ANALYSIS OF ECOLOGICAL FOOTPRINT OF RURAL-URBAN HOUSEHOLDS IN ISLAMABAD

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Session 2014-16

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Pakistan Institute of Development Economic

CERTIFICATE

This is to certify that this thesis entitled: **"Analysis of Ecological Footprint of Rural-Urban Households in Islamabad."** submitted by Usman Ali Khan is accepted in its present form by the Department of Environmental Economics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree in **Master of Philosophy in Environmental Economics.**

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Usman Ali Khan

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List of Abbreviations:

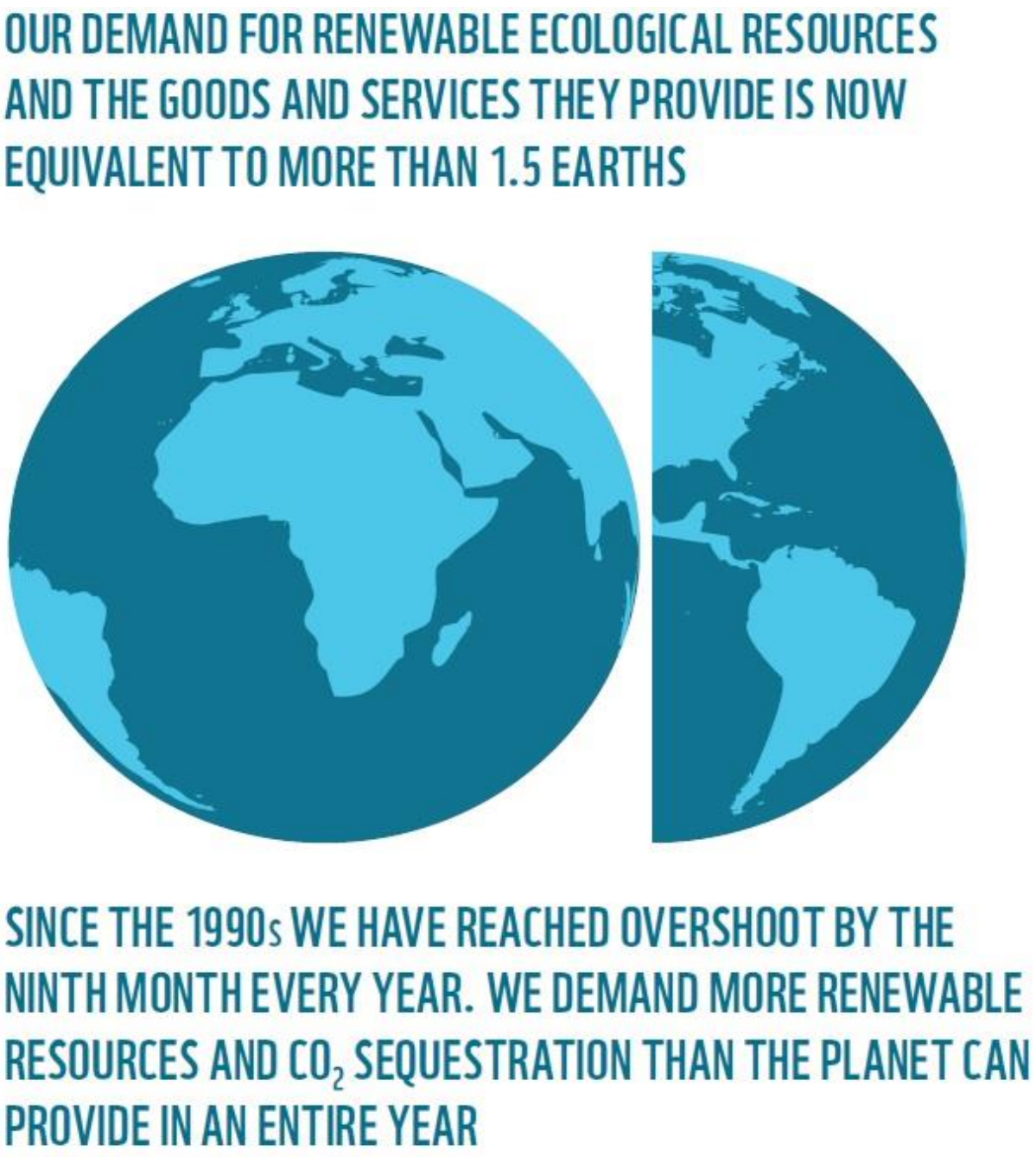
EF	Ecological Footprint
EFA	Ecological Footprint Analysis
GFN	Global Footprint Network
GHA	Global Hectares
HA	Hectares
SD	Sustainable Development
GHGs	Green House Gases
CO_2	Carbon Dioxide
BFF	Best Foot Forward
CDA	Capital Development Authority
UN	United Nations
UK	United Kingdom
USA	United States of America
HH	Household
HEF	Household Ecological Footprint
UHEF	Urban Household Ecological Footprint
RHEF	Rural Household Ecological Footprint

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. More the usage of meat by the household more will be the ecological footprint. The traveling distance in a week increases, the ecological footprint also increases. Family size of household and ecological footprint is negatively related. 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.

"The world is no longer divided by the ideologies of 'left' and 'right,' but by those who accept ecological limits and those who don't."

—Wolfgang Sachs 2003



(McLellan, Iyengar, Jeffries, & Oerlemans, 2014)

CHAPTER 1

INTRODUCTION

1.1 Background and Statement of Problem: -

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 & 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" (Mathis 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 & 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, fiber and ecological sinks for waste absorption. Human has some impact and influence on the planet and nature, because human consume and utilize 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, & 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% 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).

(***Malthis Wackernagel, 1997)***

1.1.1 The Concept of Ecological Footprints: -

Ecological footprint, (EF) is the measure of demands by human on nature. EF is the measurement of how much productive land area is required for producing the products and resources consumed and the waste generated by humans. The footprint can easily be measured for one single activity, a trip or tour by car, a set of activities performed or a household operation(Wilson & Anielski, 2005**).** The concept of EF was firstly proposed and presented in 1992 by Canadian ecological economist Rees (1992), and in 1996 further improvement and development was made to the method by Wackernagel (1996) and Zhiying and Cuiyan (2011). The 'Ecological Footprint' was originated and conceived originally as an easy and pleasing method & technique for comparison among different populations about sustainability of resource use(Lenzen & Murray, 2003**).** According to the Footprint Term Glossary of the Global Footprint Network (2016) ecological

footprint (EF) is "A measure of how much biologically productive land and water an individual, population or activity requires to produce all the resources it consumes and to absorb the waste it generates using prevailing technology and resource management practices"(Atlas, 2010).

EF doesn't predict future nor does it give any projections about future, it just simply tells us the answer of the question of sustainability that how much of the biosphere of the Earth's biocapacity has been used by human activities. EF analysis doesn't tell future it is not a window to the future but it is rather way which helps in the assessment of both the current reality situation and alternative 'what if' scenarios on the road towards sustainability(W. Rees & Wackernagel, 2008).

The ecological footprint is not only appropriate for the estimation of the area required for the sustainability of humanity today but also for many different plans and strategies to be tested for future. "Ecological Reality Check" is provided by ecological footprint analysis which leads towards a basic fundamental individual personal analysis: "Today, what can I do, while improving quality of my life to live in a more efficient sustainable lifestyle, while staying within the capacity of planet Earth?"(Wilson & Anielski, 2005**).** Measuring the ecological footprint of individual, city or nation permit us to assess the overshoot level and help us in ensuring sustainable consumption and better management of natural assets(Wiedmann, Wood, Barrett, Lenzen, & Clay, 2008). The EF can measure the area required needed for supply of ecological goods & services and the real actual land available for provision of goods & services. Biocapacity can be compared to the ecological footprints as an ecological benchmark. Both are expressed in global hectares unit**(**McLellan et al., 2014**).**

According to Ewing, Reed, Galli, Kitzes, and Wackernagel (2010); Mathis 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 & quantified.
2. Biological productive area can be scaled in proportion to its usable biomass productivity and theses productive areas can be expressed in standardized 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); Mathis 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.

For over half a century, the carbon is the most dominant and influential component of the humanity's EF. The carbon footprint measures the emissions of all the CO_2 (Carbon dioxide) and GHGs (greenhouse gases) emitted directly or indirectly through the products we use or by any other activity. And it has been on upward direction for many years. The carbon footprint was about 36 percent of the total human ecological footprint in 1961, but by the year 2010, the year having most complete data set, the carbon footprint comprised 53 percent of total EF. The primary and basic cause has been the burning and consumption of fossil fuels like oil, coal and natural gas. Carbon footprint at national level represents more than half the EF for a quarter tracked by all the countries(McLellan et al., 2014).

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, & 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.

1.1.2 World 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, figures show an upward direction and trend. For over half a century humanity demand on earth has exceeded what it regenerates. Figure 2 shows the world footprint.

As shown in Figure 3 currently human's ecological goods & services used each year need a regeneration capacity of about 1.5 earths. The number of nations are steadily increasing with each passing year, which leads the footprints to exceed their biocapacity and increasing competition, which has major significant social, political and economic implications(McLellan et al., 2014).

Due to increase in per capita consumption of population and growth, the domestic demand continues to increase. The biocapacity of many nations are subject to even greater pressure as to meet the export demands more and more biocapacity is used. The per capita ecological footprint size and composition of a nation shows the use of goods & services by an average single person in a country and the efficiency with which the resources are being used in provision of those goods

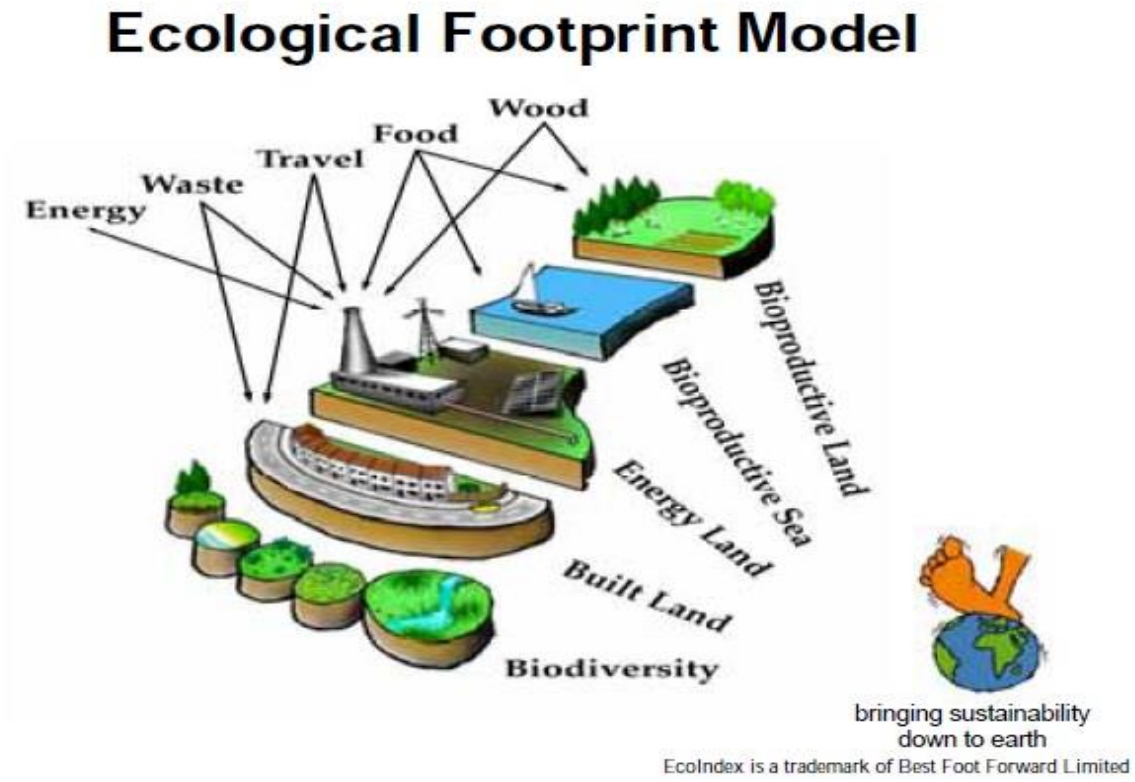
& services. About half of the total global ecological footprint is made up by top five countries of the world Figure 4 show the EF of top five nations of world.(McLellan et al., 2014).

Over the past century the global supply for and the global demand for renewable resources have changed enormously due to the growth of population shown by a regional report of humanity's EF in 1961 & 2011. Figure 5 shows where ecological footprints have increased the population is the main driving force(McLellan et al., 2014).

1.1.3 Pakistan's Ecological Footprint: -

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 is 0.8 global hectares per capita and biocapacity 0.4 global hectares per capita as shown in Figure 6 below.

Figure 1: (<u>Ecological Footprint Components</u>)



Summary of area types used for ecological footprint analysis

Source:(Wilson & Anielski, 2005).

