_9^* + \beta_{13} FHD_{10}^* + \beta_{14} FHD_{11}^* + \beta_{15} VW^* + U_i^*$$

Where

HEF is the Household Ecological Footprint in Global Hectares includes the food used by the households, housing characteristics, mode of travelling and the goods & services used by the household. (calculated from the ecological footprint Calculator).

UHEF & RHEF is the Urban and Rural Household ecological footprint in Global Hectares (Calculated from the ecological footprint Calculator).

Household Income: HY is the Household's income per month in Rupees. Income impacts the ecological footprint of the household. People having high level of income will have high ecological footprint because with the high level of income the consumption of the households will be high and so does the ecological footprint.

Household Size: HS is the household Size in number. The more the size of the household the less will be the ecological footprint. There is a negative relation of household size with the ecological footprint as Roy and Caird (2001b) also explained that as the family size grow bigger the ecological footprint decreases.

Education: ED is the number of years of education. The education and the ecological footprint have an positive relation as Abd'razack, *et al*. (2013); Oloruntegbe, *et al*. (2013) explained that with the high level of education the life standard of the people got improved and they consume more which results in high ecological footprint.

Housing Floor: HF is Housing residential position i.e. single story or double story. Dummy was used for this purpose. There is a negative relation between the housing floors and the ecological footprint. D_1= 1 for house having single floor and 0 otherwise.

Energy Usage: EU is the Energy usage two dummies were used for this purpose. The use of energy efficient appliances results in low ecological footprint GFN and Sydney (2005); Roy and Caird (2001a) proposed the action plans to reduce the ecological footprints. The households using the gaseous appliances will have high ecological footprint as the use of these appliances will result in wastage of energy as Tinsley and George (2006) reported the household using the gaseous appliances have high environmental impacts.

D_2= 1 for households using energy efficient appliances and 0 otherwise.
D_3= 1 for households using Gaseous appliances and 0 Otherwise.

Food Usage: FU is Food usage which includes food from own farm or from commercially packed products two dummies were used for this purpose. The household producing own organic farm products have low ecological footprint and using high commercial packed products have high ecological footprints.

D_4= 1 for households using own farm products and 0 otherwise
D_5= 1 for households using purchased packed food and 0 otherwise.

Mean of Transportation: MT is the Mean of Transportation used by the households two dummies were used for this purpose. The travelling has a positive relation with the ecological footprint the more you travel the high will be the ecological footprint.

D_6= 1 for households using public bus and 0 otherwise
D_7= 1 for households using own car and 0 otherwise.

Occupation Type: OC is the type of occupation which shows the type of the service or the business owned by the household two dummies were used for this purpose. As the type of job improves the ecological footprint will also increase because of standard of living, which tends to improve with good job.

D_8= 1 for Government Servant and 0 otherwise.
D_9= 1 For Own Business and 0 otherwise.

Fuel Source for Heating: FH is fuel sources for heating used by the households two dummies were used for this purpose. According to Calcott and Bull (2007) housing energy efficiency is the main part of the ecological footprint and the impact of heating the houses results in carbon emissions.

D_{10}= 1 for gas and 0 otherwise.
D_{11}= 1 for electricity and 0 otherwise.

Volume of Waste: VW Volume of waste that is number of waste bags per day per household. As the volume of waste generated by household increases the result would be high ecological footprint.

$\underline{U_i}$ is random term.

It is also worth mentioning that the above model has been estimated for total, rural and urban households separately.

3. RESULTS AND DISCUSSIONS

3.1. Introduction

The given chapter provides descriptive statistics of variables, estimation techniques, Interpretation of results of econometric model.

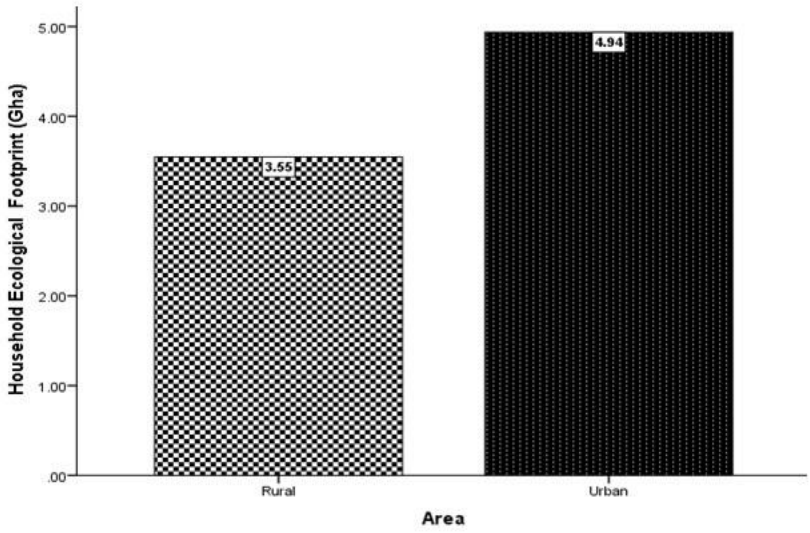
3.2. Descriptive Statistics of Variables

The descriptive statistics section explains the different relationships of variables and their comparison. The detailed analysis of the variables is explained with tables and graphs in this section.