Figure 2: (World Footprint)

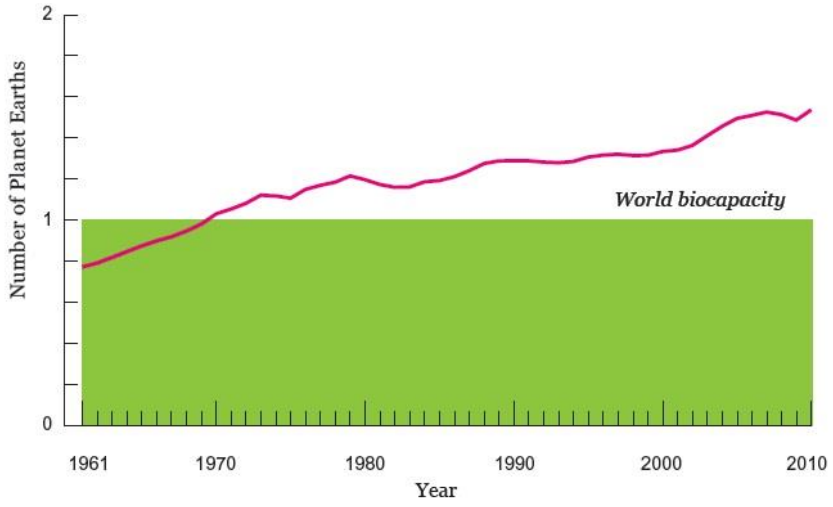


Figure : Humanity's Ecological Footprint
1.5 Earths would be required to meet the demands humanity currently makes on nature. For more than 40 years, humanity's demand has exceeded the planet's biocapacity – the amount of biologically productive land and sea area that is available to regenerate these resources (Global Footprint Network, 2014).

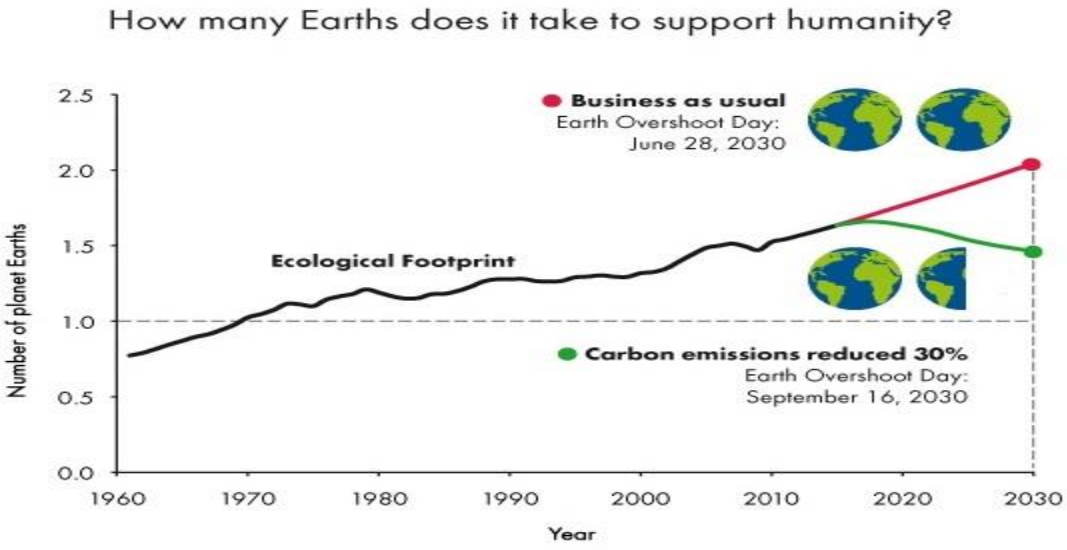
Key

Humanity's Ecological Footprint

World biocapacity

Source: (McLellan et al., 2014).

Figure 3: (Number of Planet Earth Required)



Source: (Global Footprint Network, 2016)

Figure 4: (Top Five Nations Ecological Footprint)

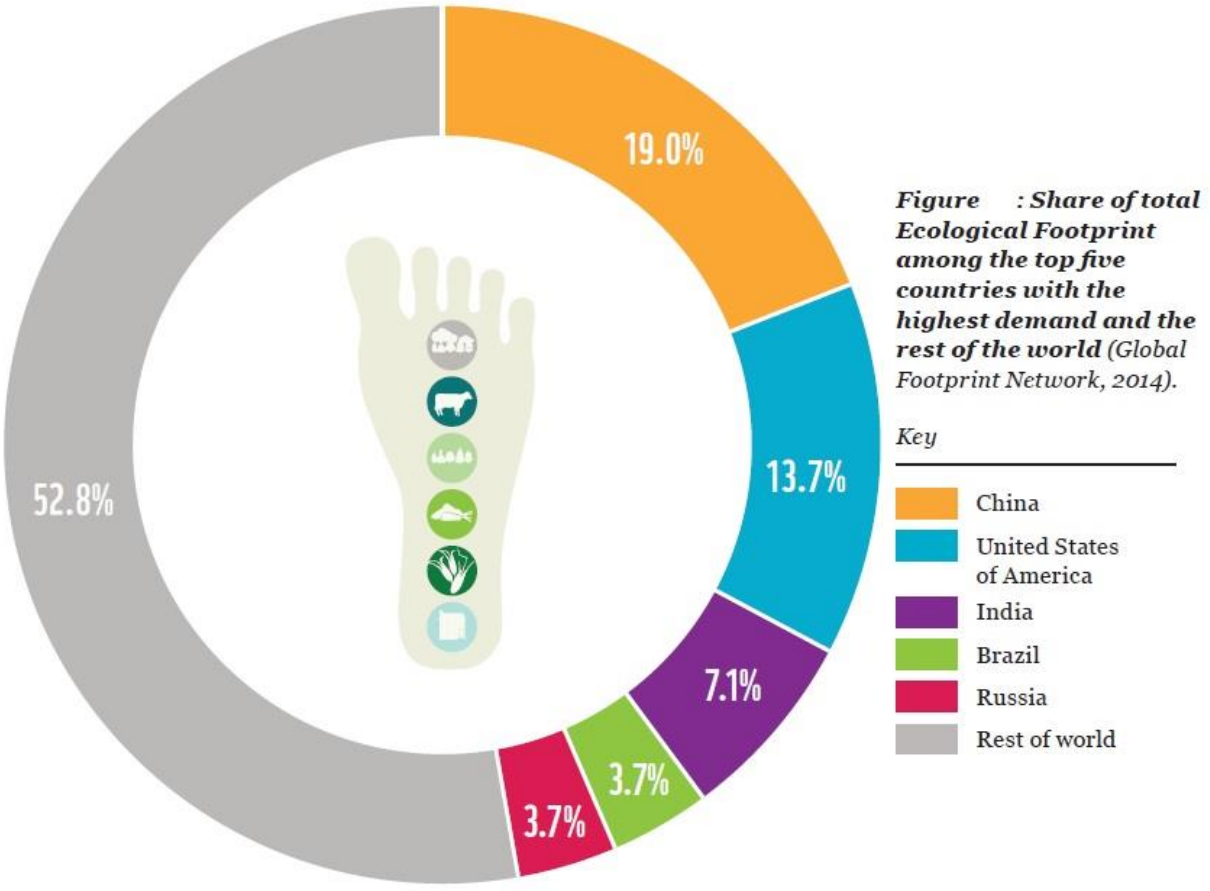


Figure : Share of total Ecological Footprint among the top five countries with the highest demand and the rest of the world *(Global Footprint Network, 2014).*

Source: (McLellan et al., 2014).

Figure 5: (Change in Ecological Footprint with Population)

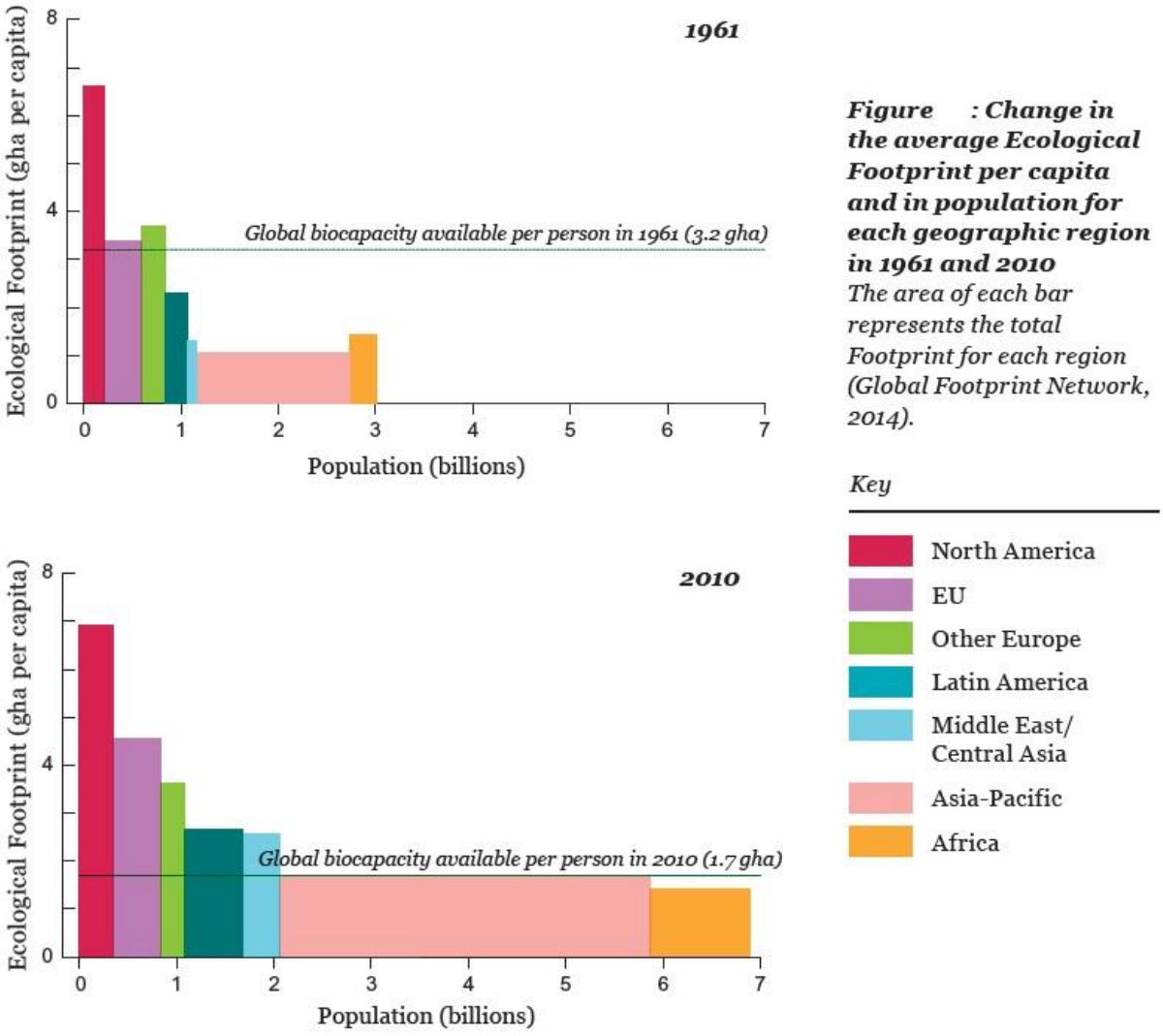
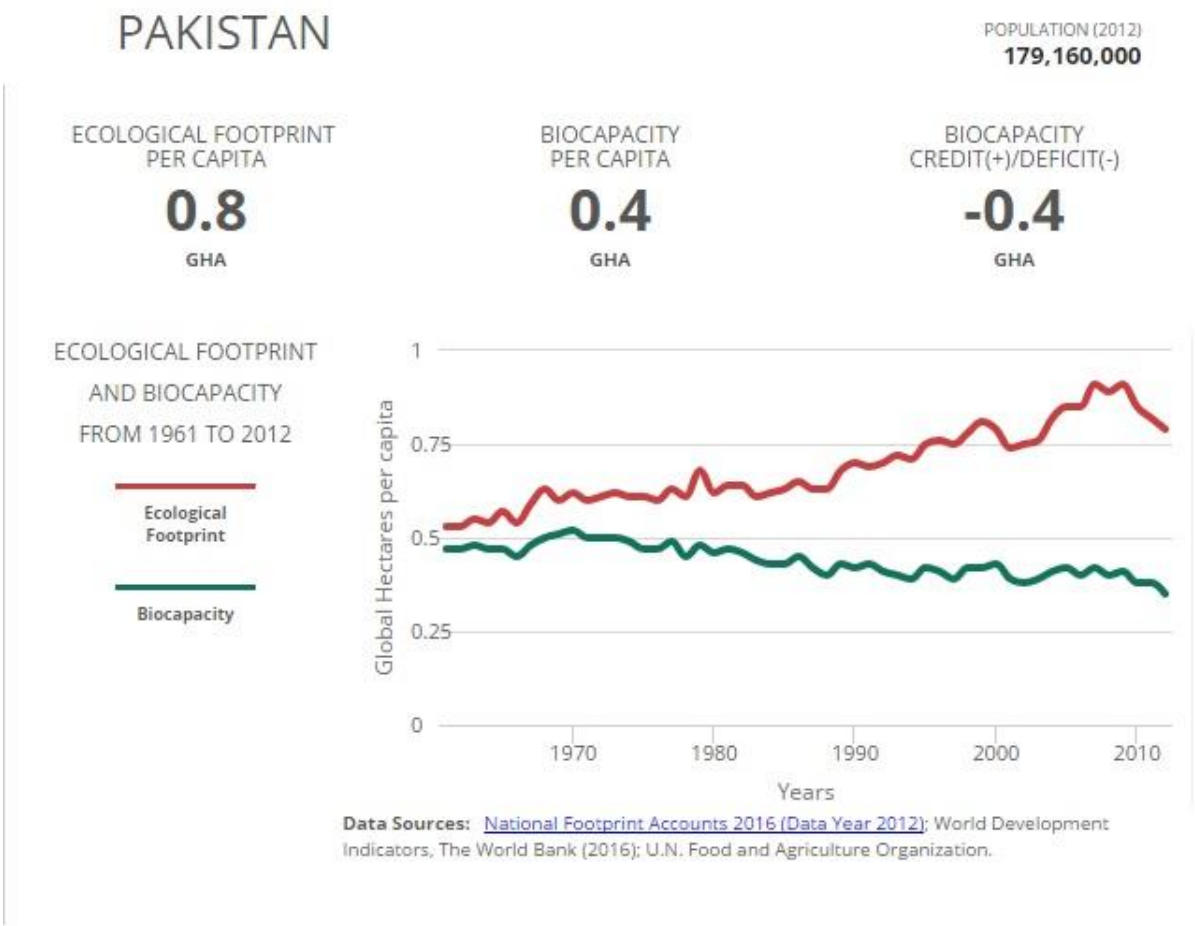


Figure : Change in the average Ecological Footprint per capita and in population for each geographic region in 1961 and 2010
The area of each bar represents the total Footprint for each region (Global Footprint Network, 2014).