3.3. Comparison of the EF in Rural-urban Areas of Islamabad

The comparison of the ecological footprint of urban and rural households of Islamabad is given Figure 1 showing that the ecological footprint of households in urban areas of Islamabad is more than the households in rural areas. The urban household ecological footprint is 4.94gha and rural household is 3.55gha. This because of the fact that in the urban areas people have more advanced infrastructure and facilities available as compared to the rural areas. They consume more as compared to rural areas people. The urban travelling by car, use of packed products, income, education and many other factors are the reason of high EF in urban areas as compared to rural areas. The Roy and Caird (2001a); Wiedmann, *et al*. (2008) also showed that the EF of the urban areas is more as compared to rural areas.

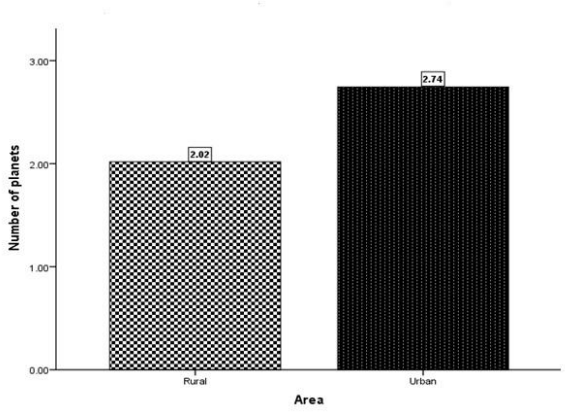
Fig. 1. EF in Rural-urban Areas of Islamabad



3.4. Number of Planet Requirements in Rural-urban Areas of Islamabad

The Figure 2 shows that the urban areas households require more number of planets as compared to the rural households. The urban areas of Islamabad need 2.74 planets to live with the current consumption level or we can say that with current way of living of households of urban sector of Islamabad they need 2.74 planets to live which is quiet more than the average global planet needs, and urban areas need 2.02 planets to live the current level of consumption.

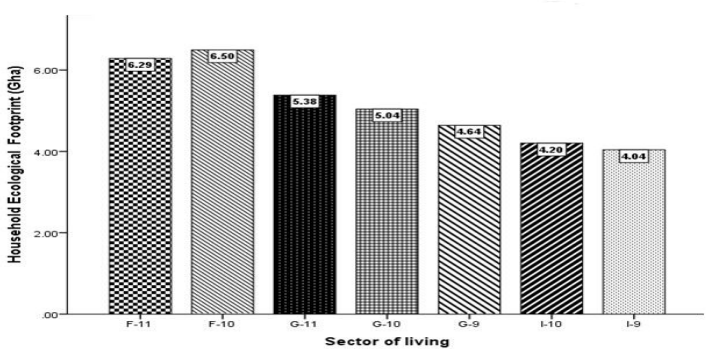
Fig. 2. Comparison of Number of Planets of Rural-urban Households of Islamabad



3.5. Sector-wise Ecological Footprint of Urban Areas in Islamabad

The Figure 3 shows that in urban areas of Islamabad sector F-10 and F-11 have high ecological footprint and I-10 and I-9 Sectors have low ecological footprints. The sectors with high level of income, high standard of living and high quality of life have high ecological footprint. The figure 4.3 depicts that the ecological footprint is decreasing as going towards the low-income sectors.

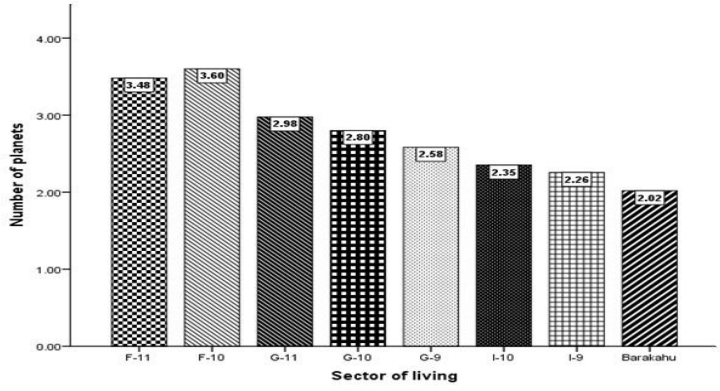
Fig. 3. Ecological Footprints of Sectors of Islamabad



3.6. Number of Planets Requirement in Islamabad

The Figure 4 shows that the more the ecological footprint the more the number of planets to be needed. The high ecological footprint sectors require more planets with current level of living. The sectors F-10 and F-11 needs 3.6 and 3.5 planets respectively and sector I-9 and Barakahu need 2.3 and 2.2 planets respectively. As we move towards more urbanised and high standard sectors more planets are required for living.

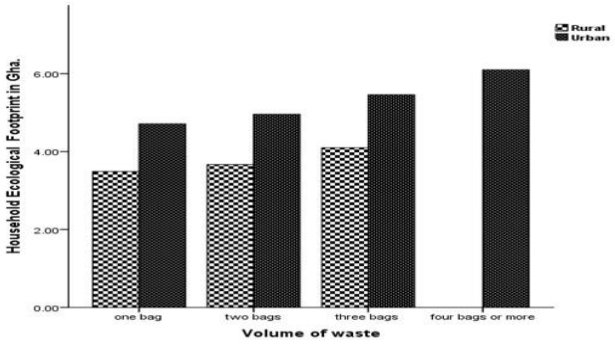
Fig. 4. Number of Planets Sector-wise in Islamabad



3.7. Ecological Footprint and Waste Generation of Rural-urban Households

The Figure 5 shows that the households with high ecological footprints are generating more amount of waste. Which means the quantity of waste generation by household is positively related to household ecological footprint. According to Abd'razack, *et al.* (2013) the ecological footprints got imbalanced due to high amount of waste generation by households. The urban households having high ecological footprint generate more waste as compared to the rural households.

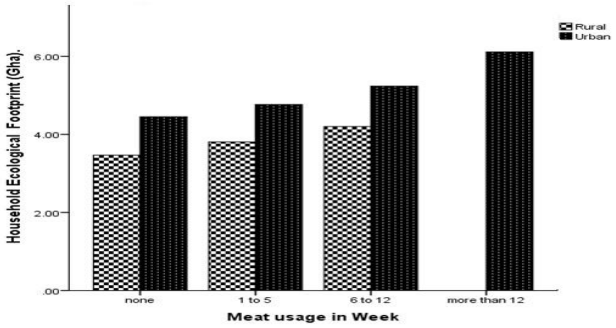
Fig. 5. Volume of Waste and EF in Rural-urban Households



3.8. Ecological Footprint and Meat Consumption by Rural-urban Households

The Figure 6 shows that more the usage of meat by the household more will be the ecological footprint. The urban household uses more meat so the ecological footprint of urban households is high. The consumption of meat is positively related to the ecological footprint as the usage of meat is high the ecological footprint will also be high.

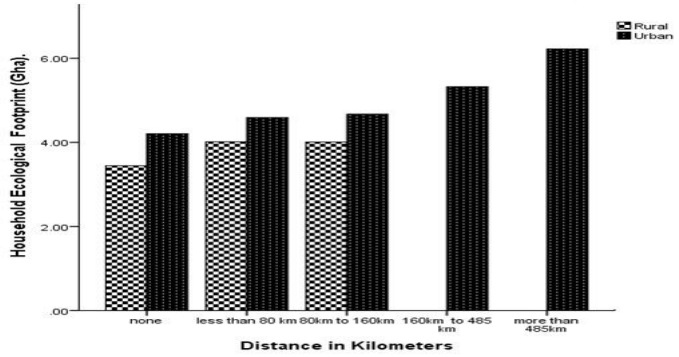
Fig. 6. Meat Usages and Ecological Footprint Urban-Rural Households of Islamabad



3.9. Ecological Footprint and Travelling by Rural-urban Households

Figure 7 below shows that as the traveling distance in a week increases, the ecological footprint also increases. The urban households travel more in week as compared to the rural households so their ecological footprint is high. According to Wiedmann, *et al*. (2008) the more the use of car the result will be high ecological footprint.

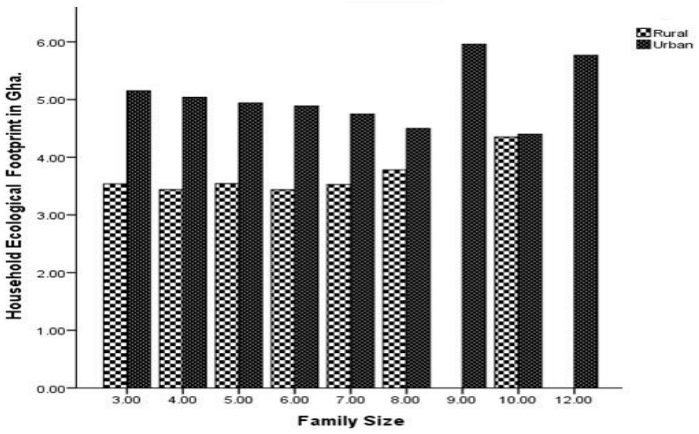
Fig. 7. Travelling and Ecological Footprint of Urban-Rural Households



3.10. Family Size and EF of Rural-urban Households

The Figure 8 shows that the family size of household and ecological footprint is negatively related. The high family size has low ecological footprint and vice versa. Roy and Caird (2001b) explained the same the low ecological footprint is because of high family size.