Source: (McLellan et al., 2014).

Figure 6: (Ecological Footprint of Pakistan)



Source: (Global Footprint Network, 2016).

1.2 Motivation of the study: -

In South Asia Pakistan is an urbanized 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.

Urban and rural areas of the country got serious-changes in ecosystem due to urbanization of country. Massive depletion of natural resources is causing serious threats to the biodiversity of country. Through vision 2025 Pakistan has set goals of sustainable development and government also recognized the urgency of conserving environment and is now committed to several international conventions and protocols. By Avoiding the environmental degradation will cause water, food and environmental securities in future, as the environment sector has not been given importance and due place in past(Pakistan Economic Survey, 2015).

Also, there is an increased trend of population and urbanization in Pakistan. People of Pakistan are now in need of more resources for consumption so waste generation will be more. As per the Global Footprint Network (2016) Pakistan is among the countries which are ecologically in deficit that is we are consuming more than the available biocapacity with us. Although the deficit of Pakistan is very little but with the rapid increase of population and higher rate of urbanization in the cities that overshoot of resources is expected to become greater in future so we have to stop this overshoot by making Pakistan an environmental friendly country.

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 research 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.

1.3 Research Questions: -

- Which ecological footprint component impacts total ecological footprint more as compared to other influencing factors?
- Is the ecological footprint of urban households more as compared to rural households?

1.4 Objectives of the Study: -

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

1.5 Hypotheses of the Study: -

- The ecological footprint of the urban households is higher as compared to rural households.
- Household size, energy efficient appliances, housing storey, farm production and gas used as fuel for heating have negative relation with EF and monthly income, education, gaseous appliances, commercial products, car usage, electricity used as fuel for heating and volume of waste have positive relation with EF

1.6 Organization of the Study: -

This study is organized in such a way that chapter one consist background and statement of problem, research questions, objectives and hypotheses of the study and motivation of the study. Chapter two reviews relevant literature, Chapter three contains Data and Methodology, Chapter four deals with Results and Discussion and Chapter five provides Conclusions and Policy Recommendations.

CHAPTER 2

REVIEW OF LITERATURE

2.1 Introduction: -

This chapter reviews relevant literature to help in understanding the significance of research problem. The origin of ecological footprint (EF) and different studies related to analysis of EF are given in subsequent sections.

2.2 Origin of Ecological Footprint: -

Originally the 'ecological footprint' was very elegant and simple method for comparison of sustainable use of resources in different populations(W. E. Rees, 1992). The consumption of populations is converted into a single index which is the land area that would be required for sustainability of that population indefinitely(Lenzen & Murray, 2003).Ecological footprint which is calculated by using the original method become an important tool of education for highlighting the level of unsustainability in the global consumption(Costanza, 2000).Ecological footprint was also proposed to be used for the planning and policy designs.(Barrett, Birch, Cherrett, & Simmons, 2004; M Wackernagel, Onisto, Linares, & Ina Susana, 1997).

The concept of Ecological footprint is simple but yet it is comprehensive potentially. This is both an educational and technical tool. It not only assess the sustainability of current activities of humans but also helpful in public awareness and decision making for conservation of resources (Mathis Wackernagel & Rees, 1998).

Sutcliffe, Hooper, and Howell (2008)analyzed that the humanity is on unsustainable development path and overshooting earth capacity by 20%. To reduce the environmental impact individual should be encouraged to take action for reduction. Ecological footprint analysis used at household level changes the behavior towards the lifestyle with less resource intensity. Global environmental sustainability can be achieved in developed countries by considerable reduction in consumption by individuals. EFA can play an important role to empower individuals to adapt environmentally sustainable lifestyles.

According to Moore, Nye, and Rydin (2007) the ecological footprint is a policy tool widely used for analyzing and visualizing the impacts on environment and primarily unsustainable nature of our economic and social activities. Levett (1998) gave message that foot-printing develops a symbol metaphor tool for management which raises many questions about the management of sustainable transition, ethics and politics. Collins and Flynn (2007) analyzed how an EF has been developed for Capital city of Whales, Cardiff. They suggested actions and policies to slow down the growth of ecological footprint of Cardiff. They recommended to use ecological footprint not only as monitoring and awareness raising tool but also to assess the effect of the new policy of council and for future formulation of policy. By Wilson and Grant (2009) the leaders, policy makers and community planners view the ecological footprint as an important tool for measuring sustainability in communities, assist them with development and community planning for sustainability and raising awareness for sustainability issues. Collins and Flynn (2005) showed EF as a well-established and important tool for raising awareness and decision making, corporate commitment to EF is necessary if the results have impact on the future developmental policy.

Mathis Wackernagel (1998) explained that the important part of current EF assessment is strong on motivational side, as it enables humans to maintain the natural level of capital for the wellbeing

of their future. These assessments of resources identify ecological limits of humanity in which sustainable economy can operate. So the ecological footprint helps people to secure the quality of life within the boundaries of nature. Barrett et al. (2004) explained ecological footprint as an important tool which can be used to notify policy makers about the impacts and influence of different policies under their consideration. From this wide range of policy options, it would be feasible to drive a comprehensive sustainable development strategy.

2.3 Ecological footprint and its components:-

GFN and Sydney (2005) analyzed that the largest contributor of the ecological footprint of Victoria is food followed by consumption of goods & services and housing next. The contribution of Food is 37%, Goods 19%, Housing 19%, Services 11% and mobility 10% to total ecological footprint. Abd'razack et al. (2013); Wilson and Anielski (2005); Zuzana Hudeková (2007) also pointed out that food, goods, services, housing and mobility are the key contributing factors of the ecological footprints.

Abd'razack et al. (2013) analyzed that the household consumption pattern affects the environment. Similarly, lifestyle of the people is directly or indirectly associated with the environment. If the consumption today is not sustainable the it puts the resources availability at risk for future generations. The ecological footprint of Nigeria varies according to its states and different class of people. Consumption items of the household were mainly housing, transport, food and goods& services and consumption of each individual household marginally adds to the environmental degradation.

Barrett et al. (2004); Barrett and Simmons (2003) explained the components of ecological footprints of UK. The EF provides the aggregate of consumption of natural resources, the components nourishment, shelter, mobility, goods and services. The consumption of UK is divided in these five high order components. In these components they checked the impacts related to food consumption, provision of houses, personal transportation & travelling and consumption of goods & services of UK. The total EF of UK was 321621000 global hectares which was equivalent to 5.45 hectares' per capita footprint. The residents of UK were among the top 14% of the global population in terms of their impact on the environment.

Schaefer, Luksch, Steinbach, Cabeca, and Hanauer (2006) analyzed that decrease in ecological footprint is due to small population size in an area and hence less consumption of humans results in efficient use of resources. The ecological footprint links the ecosystem with the overuse of sources. It is the tool used to address the hidden issues of sustainable consumption. It quantifies the ecological consumption and supply.

2.4 Household ecological footprints: -

Lenzen and Murray (2003) found that households with large footprints spend more money with low specific per dollar on commodities relatively as compared to the small footprint households in North Queens Land Australian households. Further, two working members of four member's family, living in 100 people/km^2 density area with annual expenditure $58800 dollars. The expenditure on household has the significant and remarkable impact on EF and the EF intensity tends to decrease with more expenditure.

Holden (2004) studied how the consumption differs in housing types and different localities. Ecological footprints were calculated to link sustainable development with consumption. The survey primarily focused on consumption related to housing and other consumption (i.e. on holidays) which were based on structural and physical conditions. The data from 537 households were collected on two separate forms on housing related consumption, characteristics of houses, environmental attributes, structural and physical characteristics of surroundings and socio-demographic and socioeconomic data of individual households. Four attributes of the housing produce best result for the ecological footprint reduction which came out of the survey results and they were concentrated house design, high dense residential areas, location size moderate and distance to center of town minimum. The author concluded that smaller ecological footprint of the individual households is because of decentralized concentration which means small cities having high density and minimum distance between public services and houses.

Roy and Caird (2001a) presented how the householders of UK reduce their ecological footprint after applying the EcoCal tool which assesses the households impacts by measuring footprints. Environmental problems are caused by human activities that affect their own lives and threat to planets future generation also. So the households were the main source of environmental impacts. In an industrialized world the ecological footprint which is linked with the household water consumption, materials, energy and food represents large proportion of footprint of average individual. One approach for reduction of impacts of households started by Best Foot Forward (BFF) British environmental consultants and which was taken up by UK general public in an environmental awareness campaign 'Going for Green'. This provides a development of measurement method for ecological footprints which is called EcoCal launched in 1998. EcoCal is a computer based questionnaire which calculates the household's ecological footprint from the

data of member's consumption on transport, shopping, water, energy, waste, house and garden plus the households green score. EcoCal also provides technical and behavioral recommendations to households for reduction of ecological footprints and to achieve more sustainable quality lifestyle. The study revealed that energy and transport are biggest contributors of household ecological footprints and rural households had footprints significantly larger than urban households in terms of energy and area covered by house and garden. And households without children had larger footprints.

To check, how sustainable the UK households are Roy and Caird (2001b) applied ecological footprint technique to check the environmental impacts of almost 700 households of UK. The demand on environment by the households varies depending on the income, number of occupants, ages and lifestyles. The general understanding about the pattern of increase in household consumption is not sustainable but there is a way to determine the extent of how unsustainable it is. On such method for the assessment of the degree to which people can be benefited from the available resources is 'ecological footprint'.

Wilson and Anielski (2005) analyzed that EF measures what the humanity requires from nature, for cities, nations, regions, organizations, individuals or human's. This shows us how much the productive land and water resources the humans have engaged to produce the resources they consume and the absorption of their waste. Every person has some impact and influence on the planet earth which is not a regrettable or worse thing. But in order to live happily people consume the resources provided by nature. The EFA (ecological footprint analysis) is the assessment tool which measures the sustainability of households, communities, organizations and other businesses. A good healthy EF is the one in which a household of a community has a life style within the natural and ecological limits of biocapacity resources. This needs more attention on demands by

us on environment. Sustainable lifestyle is explained as gaining eco-efficient high quality lifestyles within the careful natural ecological limits in the daily routine activities. Generally, the ecological footprint varies according to the energy consumption and per capita income. Higher income will have higher footprint. Ecological footprint helps us in thinking more clear about human's relationship with the planet earth and so also to the future generations. Ecological footprint analysis guides households and individuals living styles by giving new type of operations of sustainability audit and lifestyles of households. This analysis also provides citizens more knowledge and information about quality of life and sustainability. The ecological footprint analysis provides a basic fundamental examination of person by "ecological reality check": what a human can do for more sustainable living today, with available earth's capacity with improvement in life quality? The authors used the Canadian average per capita footprint data then estimated the local municipal footprints by using income, population, household size, household expenditure, consumption of energy, commuting distances and population densities. The analysis revealed that an average Canadian demand on nature is 7.25 hectares (18acres) and average global footprint is 2.8 hectares which is very smaller than average person of Canada and earth's capacity is 1.9 hectares but the good thing is that Canada is resource rich country with 14.24 hectares biocapacity. The analysis of 20 municipalities of Canada reveals wide range from a low 6.78 hectares to 9.86 hectares per capita. Generally, the higher household incomes have larger footprint but income is not the only thing larger footprints are linked to carbon intensive energy consumption also. Ecological footprint identifies inequalities at global level. Sustainability at global level is the need of time so that human activities stay within the nature's carrying capacity. Municipalities should encourage local households and individuals to check their own footprints by using calculators available on web.