Fig. 8. Family Size and Ecological Footprint of Urban-Rural Households of Islamabad



3.11. Average Household Ecological Footprint in Islamabad

The average mean household ecological footprint, number of planets required and the CO_2 Emissions by the households' in different sectors of Islamabad are given in Table 1. The statistics show that the average ecological footprint of Islamabad is 4.5Gha and households of Islamabad require on average 2.5 planets to live with current living standard and pattern with an average of 9.2 tonnes of CO_2 emissions by each household of Islamabad. Further, the urban sectors have more ecological footprint and need more planets as compared to the rural households. Within the sectors F-10 and F-11 have the highest ecological footprint as compared to the other sectors of Islamabad because the households in these sectors have high consumption pattern in terms of food, energy, travelling and products. The houses are bigger in size and households consume more. Moving from G-11 to I-9, it can be observed that the ecological footprint is getting lesser and lesser because many of the components of ecological footprint decrease as moving from sector F to I. It is due to the fact that households in I-10 may have one small or no car with them while households of rich sectors may have 2 or more big cars. Further, family size, consumption pattern and many other factors are different among the sectors of Islamabad which affect the ecological footprint among the sectors of Islamabad.

Table 1

Average Household Ecological Footprint, Planets Required and CO2 Emissions

Area	Average EF (Gha)	Planets required	CO_2 Emissions (Tonnes)	No. of Observations
F-11	6.3	3.5	14.8	37
F-10	6.5	3.6	14.8	26
G-11	5.4	3.0	11.4	62
G-10	5.0	2.8	10.6	71
G-9	4.6	2.6	9.4	104
I-10	4.2	2.4	8.1	79
I-9	4.0	2.3	7.7	41
Barakahu	3.5	2.0	6.5	180
Total	**4.5**	**2.5**	**9.2**	**600**

3.12. Regression Analysis of the Determinants of the Ecological Footprint

The multiple regression model was used to analyse the impact of different influencing factors on the household ecological footprint. Three models were used for the analysis, First for the household ecological footprint of Islamabad, Second for the urban household ecological footprint of Islamabad and the third for the rural household's ecological footprints of Islamabad.

3.13. Regression Results of the Determinants Household Ecological Footprint of Islamabad

The regression results of the determinants of the household ecological footprint given in Table 2 shows that monthly income has positive and

Table 2

Regression Results of the Factors Influencing Household Ecological Footprint[1]

	Unstandardised Coefficients			
Variable	B	Std. Error	T	Sig.
(Constant)	3.638	.119	30.640	.000
Monthly income (HY)	5.905E-006	.000	20.120	.000
Household Size (HS)	-.047	.008	-5.942	.000
Education (ED)	.025	.007	3.436	.001
House Floor (HFD1)	-.086	.030	-2.861	.004
Energy Efficient Appliances (EUD2)	-.027	.034	-.805	.421
Gaseous Appliances (EUD3)	.210	.031	6.821	.000
Farm Production (FUD4)	-.017	.033	-.531	.595
Commercially packed Products (FUD5)	.029	.034	.853	.394
Public Transport (MTD6)	.086	.030	2.884	.004
Own Car (MTD7)	.157	.017	9.245	.000
Job Type (OCD8)	.050	.028	1.787	.074
Business (OCD9)	.082	.032	2.578	.010
Gas Fuel for heating (FHD10)	-.113	.040	-2.787	.005
Electricity for heating (FHD11)	.038	.026	1.460	.145
Volume of waste (VW)	.035	.019	1.889	.059
Diagnostics	R-square 0.77		Adj. R-Square 0.76	

Dependent Variable= Household Ecological Footprint HEF.

statistically significant impact on household ecological footprint (HEF). This is due to the fact that increase in income leads to extend the consumption of the households which ultimately increase their ecological footprint. Wilson and Anielski (2005) also, found similar relationship. The household size has negative and statistically significant impact on the HEF i.e. as the household size increases the HEF decreases because energy consumption, resources, mode of transportation and land for housing are share by the members of the households reduces the negative environmental impacts. This finding is also in line with the findings of Roy and Caird (2001b).

Education has a positive impact on HEF, as the level of education increases the quality of life improves leading to increase HEF. Abd'razack, *et al.* (2013) also, found that the improved lifestyle increases the consumption and hence the ecological footprint. House floor is negatively related to HEF as the number of floors increases the HEF decreases. The multistoreyed building and sharing of house results in reduction and optimisation of the land used for building construction. Bastianoni, *et al.* (2006) also, showed a negative relation with the EF. The use of energy efficient appliances followed by sharing the same resources

[1]The problem of heteroscedasticity was detected in the data so we used weighted least square model to rectify the problem of heteroscedasticity. The multicollinearity was tested using the correlation matrix attached as Appendix b.