2.5 Ecological footprint and sustainable development: -

Kitzes and Wackernagel (2009) showed that the sum of ecological footprint of all the residents group of people as the ecological footprint of cities or nations. Further they highlighted that sustainability means living within the ecological limits of the nature and EF point out the conditions for achievement of goals. The EF is science based tool which quantitatively tells the individuals or populations demand.

Wiedmann et al. (2008) calculated the Victoria's EFs and illustrated that Melbourne's footprint contribution and environmental impacts of consumption of citizens. They found that people have different consumption patterns and no one consumes equally. The rural areas have different requirements for water supply, transport or education as compared to urban areas. They compared the Melbourne with other states and found apparent difference in their Ecological footprint. The citizens have high footprint in the housing, food and services areas and rural people have higher energy footprints. Higher ecological footprints are caused by many factors, the most import one is income. High income families on average purchase products with low impacts on environment.

Holmberg, Lundqvist, Robèrt, and Wackernagel (1999) examined that which existing aspect of sustainability could be accountable through ecological footprint and those which cannot be accountable. The Ecological footprint is monitoring progress tool for sustainability. EF can easily compare the consumptions of human to limited productivity of nature. It is important measurement and teaching tool, planning and communication for sustainable development by using the sustainability minimum least criteria. By current measurement of EF and then calculating the different government policy choices or different household lifestyles more accurate and efficient ways for human requirements can be implemented and assessed. So the ecological footprint tool

is not only for estimation of today's humanity needs for sustainability but also for future strategies testing. They concluded that the results of ecological footprint calculations are related to the framework of sustainability. This will help ecological footprint users to see which part of sustainability is included in the analysis. It also highlights the aspects which the ecological footprints efficiently assess for example human's economy scale of flows in relation to ecological areas or aggregate of human impacts. Comprehensive framework of sustainability identifies the parts and portions of sustainability which are not to be covered by ecological footprint assessment. The EF is effective particularly for human use and abuse of potential natural services. It is the tool which is compliment for sustainability principles: a yardstick to measure the bottom line of ecological biosphere and a necessary precondition for safety of human's life quality.

W. Rees and Wackernagel (2008) illustrated the fact that because of huge rise in the consumption of material and per capita energy which are made by modern technology and increasing trade flow, the ecological locations with much higher dense population no longer equate or coincide with the geographical locations. The city of twentieth century and industry depends on ecological productive landscapes for their survival. Sustainability cannot be achieved by urban regions or cities on their own; prerequisite for sustainable cities is sustainable global hinterland use.

2.6 Ecological footprints an Educational &Policy Tool: -

Barrett et al. (2004) reviewed how the EF has been used in the education and policy making to gain maximum benefit from ecological footprint studies and from the experiences of the others. The ecological footprint informs policy makers about the impacts of the policies they are using. A comprehensive developmental sustainable strategy can be derived from this wide range of policy information. The ecological footprint is highly informative and beneficial tool that portray our

action on the planet in a different manner to make it accessible to the policy makers, governments and the public at large. The ecological footprint combats the concept of sustainable development whereby impacts of their actions can easily be understood by peoples. The ecological footprint is most important and the only indicator that provides a comprehensive and detailed idea about the impact and influence of consumption which makes EF extremely useful tool for measurement of sustainable development.

Oloruntegbe et al. (2013) explained that less than one eighth of planet earth is available for human use. They investigated respondents randomly from two locations of Nigeria about the locations, age, educational backgrounds and genders. For data collection EF question items were used with ANOVA methods and t-tests indicated no significant impact on variables.

McLellan et al. (2014) in the Living Planet Report stated that human need 1.5 earths regeneration capacity for our yearly needs of ecological goods and services. The overshoot is because now we cut more trees and our carbon emissions are more in the environment than the capacity of forests to absorb. All the demands of humanity cannot fit in what earth can renew. The results are diminished stock of resources and faster waste accumulation than absorption and recycling, such as with the growing and increasing carbon concentrations in environment. Technological advancement can increase efficiency in use of resources, energy and also improves the ecosystem yield to decrease overshoot but tradeoff may also happen.

Mathis Wackernagel et al. (2002) reports 146 nations ecological impact. They illustrated the level globally a nation can reproduce its consumption. The accounts documented that by 20 percent humanity exceeds the Earth's biological capacity. The increasing population with growing appetite for resources exacerbates the global ecological deficit in spite of technological advancements. As

a result, the natural capital of Earth is liquidated by human economy. The report explained how to build a sustainable future by introducing the ecological accounts rationale and assessment methods.

After the reviewing the relevant literature, it can be concluded that humans have limited resources available with them and people have to take care of the Earth by sustainable use of the resources. Many of the authors focused on national, city and individual level ecological footprint analysis. Individual household affects the environment more because they are very significant source of energy use, emissions, production, food consumption and other environmental effects. In order to save the environment, the individuals' impact on the planet earth should be taken into account. To this end, the present study is devoted to study the household's ecological footprint in both rural and urban areas as a separate identity. As the Abd'razack et al. (2013); GFN and Sydney (2005); Zuzana Hudeková (2007) expressed the food, housing, goods, services and mobility as the main contributors of ecological footprint so the study will calculate the individual households consumption of the aforementioned components and their contribution to the ecological footprint. Besides, in the study area because of the rapid changes in the environment and urbanization, the policy makers/authorities should have informed decision to save the earth planet.

CHAPTER 3

DATA AND METHODOLOGY

3.1 Introduction: -

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

3.2 Theoretical Background: -

In 1970s, Paul Ehrlich American ecologist and John Holdren, developed formula to evaluate the impact of humans on the environment. The formula IPAT equation which is well known in which:

$$(I)= (P) * (A) * (T)$$

Where in the given formula

I represent the Impact, P is the Population, A is the Affluence and T is the Technology.

The above formula equation shows that an increase in the human population P results in an increase in the impact on human i.e. I. Similarly, the technology T will reduce the Impact I and increase in affluence A will increase the impact I as increase in population affluence there will be increase in consumption. We can further simplify the model by considering the consumption as a product of technology and affluence

Impact = Population X Consumption

The above equations show how I, P, A, and T are related but this needs further modification. For the global ecological sustainability to be achieved the 'Impact' should be within the natural limits of the planet (Chambers, Simmons, & Wackernagel, 2014). Then Ecological footprint analysis entered as a tool created by, a Canadian William Rees, in 1992 and since then advanced and developed by Policy Institute, Redefining progress.

The background points for understanding the concept of ecological footprints are:

- Earth is said to be a closed system which means that everything humans consumed and produced from earth returns back to earth.
- Earth is limited or finite in its size, implying that there are boundaries or limits on the earth's productive and absorptive capacity.
- Earths capacity of production and capacity to absorb waste can be calculated and measured in terms of consumption by humans and production of waste.

In 1987 the report by Brundtland commission titled 'Our Common Future' explained most commonly used definition of sustainable development (SD) is, "It is a development which meets the needs of present without compromising the ability of future generations to meet their own needs"(Brundtland et al., 1987). The main strength of SD is that it includes all the economic, social and environmental dimensions and aspects. This is also considered to be the weakness because what if something falls away from the scope SD is not clear about that. So, it was felt the sustainable concept has caused many errors and many doubts are raised in decision and policy making. In an attempt to lessen or overcome these doubts and errors many indicators were designed

to measure sustainability. Prominent examples are genuine progress indicator (GPI) (Hamilton, 1999) and another one is the material intensity per unit of service (MIPS) by Schmit-Bleek 1994.

It needs to be clear and noted here that there is no perfect indicator for measurement of sustainability. Almost all of them have various strengths and weaknesses. However, ecological footprint indicator gained recognition and wide application. It was developed by William Rees and Malthis Wackernagel in 1990s. The original concept of ecological footprint was demonstrated in (Mathis Wackernagel & Rees, 1998) was appropriate for foot-printing at national scales. According to Lenzen and Murray (2003); Walsh, McLoone, O'Regan, Moles, and Curry (2006) the original model of EF divided consumption into five main different categories of food, transportation, housing and consumer products and services(Walsh et al., 2006).

Mathis Wackernagel and Rees (1998) developed a measurement tool called ecological footprint analysis to make sustainable development a true reality. This tool determines that whether the demands of humanity are within the limits of natural global capital stock(Keleş, 2010). The EF is very famous and well known tool for effective communication and is used for increasing the general public awareness about the impacts on the nature and environment which results from consumption and production(Fang, Heijungs, & de Snoo, 2014). The EF is an emblem for impact on ecology notwithstanding where the impact occurs(McManus & Haughton, 2006). EF is the most visual indicator for measurement of consumption(Grigoryeva, 2010). The EF is a strong and powerful tool for communicating and measuring the impacts on the environment and sustainable use of resources. It expresses and shows the relationship of available natural resources and consumption. Amongst all the ecological economist the concept of ecological footprint is very well known for environmental policy making and planning (Marta, 2010; McManus & Haughton, 2006; Moffatt, 2000). By the innovator Mathis Wackernagel and Rees (1998) the ecological

footprint calculations stated that humans are living beyond the biophysical means of earth. The footprint tool is an attempt in biophysical based ecological economics which is better than many of the economic models. The EF represents the clear impact of humans on the environment and earth(Moffatt, 2000). EF is a resource accounting tool and index which converts humanity demands of resources to the area of land that is needed for resource production or disposal or sequestration of waste. Since then much of the research has been done to further develop the methodology of foot-printing(Walsh et al., 2006).

Over the last few decades new exciting developments had been witnessed about the tools which measure the use of nature by the people: Life cycle assessments (1990), energy analysis & energy based lifestyle appraisals (1991), environmental space calculations (1993), the human appropriation of net primary production (1997), the documentation of regional and industrial metabolism (1995), mass intensity per unit of service MIPS (1994), sustainable process index (1996), socio-ecological indicators (1996), resource accounting input-output models (1994), the computer based spatial model analyzing land use developments and ecological potentials (1995), the computer based scenario models 'polestar'(1997) and the ecological footprint assessment (1996). Many of these are accounting tools which register material balances of renewable & non-renewables resources. The results are then shown in the form of space, mass, or energy and combined of all them while the representation and application are different but their objective is same that is to quantify the use of nature by humans to reduce that human impact. The EF gained popularity as it expresses results in the form spatial units which can easily and simply be communicated and which allow the human consumption comparison to the limited and little productivity of nature. It is one of the few tools which sum up the various human impacts which are inconsistence with ecological principles and thermodynamic laws. It becomes important and

attractive measure and tool for communicating about, planning and teaching for sustainability(Holmberg et al., 1999).

Over the past few decades continuously a number of footprint indicators were introduced in the world of scientific community with the basic aim to raise the awareness among public about how human beings are exerting pressure on the environment. The deeper and comprehensive understanding of footprint is required to support policy makers for the choice and measurement of strategies to mitigate environmental impacts(Fang et al., 2014). The EF has the strong ability of converting and transforming an unclear and uncertain concept into an accountable and measurable goal and aim. The global budget approach which divides the earth planet into per capita available ecological space. The main objective is estimation of relative share of the resource globally devoted by certain country, region, activity or human population as a decision and policy making on sustainability (Folke & Kautsky, 2000).

The most appealing and attractive aspect of the ecological footprint accounting is that it draws attention towards several topics related to sustainable development. The ecological footprint basically focuses on the consumption and highlights the different aspects of wastage of resources, impacts of consumption pattern in terms of composition and size and reallocation of environmental pressures exerted geographically. It is indicator for pressure exerted by humanity on environment from different production and consumption patterns. Methodological innovations of the ecological footprint are

- It focuses on final consumption of the certain people or population which causes environmental damages. This includes domestic pressure and also pressures from outside regions.

- The ecological footprint sum up the total data of different resources to single indicator.(Smeets & de Kruijf, 1999).

The EF account for the consumption impact and following the discharge of waste which includes food consumption, transportation, housing and consumer products & services by converting these variables into a single unit of land. The approach at national level works the best and more extra work is required for the comparative purposes for improving the application of approach at urban and personal levels(McManus & Haughton, 2006).

The increasing environmental problems are becoming universal and global. Today humanity is exceeding the limits of the planets; ecological assets are getting more critical. Every country around the globe has its own profile for ecological risks. Many countries are in ecological deficit with ecological footprint greater than their biological capacity and some others depend on resources from outside which exert pressure. Natural capital accounting can be useful for sustainable management of the economy and the environment (Global Footprint Network, 2016; Strbac, 2012).

The ecological friendly lifestyle and consumption are not sufficiently encouraged in the societies and especially among the young generation. The EF can be successful tool in the process of sustainable development education. According to Venetoulis and Talberth (2008) EF has been used widely in sustainability analysis over past decades. So it can also be effective in changing the generalized views about the natural resources unlimited availability and in the systematic process of making decision related to the more effective eco-friendly consumption. The current advance society's continuously exerting strong pressure on nature and the level of that pressure is shown in an 'ecological footprint'. Since 1998 the Living Planet Report by WWF (World Wildlife Fund)

provides a very quantitative estimation of our environment condition and the impacts on it by humans(Grigoryeva, 2010).

The footprint analysis implies the observations of the relative mass of the different categories of consumption and their impacts on the environment. It reduces all the impacts to per capita global hectares a common unit. The analysis of EF is a static and stable process which provides the aggregate measures of ecological burdens at some specified year or a date. It is an important technique and tool in the measures of toolkit and resources which helps in the sustainability assessment although it is not strong in terms of poverty or social differences and inequalities among different nations and societies. EFA should be augmented with many other measures and steps to take into account human welfare components in a broader perspective. Costanza (2000); Moffatt (2000) notified that this aggregate comprehensive indicator has many advantages and some disadvantages too. EF can also be used as awareness raising tool for demonstrating the resource use of human and waste generation. It incorporates trade flows as an area based indicator for sustainability and some regard it as against the international trade arguments homologous to fair or ethical trading debate, the consumption footprint via a balanced national equation is defined in terms of trade flows Giljum et al. (2007); W. Rees and Wackernagel (1996)

$$(\text{Consumption}) = (\text{Production footprint}) + (\text{Imports}) - (\text{Exports})$$

In the above equation imports and exports are converted to equivalent common footprint basis hectares (Ha). Which means a product manufactures in Japan and then imported by UK, it will contribute to the UK and not to the Japan's footprint of environment(Hammond, 2006).

Comparison of global available productive area to the ecological footprint gives us an environmental sustainability indicator which can be examined to determine trend over time. The

EF involves data collection from resource flow analysis and other sources about different activities like product consumption, water use, waste production, energy use and transport. The impact of these is converted to global hectare (Gha) a common currency for ecological foot-printing. Because of the common currency a wide range of impact are aggregated to derive footprints for countries, regions, organizations, processes, individuals and households. For example, in the year 2001 the EF of South West resident was 5.56 gha per person which can be broken down into components for analysis. The components analyzed were Materials, Direct energy, personal transport, material and waste, built land, water and food. This analysis of breakdown of EF components gives a better understanding of which component of consumption has low or high impact on environment(Chambers et al., 2005).

The EF, a sustainability indicator, converts the waste production and consumption to the equivalent land area units. It is an educational and teaching model and tool for measuring the impacts of individuals and nations on environment. Ecological footprint is a very broad and rich resource for students, teachers and policy makers at all levels, it will help societies and communities all around the globe to make their lifestyle and standard of living more sustainable and provide consistent life quality for present as well as future generations (Keleş, 2010). Sustainable development makes the humans consider the intra & intergenerational problems of equity. As the ecological footprint currently reported shows unsustainable human development, there is only one earth with us. So we need to actively participate in the developmental process to establish and setup indicators for our understanding that if we are moving away from sustainability or we are going and moving on the road which is leading to a sustainable future. We also need to understand which path is equitable economically, ecologically achievable and desirable also(Moffatt, 2000).

The ecological footprint becomes popular in the last few decades which have resulted in sudden big increase of ecological footprint studies. For example, over more than 500 journal articles for 'Ecological Footprints' were delivered by ISI Web of knowledge the studies on ecological footprint analysis increased from few 20 in year 2001 to the 104 in year 2018. In Elsevier journals in more than 1000 articles this concept was appeared, one third of them were published in Ecological Economics. "An introduction to the ecological footprint" is one of the most citied articles. Google and Google scholars deliver more than about 2.8 million and some more than 32000 hits for EF respectively (4 April 2013). This is the result of all the intense communication activities around ecological footprint which were undertaken by GFN (Global footprint Network) with support from WWF (World Wildlife Fund) and a long list of research and environmental institutions. The environmental footprint is popular not only because it shows the overall indicator for human's environmental impact or pressure on the nature but also because it pressurize activities of humanity should not cross or exceed the natural environmental limits(Bergh & Grazi, 2014).

The EF has been calculated and estimated for many cities, communities and subnational populations but there is no consistent framework for calculation of EF has been emerged. Prevailing strategies for estimation and calculations includes measure and indicators as representative for adjustment of Resource Flow method, National Data Indicator Approach, Household Expenditure survey approach and Community Based questionnaires each of these approaches have prominent strengths and stability and also supported key EF projects(Wilson & Grant, 2009).

The current study about the household ecological footprint can be used as basis for the policy making as well as educational purposes in academia as well. As explained above that the EF is indicator for sustainability measurement the current study also used the EF as an indicator for the

measurement of sustainability and further analysis of the study can be used for the policy making as well. The EF used as a tool to measure the consumption of resources by the households of study area and waste generated by them, which further on explained the analysis of the determinants of the EF tool. Hence the study used the EF as an economic and environmental tool to measure the sustainability and efficient use of resources by the households of study area.

3.3 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 33º 49´ and Longitudes 72º24´east of Greenwich. The area of Islamabad is 906.50 square kilometers of which urban area is 220.12 square kilometer and the rural area is 466.20 square kilometers 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). Many of the international websites and print media in Pakistan stated that Islamabad is the 2nd most beautiful capital of the world (Ali, 2015; Capital Development Authority, 2015; Ikram Junaidi, 2015).

In South Asia Pakistan has the highest urbanization rate with an annual urbanization rate of 3.06% and the projected population of the country is 335 million by the year 2050. In Punjab and Sindh provinces urbanization is about half of the total population and in Baluchistan and Khyber Pakhtunkhwa the level is 23.89% and 16.87% respectively. According to UNDP (2013) the urban population of Pakistan is 35% and it is projected to be at 50% by 2030(Sawas, Anwar, Iqtidar, & Viqar, 2014).

According to the World Development Indicators, Islamabad is the only city which has a rapid increase in its population during the last ten years. The population was 787508 in 2005 and it reached to 1.03 million in 2010 and total population is 1.36 million in 2015. Hence the total increase in urban population of Islamabad from 2005 to 2015 is 73 percent which is the highest ratio in Pakistan as compared to other cities(Durrani, 2015).

The major problems which are resulting from rapid urbanization 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 urbanization rate, this study selected Islamabad for the analysis.

3.4 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. 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.

3.5 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% while confidence interval as 4%. Depending on the urbanization of the city almost 70% of the households were collected from urban areas and 30% 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% 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.

As population of Islamabad has increased more in urban areas over the past decade and by Durrani (2015) it is almost 73% increase in population so Zone 1 was used for sampling purpose including these sectors I-10, I-9, G-11, G-10, G-9, F-11 and F-10 because Zone 1 is the dense zone having majority of urban population living in this zone. Different villages of Bara Kahu Malpur, Lakhwal, Shahdara, Kot Hathyal, Mangyal and Mohra Noor covered the sampled area. The sample size was

proportionally allocated to the selected target areas. The details of the relevant population and sample size calculation are given by Table 3.1 below.

Table 3.1Target Population and sample size selection

Area	Population 1998	Household Size	Projected Population 2016	Households	Sample
F 11	17289	5.5	24346	4427	37
F 10	12796	5.8	18019	3107	26
G 11*	1044	6.4	47392	7405	62
G 10	33654	5.6	47392	8463	71
G 9	50986	5.8	71799	12379	104
I 10	40173	6	55506	9251	79
I 9	20810	5.9	29304	4967	42
Bara Kahu	78882	6	111082	18514	180
Total Household and Sample Size				**68512**	**600**

*****G-11 sector is developed far late than Islamabad's other sector so in 1998 population was low but now it is well developed and populated sector of Islamabad so I used the population of G-10 as a proxy for sampling.

Source: (Pakistan Bureau of Statistics, 2016).

3.6 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 modeled by the Stockholm Environment Institute (SEI). Besides, for the analysis of data both descriptive statistics and regression analysis have been used.

3.6.1 Econometric modeling: -

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 is the Urban Household ecological footprint in Global Hectares (Calculated from the ecological footprint Calculator).

RHEF is the 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. According to Abd'razack et al. (2013); Roy and Caird (2001b); Wilson and Anielski (2005) there is a positive relation between income and ecological footprint which means the higher level of income will result high 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 from one, two, three and so on the ecological footprint decreases because most of the energy consumption, personal transport and land for housing is shared by all of them to reduce the negative impact of the environment.

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. As Bastianoni, Galli, Niccolucci, and Pulselli (2006) also explained that the house sharing, reducing the built-up area and multistoried buildings are very important and necessary for the reduction and optimization of bio-productive land in construction of building.

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 which involves the use of energy saving bulbs and energy efficient appliances which results in low footprint. 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. According to E. Victoria (2008); E. I. C. Victoria (2008) the growing own farm products uses the less energy and results in low waste and it reduces our footprint and using high commercial packing products damages the environment.

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. As GFN and Sydney (2005); Wiedmann et al. (2008); Wilson and Anielski (2011) transportation and travelling is the major contributor of the high ecological footprint as the more travelling will result in high GHGs emissions.

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. So the usage of gas as a fuel for heating results in low ecological footprint and the electricity results high ecological footprint.

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. Abd'razack et al. (2013); Barrett, Vallack, Jones, and Haq (2002) concluded that the more the waste generated the high will be the ecological footprint.

U_i is random term.

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

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction: -

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

4.2 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.

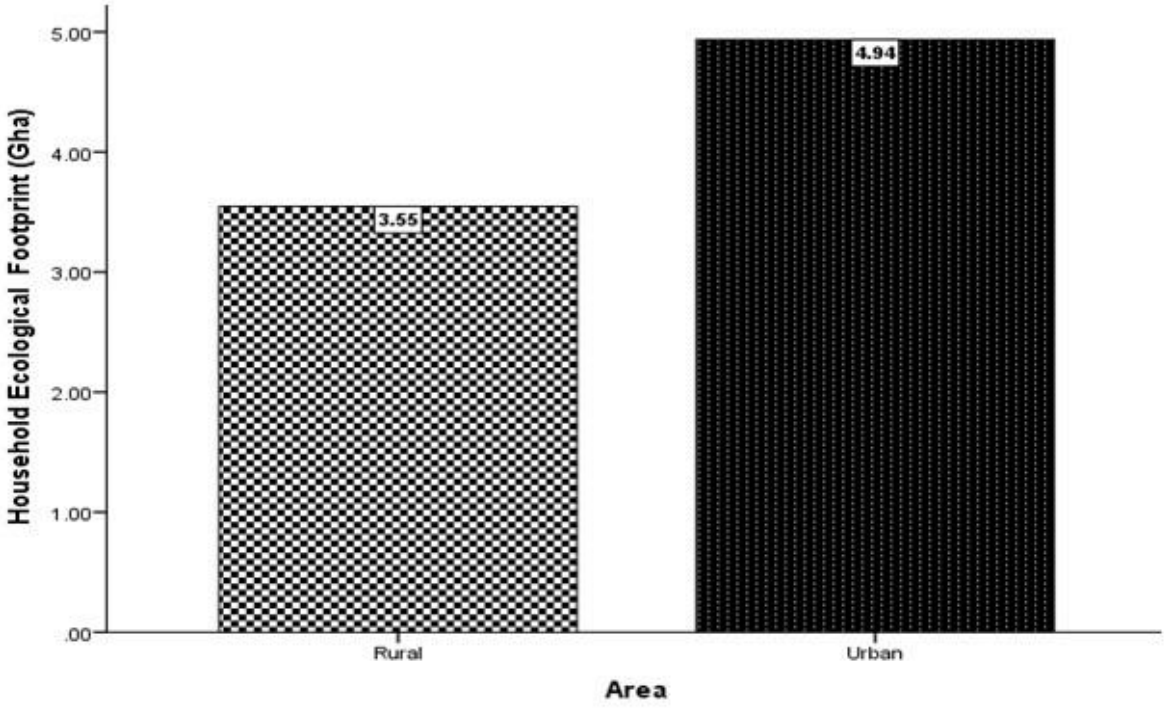
4.2.1 Comparison of the EF in rural-urban areas of Islamabad: -

The comparison of the ecological footprint of urban and rural households of Islamabad is given figure 4.1 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.[1] 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

[1] The per capita footprint for rural household is 0.83 Gha per capita, it is calculated by dividing household EF with household size 6 of Islamabad. And EF per capita for rural household is 0.60 Gha per capita.

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.

Figure 4.1 Comparisons of Ecological Footprints of rural-urban Households of Islamabad.