decreases the household ecological footprint. The gaseous appliances usage increases the HEF. Production of the organic products in own farm decreases the household ecological footprint. Usage of commercially packed products and use of public transport leads to increase the HEF. The public transport has positive impact because of non-availability and inefficiency, in Islamabad mostly diesel vans and taxis are used as public transport which increases the EF. The personal use of car increases the HEF and its coefficient is also statistically significant. Wiedmann, *et al*. (2008) also, found that the higher EF depends on more car travelling. The job type and business are positively related to the HEF as it improves the standard of living of the households. Gas used as a fuel for heating purpose decreases the HEF but electricity used as a fuel for heating increases the HEF and it is statistically significant. The volume of waste generated by household increases the household ecological footprint. Its coefficient is also statistically significant. Abd'razack, *et al*. (2013) showed the high amount of waste generation by household causes ecological imbalances.

3.14. Regression Analysis for Urban Households of Islamabad

The second regression model was used to check the impact of various influencing factors on EF of urban households of Islamabad. These regression results are given in Table 3. The analysis shows that the monthly income of the urban households has positive impact on the ecological footprint of urban households and it is statistically significant which means. Wilson and Anielski (2005) also, found that the high income has high ecological footprints.

Table 3

Regression Results of the Factors Influencing EF of Urban Households

	Unstandardised Coefficients			
Variable	B	Std. Error	T	Sig.
(Constant)	3.732	.147	25.397	.000
Monthly income (HY)	6.187E-006	.000	17.863	.000
Household Size (HS)	-.051	.010	-5.228	.000
Education (ED)	.018	.009	2.074	.039
House Floor (HFD1)	-.100	.037	-2.694	.007
Energy Efficient Appliances (EUD2)	-.044	.041	-1.075	.283
Gaseous Appliances (EUD3)	.204	.037	5.533	.000
Farm Production (FUD4)	-.033	.041	-.799	.425
Commercially packed Products (FUD5)	.013	.044	.293	.770
Public Transport (MTD6)	.064	.034	1.860	.064
Own Car (MTD7)	.185	.021	8.757	.000
Job Type (OCD8)	.062	.034	1.820	.070
Business (OCD9)	.055	.038	1.427	.154
Gas Fuel for heating (FHD10)	-.142	.052	-2.717	.007
Electricity for heating (FHD11)	.037	.032	1.160	.247
Volume of waste	.052	.024	2.208	.028
Diagnostics	R-square 0.77		Adj. R-Square 0.77	

Dependent Variable= Urban Household Ecological Footprint HEF.

The household size has negative impact on EF of urban households and it is also statistically significant which means as the household size grows the EF of urban households' decreases. Roy and Caird (2001b) also, found similar relationship. Education has a positive impact on the EF of urban households and it is statistically significant. This is due to the fact that with the high level of education the quality of life improves leading to increase the ecological footprint. Abd'razack, *et al*. (2013) showed the same results that the improved lifestyle increases the consumption and hence the ecological footprint. Houses floors and use of energy efficient appliances have negative relation with the EF of urban households. The Gaseous appliances usage has positive and statistically significant impact EF of urban households. Farm Production has a negative impact on the EF of urban households i.e. own organic production of food decreases the ecological footprint. Commercially packed products and public transport have positive impact on the EF of urban households, as the more use of public transport results in high ecological footprint. The use of personal car for travelling also results in high EF of urban households and it is statistically significant. Wiedmann, *et al*. (2008) also, found that the more car driving results in higher EF. Job type and business have a positive impact on the EF of urban households. The gas used as a fuel for heating in the urban areas of Islamabad has negative impact on the ecological footprint and it is statistically significant while the electricity used as a fuel has a positive impact. The volume of waste generated by urban households has a positive and statistically significant impact on the EF of urban households, as the amount of waste generated increases. Abd'razack, *et al*. (2013) showed that high amount of waste generation by household leads to high ecological footprint.

3.15. Regression Analysis for Rural Households of Islamabad

The third regression model was used to analyse the impact of various influencing factors of the EF of rural households of Islamabad. The results show that the monthly income has a positive and statistically significant impact on the RHEF; as the income increases the ecological footprint also increases. Wilson and Anielski (2005) also, showed that the high-income level leads to increase ecological footprints.