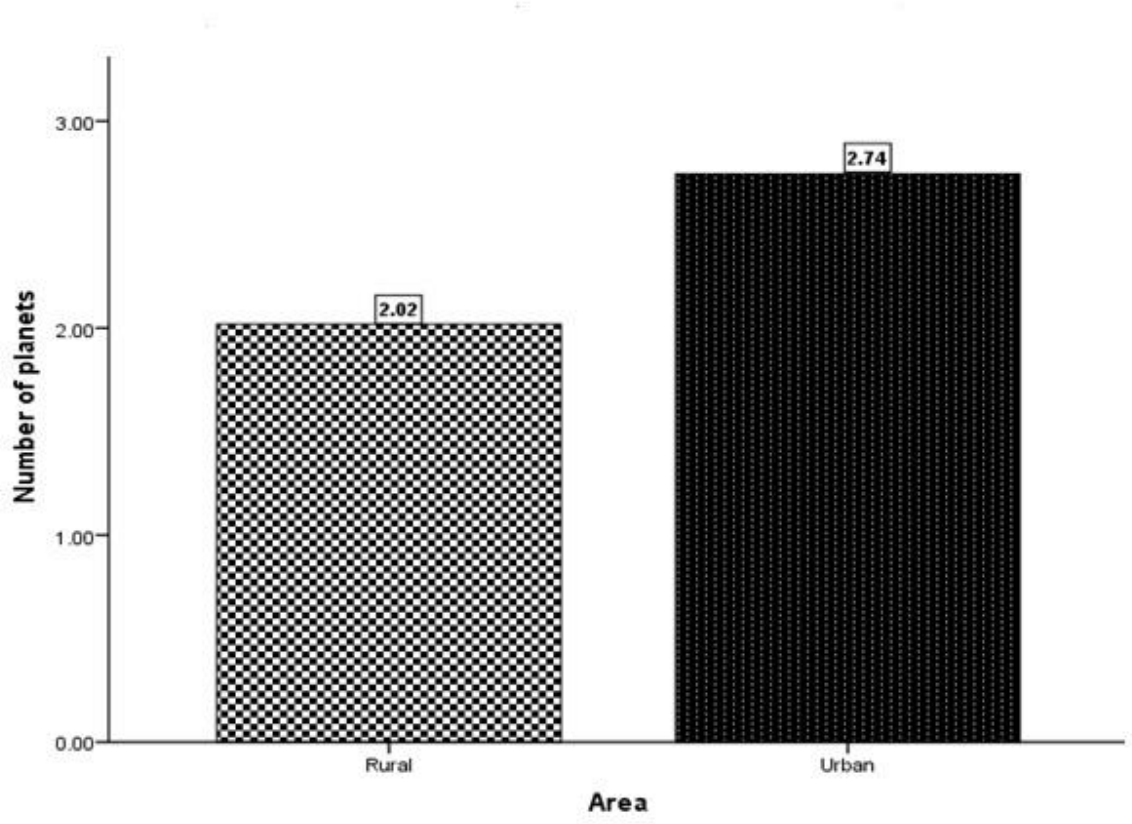


(Source: Field Survey)

4.2.2 Number of planet requirements in rural-urban areas of Islamabad: -

The figure 4.2 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.

Figure 4.2 Comparison of Number of Planets of rural-urban Households of Islamabad

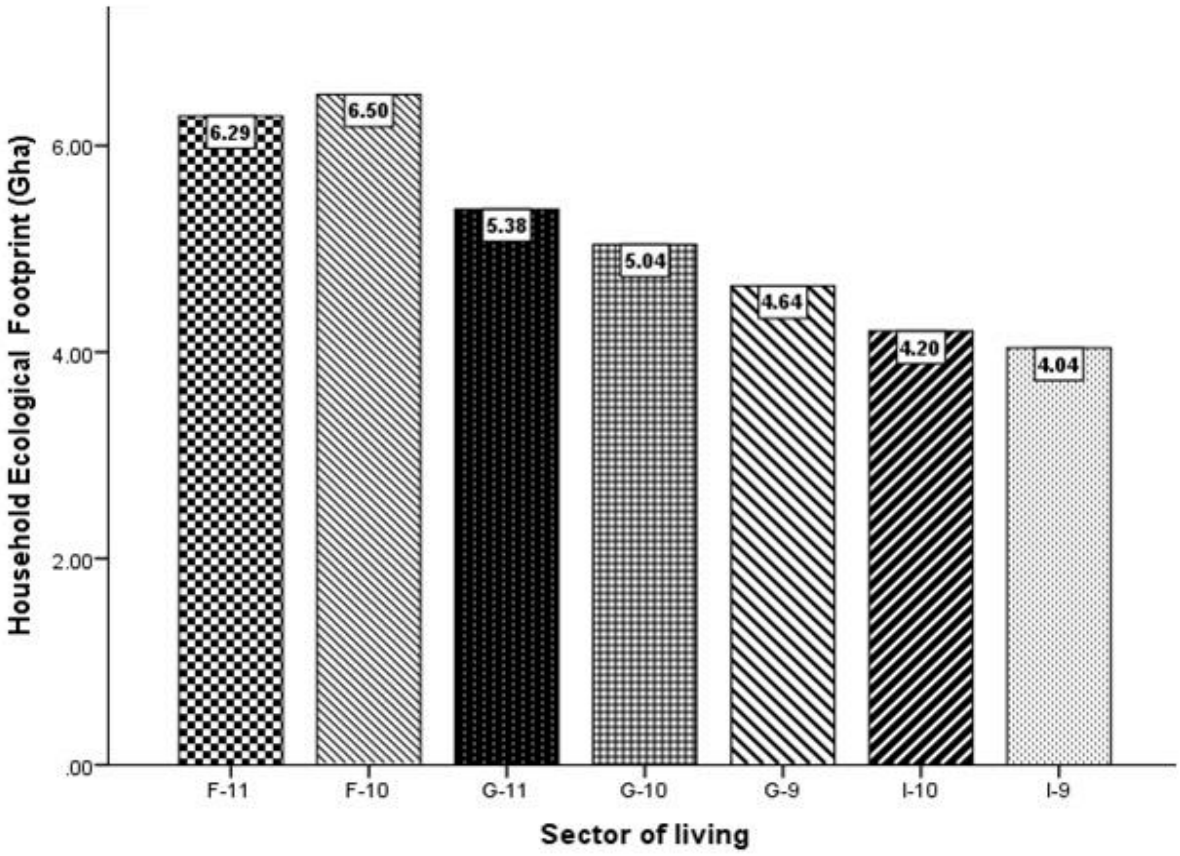


(Source: Field Survey)

4.2.3 Sector-wise Ecological footprint of urban areas in Islamabad: -

The figure 4.3 shows that in urban areas of Islamabad sector F-10 and F-11 have high ecological footprint and I -10 & 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.

Figure 4.3 Ecological Footprints of Sectors of Islamabad.

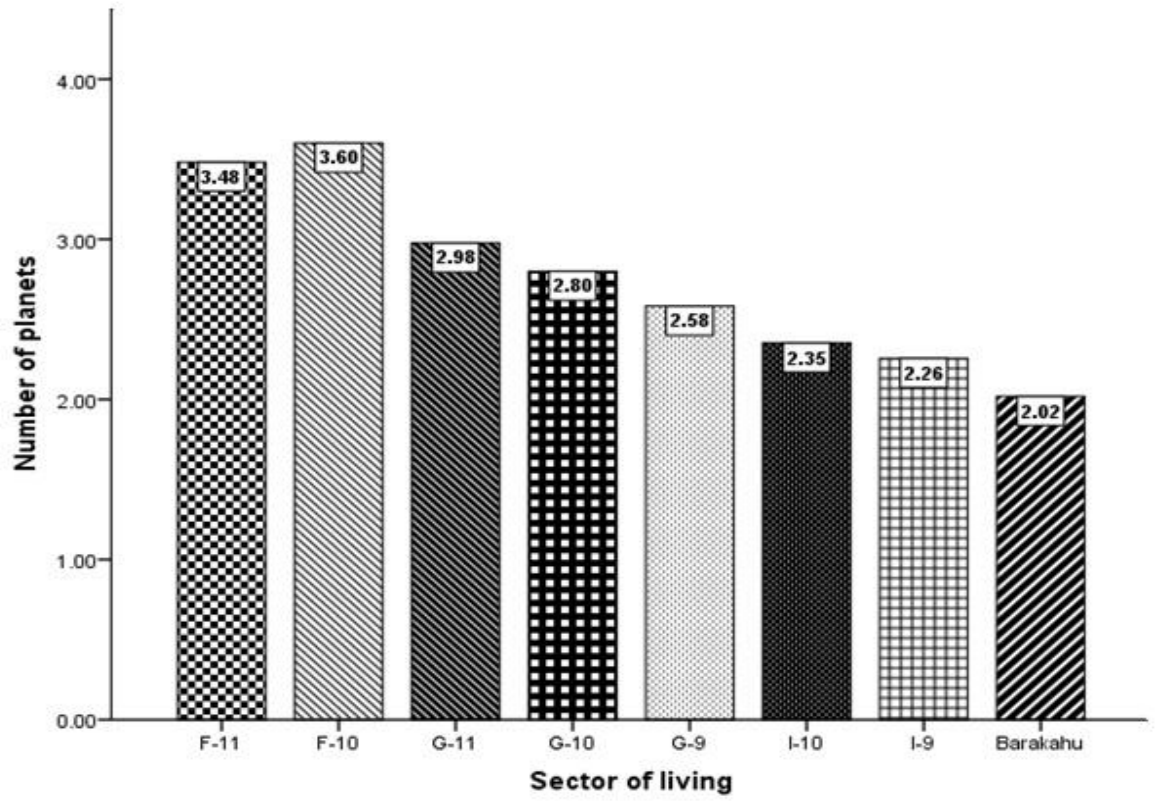


(Source: Field Survey)

4.2.4 Number of Planets requirement in Islamabad: -

The figure 4.4 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 urbanized and high standard sectors in Islamabad more planets are required for living.

Figure 4.4 Number of Planets sector-wise in Islamabad.

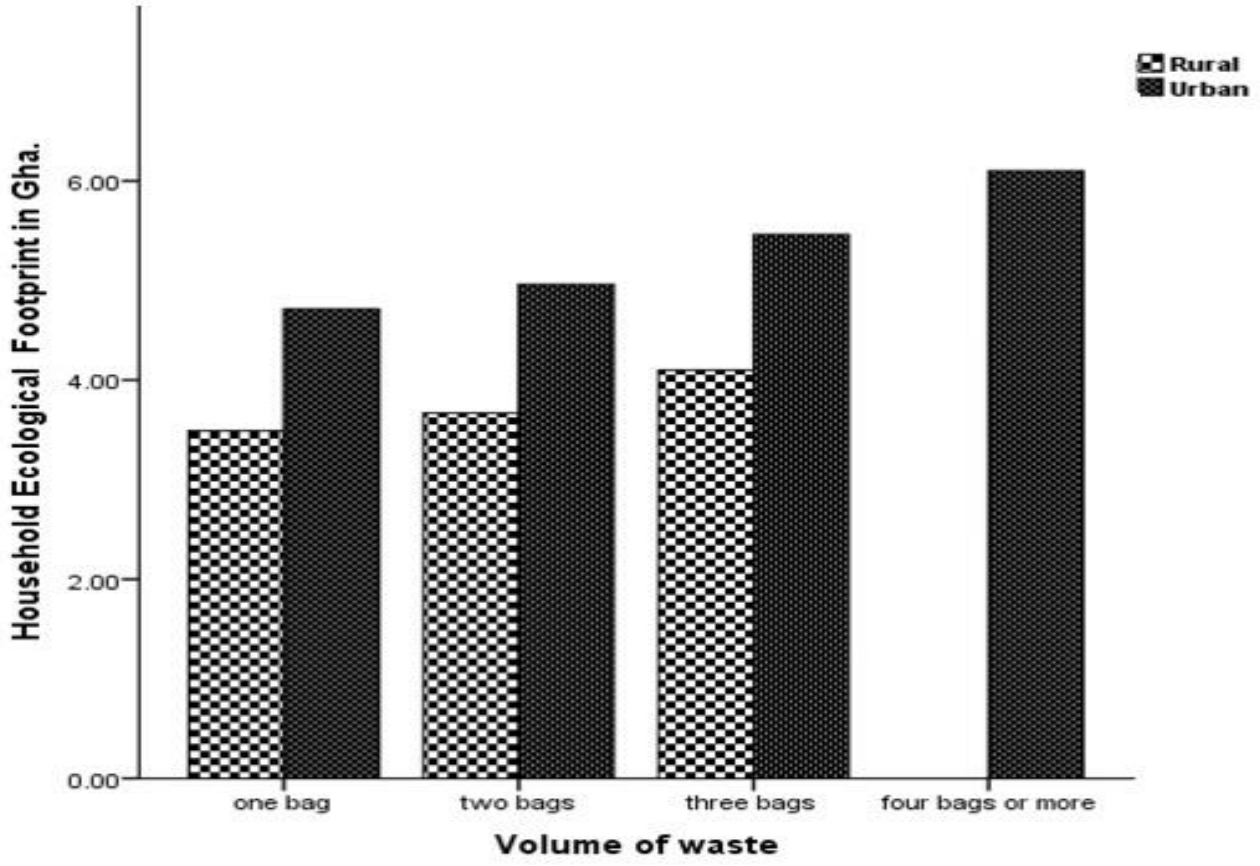


(Source: Field Survey)

4.2.5 Ecological footprint and waste generation of rural-urban households: -

The figure 4.5 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.

Figure 4.5 Volume of waste generation and ecological footprint in rural-urban households.

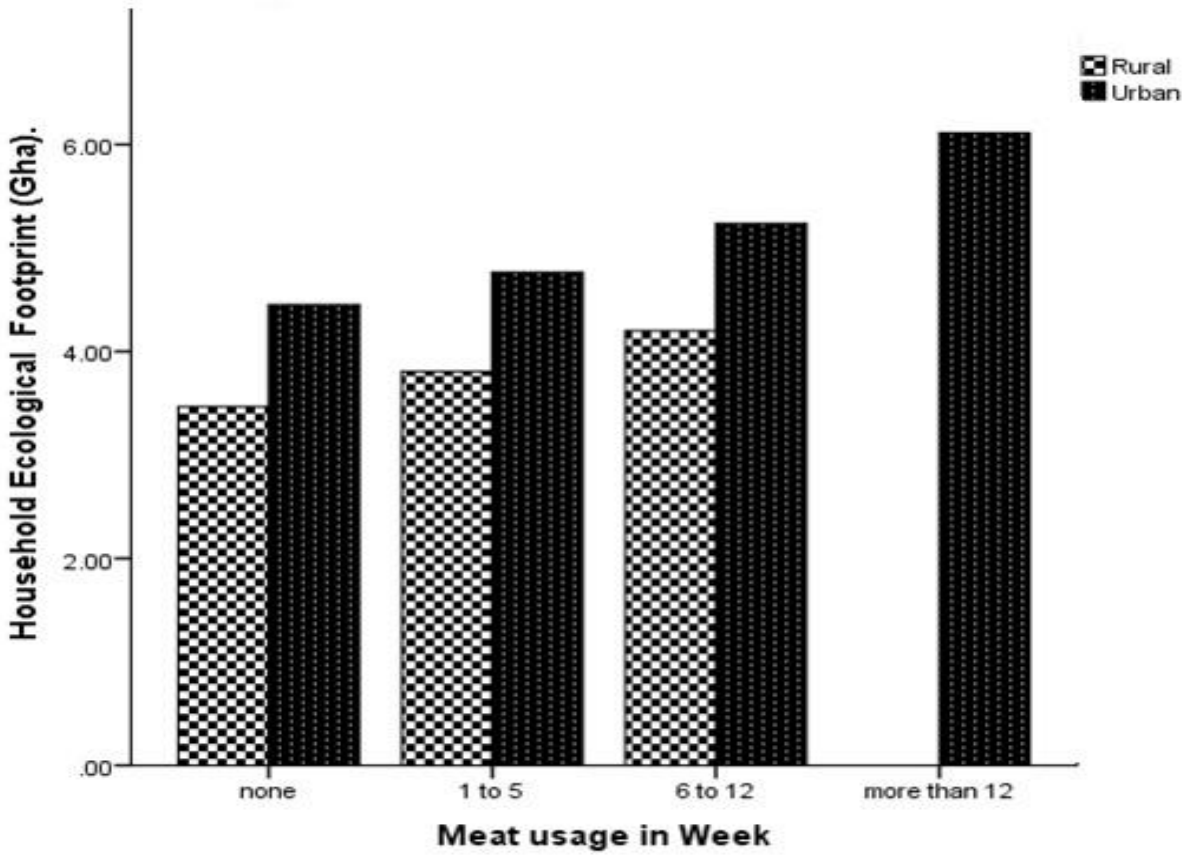


(Source: Field Survey)

4.2.6 Ecological footprint and meat consumption by rural-urban households: -

The figure 4.6 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

Figure 4.6 Meat Usages and Ecological Footprint Urban-Rural Households of Islamabad



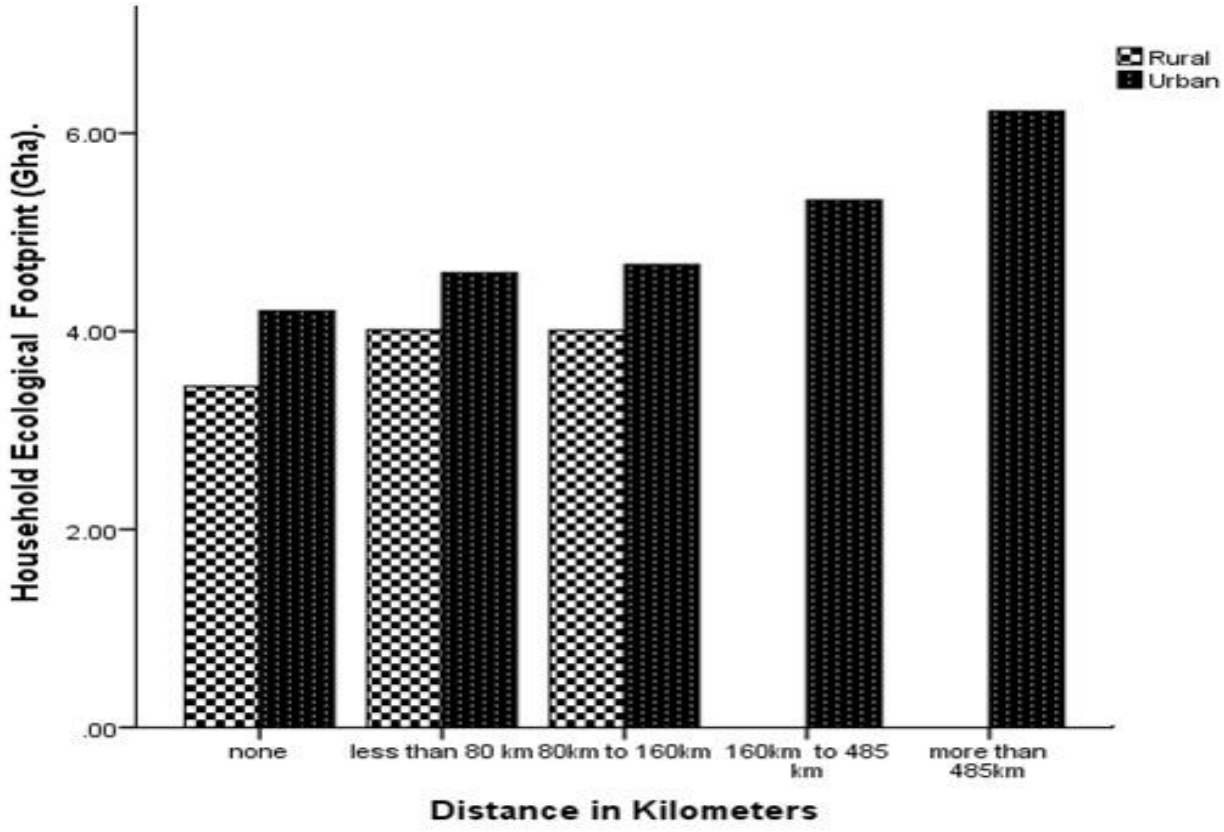
(Source: Field Survey)

4.2.7 Ecological footprint and travelling by rural-urban households: -

Figure 4.7 below shows that as the traveling distance in a week increases, the ecological footprint also increases. The figure shows the urban households travel more as compared to the rural households so their ecological footprint is high. The households whose travelling in a week is high have high ecological footprint and as the travelling is decreasing the ecological footprint is less.

According to Wiedmann et al. (2008) the more the use of car the result will be high ecological footprint.

Figure 4.7 Travelling and Ecological Footprint of urban rural households

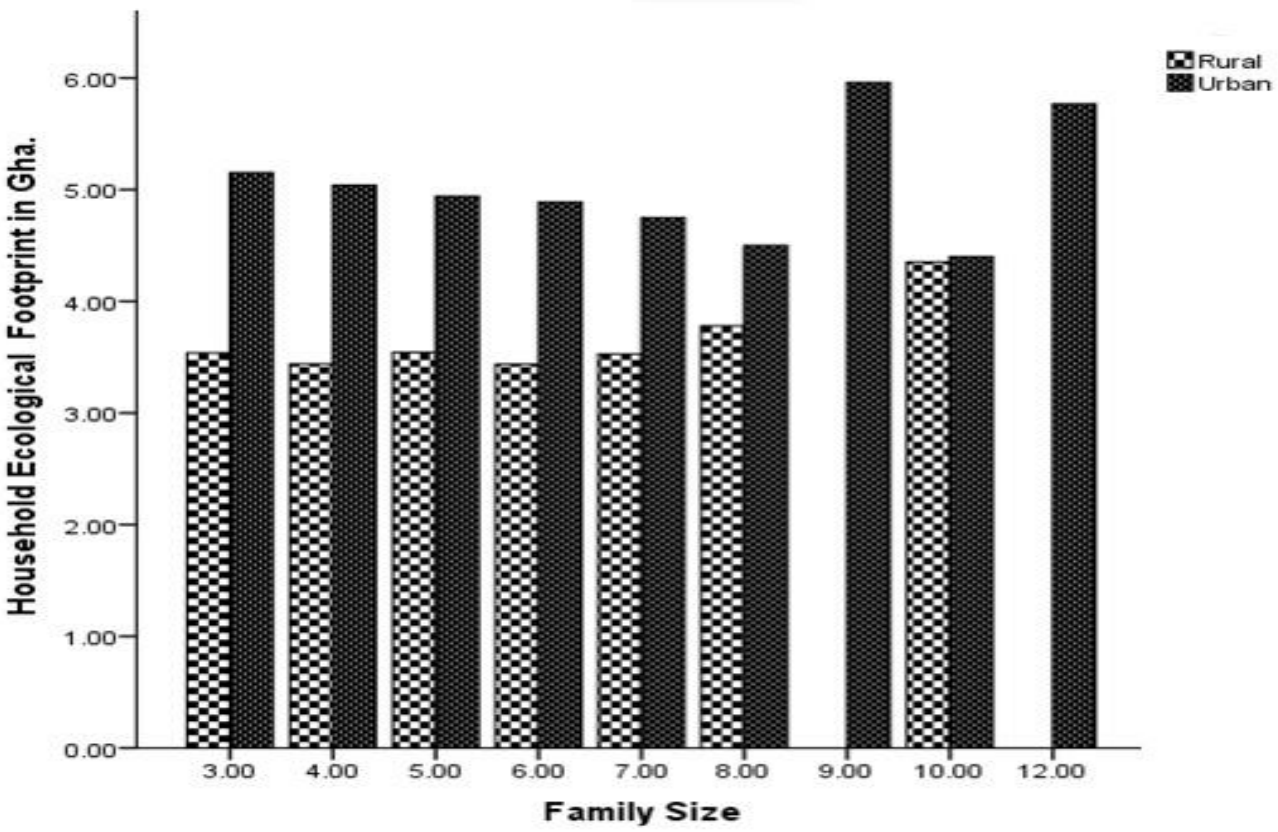


(Source: Field Survey)

4.2.8 Family size and EF of rural-urban households: -

The figure 4.8 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.

Figure 4.8 Family Size and Ecological footprint of Urban-Rural Households of Islamabad.



(Source: Field Survey)

4.3 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 4.1. 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 4.1 Average Household Ecological Footprint, Planets Required and CO_2 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**

Source: Field Survey

4.4 Simulation of the ecological footprint in major cities of Pakistan: -

The simulations of the ecological footprint of for major cities of Pakistan are given in table 4.1. For assessing the quick ranking and comparison in terms of ecological footprint, Annexure B is also attached.

Table 4.2 Total Ecological footprint of all households in major cities of Pakistan 2016 (000, Gha).

Area	Urban		Rural		Total	
	[2]Projected Number households	Ecological footprint of all households	Projected Number households	Ecological footprint of all households	Projected Number households	Ecological footprint of all households
Islamabad	120194	593.8	62701	222.6	182894	823.0
Lahore	1018823	5033.0	217033	770.5	1235856	5561.4
Rawalpindi	387427	1913.9	341360	1211.8	728787	3279.5
Faisalabad	453452	2240.1	608489	2160.1	1061941	4778.7
Multan	257146	1270.3	352465	1251.3	609611	2743.2
Jhelum	58902	291.0	153910	546.4	212813	957.7
Peshawar	160932	795.0	170957	606.9	331889	1493.5
Swat	27823	137.4	173424	615.7	201247	905.6
Nowsehra	41520	205.1	118389	420.3	159910	719.6
Mansehra	12900	63.7	229405	814.4	242306	1090.4
D.I. Khan	23311	115.2	134742	478.3	158053	711.2
Karachi	1962891	9696.7	108726	386.0	2071616	9322.3
Hyderabad	354642	1751.9	323998	1150.2	678640	3053.9
Sukkur	103109	509.4	90707	322.0	193816	872.2
Larkana	237147	1171.5	222827	791.0	459954	2069.8
Thatta	162729	803.9	144647	513.5	307376	1383.2
Quetta	93628	462.5	32274	114.6	125901	566.6
Sibbi	11633	57.5	24658	87.5	36291	163.3
Gawadar	25643	126.7	21852	77.6	47495	213.7
Chagai	7434	36.7	34515	122.5	41949	188.8
Khuzdar	30837	152.3	78030	277.0	108867	489.9
Pakistan	8912438	44027.4	18496485	65662.5	27408924	123340.2

[2] The population of the cities were projected by taking growth rate 1.92 from Pakistan Economic Survey (2015) and population of 1998 was the starting periods from Pakistan Bureau of Statistics (2016), then we converted the projected population to number of households on the basis of average household size of city from Pakistan Bureau of Statistics (2016)and divided them as urban and rural households.

It is clear from the table that the urban households have high EF as compared to the rural EF. The urban households have advanced technology, modern infrastructure and more resources which impact the urban EF. The rural households are mostly dependent on agriculture and they lack modern technology and infrastructure leading low ecological footprint. The cities having high population have high ecological footprint as we can see Karachi, Lahore, Faisalabad, Hyderabad and Larkana have high population and therefore have high EF. In Pakistan, majority of the population in rural areas is dependent on agriculture and their pressure on resources consumption is low followed by low use of vehicles and less wastages leads to have low ecological footprint.

4.5 Regression analysis of the Determinants of the Ecological footprint: -

The multiple regression model was used to analyze 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.