The household size has negative and statistically significant impact on the RHEF; as the household size increases it leads to decrease the ecological footprint Roy and Caird (2001b) also derived the same result. Education in rural areas of Islamabad has a positive and statistically significant impact on the ecological footprint because education improves the life quality of the households which results in high ecological footprint. Abd'razack, *et al*. (2013) also, found that that the improved lifestyle increases the consumption and hence affect the ecological footprint. The floors of the house have a negative impact on the RHEF as the floors of house increases it will result in low ecological

Table 4

Regression Results of the Factors Influencing EF of Rural Households

	Unstandardised Coefficients			
Variable	B	Std. Error	T	Sig.
(Constant)	2.882	.140	20.576	.000
Monthly income (HY)	7.710E-007	.000	1.682	.094
Household Size (HS)	-.023	.011	-2.072	.040
Education (ED)	.050	.008	6.463	.000
House Floor (HFD1)	-.031	.049	-.634	.527
Energy Efficient Appliances (EUD2)	-.043	.036	-1.183	.239
Gaseous Appliances (EUD3)	.091	.168	.544	.587
Farm Production (FUD4)	-.096	.050	-1.895	.060
Commercially packed Products (FUD5)	.025	.073	.346	.730
Public Transport (MTD6)	.084	.040	2.105	.037
Own Car (MTD7)	.198	.052	3.805	.000
Job Type (OCD8)	.075	.034	2.198	.029
Business (OCD9)	.074	.152	.489	.625
Gas Fuel for heating (FHD10)	-.245	.049	-4.988	.000
Electricity for heating (FHD11)	.206	.048	4.260	.000
Volume of waste	.062	.022	2.830	.005
Diagnostics	R-square 0.72		Adj. R-Square 0.70	

Dependent Variable= Rural Household Ecological Footprint (RHEF).

footprint. Use of energy efficient appliances is negatively related with the RHEF. This is due to the severe electricity breakdown and mis-reporting of actual consumption of electricity in rural areas of Islamabad. The use of gaseous appliances has positive impact on the ecological footprint of rural households of Islamabad. The production of organic food in own farm is negatively related to the RHEF and its coefficient is also statistically significant. Commercially packed products have positive impact on RHEF and use of public transport by the households of rural areas has positive and statistically significant impact on RHEF. The car driving has a positive impact on the RHEF and Similar results were also derived by Wiedmann, *et al*. (2008). Job Type and business have positive impact on the RHEF. The gas used as a fuel for heating has negative and statistically significant impact on the RHEF. The electricity used for heating by the rural households has positive and statistically significant impact on the RHEF. The volume of waste generated by households of rural areas has a positive and statistically significant impact on the RHEF. Abd'razack, *et al.* (2013) also, found that the high amount of waste generation by household leads to high ecological footprint.

4. CONCLUSION AND POLICY RECOMMENDATIONS

The main objective of the study was to estimate Ecological footprints for urban and rural household in Islamabad taking into account the components of food, transportation, housing and consumer goods and services. Further, the impact of various influencing factors on the ecological footprint in urban and

rural areas was also estimated. For this purpose, primary data had been collected through questionnaires from sampled urban and rural areas of Islamabad. The major findings are given as under:

(i) The average ecological footprint of Islamabad is 4.5Gha and households of Islamabad require on average 2.5 planets to live with current living standard and pattern with an average of 9.2 tonnes of CO_2 emissions by each household of Islamabad
(ii) The sectors with high level of income, high standard of living and high quality of life have high ecological footprint.
(iii) Households with high ecological footprints are generating more amount of waste
(iv) More the usage of meat by the household more will be the ecological footprint
(v) The traveling distance in a week increases, the ecological footprint also increases
(vi) Family size of household and ecological footprint is negatively related.
(vii) The major influencing factors of the ecological footprint were monthly income, family size, education, job type, business, house story, energy efficient appliances, gaseous appliances, farm production, commercially packed products, public transport, gas fuel for heating, electricity for heating, volume of waste and car ownership.

The study finds that in Islamabad the urban households have high ecological footprint as compared to rural households. Hence, the urban households require more number of planets as compared rural households. The households in urban areas consume more as compared to rural households because they have high level of income, education and improved standard of living which results in high EF while rural households have fewer resources and produces organic food and consumes less which results in low EF. The main component is the consumption of resources in the form of food and energy has major impact on the ecological footprint as compared to other components. Consumption of food and more travelling directly impacts the EF while the family size and energy efficient products are indirectly related to the ecological footprint. The household ecological footprint of Islamabad needs to be reduced to lessen the pressure on the consumption of resources and also to reduce the emission level for sustainable development of the city.

Based on the findings, the following recommendations are given:

(i) Authorities should inform and educate citizens through the conferences, workshops and trainings to inform households about their current pressure on resources and on the earth planet followed by emission level for sustainable development in the cities.

(ii) Government should offer incentives for efficient solar fitted buildings, and support local food industry and production of organic & sustainable agriculture. They should support gardens outside the houses in cities and protect the urban green spaces. They should introduce programs that will help the households to reduce their footprint for example to travel less by car or use public buses & transit or bicycles initiatives, many other projects and technical programs which helps the organic food growers and the local farmers.

(iii) Special attention should be paid towards the ideas for reduction of environmental impacts of energy and transport, because both are the main contributors to the ecological footprint. To reduce the energy consumptions, insulate houses, dry clothes in open air rather than using dryer, replace all appliances with energy efficient appliances like energy savers, washing machines and freezers. These measures will reduce the energy consumption which would ultimately reduce the emissions.

(iv) Plant trees around the house to block the wind and shade, use energy efficient bulbs and appliances and use sunlight as much as possible, reduce water usage by taking short showers and with efficient showerheads, switch to recreational and tourism activities with low ecological impacts. Grow own vegetables and purchase products in bulk with low packaging, walk wherever possible and use bicycle and public transport rather than using car and shift your car to fuel efficient or hybrid car and last but not the least reduce, reuse, recycle and compost.

(v) The Authorities of the city should rely on the locally available resources rather than imported ones, increase the local ownership of the resources, encourage locally sound ecological friendly businesses, encourage use of solar panels by the households, hybrid and fuel efficient vehicles should be introduced for use to save energy, build mass transit system to reduce the car use and congestion of traffic, provide incentives on the energy efficient appliances, build up the communities and new housing societies with proper infrastructure and taking into account all the environmental concerns.

There were few limitations of this research. Because of shortage of time and resources the survey was conducted for angle city namely Islamabad however, it can be extended to other cities of Pakistan as well. Moreover, the research focused on the household's EF so further research can also be done at city level to calculate the EF of cities taking account built up land, carbon land, grazing land, fishing grounds, forest land.

Appendix A: QUESTIONNAIRE:

HOME:

1. What type of home do you live in?

   House Bungalow Flat

2. What kind of home?

   - Detached
   - Semidetached
   - Mid terrace
   - End terrace

3. No. of bedrooms in your home?

   1 2 3 4 or more

4. How many people live in your house?

   1 2 3 4 5 6 or more

5. Approximately how many of your light bulbs are energy efficient?

   0 ¼ ½ ¾ all

6. Approximately how many of your household appliances are energy efficient (e.g. washing machines, fridge freezers that have a high energy rating)?

   0 ¼ ½ ¾ all

7. Which of these home energy efficiency improvements have you taken (or are already place)?

   - Thick loft insulation (150mm-270mm)
   - Thin loft insulation less than 150mm
   - Condensing boiler
   - Hot water tank insulation
   - Cavity wall insulation
   - External wall insulation
   - double or triple glazing

WASTE:

8. Approximately how full is your general rubbish wheely bin by the end of one week? (If you don't have a wheely bin, think in terms of bin bags - one bin bag is about a quarter of a bin.)

Less than ¼ ¼ ½ Full

9. Which of these statements best describes how much you recycle?

- I recycle everything that can be recycled
- I recycle a lot but not everything that can be recycled
- I recycle a bit
- I do not recycle

TRANSPORT:

10. Do you travel by car?

Yes No

11. What type of car do you travel in normally?

- Small car (less than 1.4 liters)
- Medium car (between 1.4 and 2 liters)
- Large car (over 2 liters

12. How far do you normally travel by car in a week?

- Less than 50 miles
- 50 to 100 miles
- 100 to 300 miles
- More than 300 mile

13. How far do you normally travel by bus or tram in a week?

- I don't travel by bus
- Less than 10 miles
- 10 to 50 miles
- 50 to 100 miles
- More than 100 miles

14. How far do you normally travel by train or underground in a week?

- I don't travel by train
- Less than 50 miles
- 50 to 100 miles
- 100 to 300 miles
- More than 300 miles

15. In the last 12 months how many return flights did you take?

None One Two or more

Material:

16. Which of these items have you bought in the last year?

- Large piece of furniture
- Washing machine
- Mobile phone
- Mp3 player
- Fridge or freezer
- Dish washer
- Camera
- Flat screen TV

17. How frequently do you redecorate your home?

- Rarely - I haven't redecorated in years
- Occasionally - I redecorate one room every year on average
- Often - I always have a redecorating job on the go

Food:

18. How many of your meals contain meat in one week?

None 1 or 5 6to 12 more than 12

19. How often do you buy organic food?

Never occasionally often nearly always

20. Do you grow any of your own vegetables?

Not at all a small amount

I have a large vegetables patch /allotment

Water:

21. Which of these do you use most often?

Bath shower power shower

22. How water efficient is your toilet cistern?

- I have a dual flush toilet
- Toilet age 1990 to 2001
- Toilet age 2001 to present
- Toilet age pre 1990

23. In summer, how many times a week do you use a hose or water sprinkler to water your garden?

Never once twice three or more

Land Use and Wild Life:

24. If you have a garden, do you manage it to help attract wildlife? Tick the things you do:

- Leave an undisturbed area of garden or a log pile
- Plant native flowering plants to attract insects
- Avoid the use of garden chemicals where possible
- Provide bird or bat boxes
- Have a pond

25. Do you ensure that where possible any wood or paper products you buy come from sustainably managed forests (e.g. certified by the FSC) or made from recycled material?

    Yes no

26. Have you participated in any of the following activities in the past year?

    - Visited a local museum or gallery
    - Used your local library
    - Attended an evening class or group (e.g. dance, music lessons, life drawing, language skills)
    - Visited a historic / heritage site

27. Do you ever buy Fair-trade and sweatshop-free goods where possible?

    Never occasionally often always

28. Do you buy goods from independent local shops where possible

    Never occasionally often always

HEALTH AND HAPPINESS

29. On the whole, how satisfied are you with the life you lead?

    Very satisfied Fairly satisfied
    Not very satisfied Not at all satisfied

30. How much exercise do you get on average per week? (Include walking or cycling to work/school etc.) The Govt. recommends 30 mins 5 days a week, totaling 2 ½ hours.

    Less than 2.5 hours 2.5 to 5 hours over 5 hours

DEMOGRAPHIC QUESTIONNAIRE

1. Income: Size of Family: Education: Type of your job:
2. Do you have your own business?

   Yes No

3. Is your house being single story?

   Yes No

4. In your house the appliances are energy efficient?

   Yes No

5. Do you have any gaseous appliances?

   Yes No

6. Do you use your own farm produced products milk, eggs and vegetables etc.?

   Yes No

7. Do you purchase commercially packed products?

   Yes No

8. Do you use public bus for transportation?

   Yes No

9. Do you use own car for transportation?

   Yes No

10. Do you use gas as Fuel sources for heating purpose?

    Yes No

11. Do you use electricity as fuel source for heating purpose?

    Yes No

12. What is the Volume of waste generated from your house per day?

    1 bag 2 bag 3 bag 4 or more

Appendix B

Correlation Matrix[2]

	HEF	HY	HS	ED	OCD_8	OCD_9	HFD_1	EUD_2	EUD_3	FUD_4	FUD_5	MTD_6	FHD_{10}	FHD_{11}	VW	MTD_7
HEF	1	.797**	-.147**	.546**	-.073	.262**	-.381**	.056	.591**	-.353**	.097*	.028	.510**	.291**	.433**	.812**
HY	.797**	1	-.059	.362**	-.081*	.327**	-.219**	.039	.339**	-.155**	-.004	-.009	.324**	.202**	.400**	.649**
HS	-.147**	-.059	1	.051	-.036	.037	.092*	-.090*	-.063	-.063	-.055	.014	-.023	.048	-.066	-.036
ED	.546**	.362**	.051	1	-.065	.013	-.400**	-.032	.592**	-.484**	.092*	.095*	.572**	.316**	.245**	.528**
OCD_8	-.073	-.081*	-.036	-.065	1	-.410**	-.005	.087*	-.084*	.163**	.015	-.106**	-.135**	-.225**	-.048	-.081*
OCD_9	.262**	.327**	.037	.013	-.410**	1	.103*	.077	.094*	-.053	.016	.068	.085*	.176**	.125**	.250**
HFD_1	-.381**	-.219**	.092*	-.400**	-.005	.103*	1	-.088*	-.468**	.354**	-.058	-.086*	-.483**	-.037	-.262**	-.365**
EUD_2	.056	.039	-.090*	-.032	.087*	.077	-.088*	1	.087*	-.013	.057	.063	.006	-.046	.042	.055
EUD_3	.591**	.339**	-.063	.592**	-.084*	.094*	-.468**	.087*	1	-.559**	.132**	.159**	.643**	.240**	.265**	.535**
FUD_4	-.353**	-.155**	-.063	-.484**	.163**	-.053	.354**	-.013	-.559**	1	-.061	-.108**	-.554**	-.108**	-.049	-.365**
FUD_5	.097*	-.004	-.055	.092*	.015	.016	-.058	.057	.132**	-.061	1	.032	.034	.099*	.036	.150**
MTD_6	.028	-.009	.014	.095*	-.106**	.068	-.086*	.063	.159**	-.108**	.032	1	.120**	.057	-.008	-.084*
FHD_{10}	.510**	.324**	-.023	.572**	-.135**	.085*	-.483**	.006	.643**	-.554**	.034	.120**	1	.200**	.323**	.484**
FHD_{11}	.291**	.202**	.048	.316**	-.225**	.176**	-.037	-.046	.240**	-.108**	.099*	.057	.200**	1	.199**	.280**
VW	.433**	.400**	-.066	.245**	-.048	.125**	-.262**	.042	.265**	-.049	.036	-.008	.323**	.199**	1	.275**
MTD_7	.812**	.649**	-.036	.528**	-.081*	.250**	-.365**	.055	.535**	-.365**	.150**	-.084*	.484**	.280**	.275**	1

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[2]HEF (Household Ecological Footprint), HY (Monthly income), HS (Family Size), ED (Education), OCD_8 (Job Type), OCD_9 (Business), HFD_1 (House Story), EUD_2 (Energy Efficient Appliances), EUD_3 (Gaseous Appliances), FUD_4 (Farm Production), FUD_5 (Commercially packed Products), MTD_6 (Public Transport), FHD_{10} (Gas Fuel for heating), FHD_{11} (Electricity for heating), MTD_7 (Own Car), VW (Volume of waste).

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