4.5.1 Regression results of the Determinants Household ecological footprint of Islamabad:

The regression results of the determinants of the household ecological footprint given in table 4.3 shows that monthly income has positive and 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).

Table 4.3 [3]Regression results of the factors influencing Household Ecological Footprint

Dependent Variable= Household Ecological Footprint HEF

Variable	Unstandardized Coefficients		T	Sig.
	B	Std. Error		
(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 (HFD_1)	-.086	.030	-2.861	.004
Energy Efficient Appliances ($EUD_{2)}$	-.027	.034	-.805	.421
Gaseous Appliances ($EUD_{3)}$	.210	.031	6.821	.000
Farm Production (FUD_4)	-.017	.033	-.531	.595
Commercially packed Products (FUD_5)	.029	.034	.853	.394
Public Transport (MTD_6)	.086	.030	2.884	.004
Own Car (MTD_7)	.157	.017	9.245	.000
Job Type (OCD_8)	.050	.028	1.787	.074
Business (OCD_9)	.082	.032	2.578	.010
Gas Fuel for heating (FHD_{10})	-.113	.040	-2.787	.005
Electricity for heating (FHD_{11})	.038	.026	1.460	.145
Volume of waste (VW)	.035	.019	1.889	.059
Diagnostics	R-square 0.77		Adj. R-Square 0.76	

[3] 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 c.

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 multistoried building and sharing of house results in reduction and optimization 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 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.

4.5.2 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 4.4. 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. 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.

Table 4.4 Regression results of the factors influencing EF of Urban Households.

Variable	Unstandardized Coefficients		T	Sig.
	B	Std. Error		
(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 (HFD_1)	-.100	.037	-2.694	.007
Energy Efficient Appliances ($EUD_{2)}$	-.044	.041	-1.075	.283
Gaseous Appliances ($EUD_{3)}$	.204	.037	5.533	.000
Farm Production (FUD_4)	-.033	.041	-.799	.425
Commercially packed Products (FUD_5)	.013	.044	.293	.770
Public Transport (MTD_6)	.064	.034	1.860	.064
Own Car (MTD_7)	.185	.021	8.757	.000
Job Type (OCD_8)	.062	.034	1.820	.070
Business (OCD_9)	.055	.038	1.427	.154
Gas Fuel for heating (FHD_{10})	-.142	.052	-2.717	.007
Electricity for heating (FHD_{11})	.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

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; as the floors of house increases the EF will be low. Energy efficient appliances save the energy usage which lowers the EF. 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.

4.5.3 Regression analysis for Rural Households of Islamabad: -

The third regression model was used to analyze the impact of various influencing factors of the EF of rural households of Islamabad. These regression results are given in Table 4.5. 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.

Table 4.5 Regression results of the factors influencing EF of Rural Households.

Variable	Unstandardized Coefficients		T	Sig.
	B	Std. Error		
(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 (HFD_1)	-.031	.049	-.634	.527
Energy Efficient Appliances ($EUD_{2)}$	-.043	.036	-1.183	.239
Gaseous Appliances ($EUD_{3)}$	.091	.168	.544	.587
Farm Production (FUD_4)	-.096	.050	-1.895	.060
Commercially packed Products (FUD_5)	.025	.073	.346	.730
Public Transport (MTD_6)	.084	.040	2.105	.037
Own Car (MTD_7)	.198	.052	3.805	.000
Job Type (OCD_8)	.075	.034	2.198	.029
Business (OCD_9)	.074	.152	.489	.625
Gas Fuel for heating (FHD_{10})	-.245	.049	-4.988	.000
Electricity for heating (FHD_{11})	.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)

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 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.

CHAPTER 5

CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Introduction: -

This chapter provides details about major findings, conclusions and policy recommendations. These are discussed in subsequent sections.

5.2 Major Findings of the study: -

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 & 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.

5.3 Conclusion: -

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.

5.4 Policy Implication: -

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 & 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.

5.5 Limitations of study and Further Research: -

1. There were few limitations of this research. Because of shortage of time and resources the survey was conducted for single 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.

REFERENCES

Abd'razack, N., Ludin, A., & Umaru, E. (2013). Ecological Footprint, Lifestyle and Consumption Pattern in Nigeria. *American-Eurasian Journal of Agriculture and Environmental Science, 13*(4), 425-432.

Ali, S. (2015, 15 May 2015). Islamabad declared world's second most beautiful capital. *Daily Pakistan Global*. Retrieved from http://en.dailypakistan.com.pk/viral/islamabad-declared-worlds-second-most-beautiful-capital/

Atlas, F. (2010). Oakland: Global Footprint Network. *Global Footprint Network (2010). National Footprint Accounts Data Set. Oakland, CA. Retrieved Febru*.

Barrett, J., Birch, R., Cherrett, N., & Simmons, C. (2004). An analysis of the policy and educational applications of the ecological footprint. *Stockholm Environment Institute, York and WWF Cymru, Cardiff*.

Barrett, J., & Simmons, C. (2003). An ecological footprint of the UK: Providing a tool to measure the sustainability of local authorities. *York: Stockholm Environment Institute, University of York*.

Barrett, J., Vallack, H., Jones, A., & Haq, G. (2002). A material flow analysis and ecological footprint of York. *Stockholm Environment Institute, Stockholm*.

Bastianoni, S., Galli, A., Niccolucci, V., & Pulselli, R. (2006). The ecological footprint of building construction. *The Sustainable City IV: Urban Regeneration and Sustainability*, 345-356.

Bergh, J. C., & Grazi, F. (2014). Ecological footprint policy? Land use as an environmental indicator. *Journal of Industrial Ecology, 18*(1), 10-19.

Brundtland, G., Khalid, M., Agnelli, S., Al-Athel, S., Chidzero, B., Fadika, L., . . . de Botero, M. M. (1987). Our Common Future (\'Brundtland report\').

Calcott, A., & Bull, J. (2007). Ecological footprint of British city residents. *Panda House, Wayside Park*.

Capital Development Authority. (2015). About Islamabad. Retrieved from http://www.cda.gov.pk/about_islamabad/history/#

Chambers, N., Child, R., Jenkin, N., Lewis, K., Vergoulas, G., & Whiteley, M. (2005). Ecological footprint analysis and sustainability assessment. *Stepping forward: A resource flow and ecological footprint analysis of the south west of England Oxford, UK: Best Foot Forward*.

Chambers, N., Simmons, C., & Wackernagel, M. (2014). *Sharing nature's interest: ecological footprints as an indicator of sustainability*: Routledge.

Collins, A., & Flynn, A. (2005). A new perspective on the environmental impacts of planning: A case study of Cardiff's International Sports Village. *Journal of Environmental Policy and Planning, 7*(4), 277-302.

Collins, A., & Flynn, A. (2007). Engaging with the ecological footprint as a decision-making tool: process and responses. *Local Environment, 12*(3), 295-312.

Costanza, R. (2000). The dynamics of the ecological footprint concept. *Ecological economics, 32*(3), 341-345.

Durrani, F. (2015, 30 July 2015). Islamabad having highest rise in urban population. *The News*.

Ewing, B., Reed, A., Galli, A., Kitzes, J., & Wackernagel, M. (2010). Calculation methodology for the national footprint accounts: Oakland: Global Footprint Network.

Fang, K., Heijungs, R., & de Snoo, G. R. (2014). Theoretical exploration for the combination of the ecological, energy, carbon, and water footprints: Overview of a footprint family. *Ecological Indicators, 36*, 508-518.

Folke, C., & Kautsky, N. (2000). The ecological footprint: Communicating human dependence on nature's work. *Ecological economics, 32*, 351-355.

GFN, & Sydney, U. o. (2005). The Ecological Footprint of Victoria Assessing Victoria's Demand on Nature.

Giljum, S., Hammer, M., Stocker, A., Lackner, M., Best, A., Blobel, D., . . . Simmons, C. (2007). Scientific assessment and evaluation of the indicator "Ecological Footprint". *Dessau-Roßlau, Germany: German Federal Environment Agency*.

Global Footprint Network. (2016). Ecological Footprint and biocapacity in Pakistan. Retrieved from http://www.footprintnetwork.org/en/index.php/GFN/page/trends/pakistan/

Grigoryeva, V. (2010). *Research of Parameters of a Personal Ecological Footprint as an Effective Tool of Education for Sustainable Development.* Paper presented at the The State of the Art in Ecological Footprint Theory and Applications Footprint Forum 2010 Academic Conference Short Communications. Editor Simone Bastianoni Colle Val d'Elsa, 9th-10th June, Italy.

Hamilton, C. (1999). The genuine progress indicator methodological developments and results from Australia. *Ecological economics, 30*(1), 13-28.

Hammond, G. P. (2006). *'People, planet and prosperity': The determinants of humanity's environmental footprint.* Paper presented at the Natural Resources Forum.

Holden, E. (2004). Ecological footprints and sustainable urban form. *Journal of Housing and the Built Environment, 19*(1), 91-109.

Holmberg, J., Lundqvist, U., Robèrt, K.-H., & Wackernagel, M. (1999). The ecological footprint from a systems perspective of sustainability. *International Journal of Sustainable Development & World Ecology, 6*(1), 17-33.

Ikram Junaidi. (2015, 06 July 2015). Islamabad 'the second most beautiful capital', boasts CDA. *DAWN*. Retrieved from http://www.dawn.com/news/1192658

Keleş, Ö. (2010). *Pre-Service Science Teachers' Views of Ecological Footprint.* Paper presented at the The State of the Art in Ecological Footprint Theory and Applications Footprint Forum 2010 Academic Conference Short Communications. Editor Simone Bastianoni Colle Val d'Elsa, 9th-10th June, Italy.

Kitzes, J., Peller, A., Goldfinger, S., & Wackernagel, M. (2007). Current methods for calculating national ecological footprint accounts. *Science for environment & sustainable society, 4*(1), 1-9.

Kitzes, J., & Wackernagel, M. (2009). Answers to common questions in ecological footprint accounting. *Ecological Indicators, 9*(4), 812-817.

Lenzen, M., & Murray, S. A. (2003). The ecological footprint–issues and trends. *ISA research paper, 1*, 1-3.

Levett, R. (1998). Footprinting: A great step forward, but tread carefully—a response to Mathis Wackernagel. *Local Environment, 3*(1), 67-74.

Malthis Wackernagel, L. O., Alejandro Callejas Linares, Ina Susana López Falfán, Jesus Méndez García, Ana Isabel Suárez Guerrero and Ma. Guadalupe Suárez Guerrero,. (1997). Ecological Footprints of Nations.

Marta, H., HernandoCarrasco Eugenio, F Enrique, Roca. (2010). *Methodological advances in Ecological Footprinting.* Paper presented at the FOOTPRINT FORUM 2010Academic Conference.

McLellan, R., Iyengar, L., Jeffries, B., & Oerlemans, N. (2014). Living planet report 2014: species and spaces, people and places. *WWF International, Gland*.

McManus, P., & Haughton, G. (2006). Planning with ecological footprints: a sympathetic critique of theory and practice. *Environment and urbanization, 18*(1), 113-127.

Moffatt, I. (2000). Ecological footprints and sustainable development. *Ecological economics, 32*(3), 359-362.

Moore, S., Nye, M., & Rydin, Y. (2007). Using ecological footprints as a policy driver: The case of sustainable construction planning policy in London. *Local Environment, 12*(1), 1-15.

Oloruntegbe, K., Oluwatelure, T. A., & Agbayewa, O. (2013). Eco-cultural Factors and Ecological Footprint as Variables and Measure of Environmental Consciousness and Accounting in Nigeria. *Journal of Education and Practice, 4*(16), 91-94.

Pakistan Bureau of Statistics. (2016). *Islamabad District at Glance*. Retrieved from http://www.pbs.gov.pk/sites/default/files//tables/District%20at%20glance%20Islamabad.pdf.

Pakistan Economic Survey. (2015). *Pakistan Economic Survey 2014-15*. Islamabad Retrieved from http://www.finance.gov.pk/survey/chapters_15/16_Environment.pdf.

Rees, W., & Wackernagel, M. (1996). Urban ecological footprints: why cities cannot be sustainable—and why they are a key to sustainability. *Environmental impact assessment review, 16*(4), 223-248.

Rees, W., & Wackernagel, M. (2008). Urban ecological footprints: why cities cannot be sustainable—and why they are a key to sustainability *Urban Ecology* (pp. 537-555): Springer.

Rees, W. E. (1992). Ecological footprints and appropriated carrying capacity: what urban economics leaves out. *Environment and urbanization, 4*(2), 121-130.

Roy, R., & Caird, S. (2001a). Environmental actions to reduce household ecological footprints. *International Journal of Environmental Education and Information, 4*(2), 315-332.

Roy, R., & Caird, S. (2001b). Household ecological footprints–moving towards sustainability? *Town and Country Planning, 70*(10), 277-279.

Sawas, M. A., Anwar, N. H., Iqtidar, H., & Viqar, M. S. (2014). Urbanization, Gender and Violence in Rawalpindi and Islamabad: A Scoping Study.

Schaefer, F., Luksch, U., Steinbach, N., Cabeca, J., & Hanauer, J. (2006). Ecological footprint and biocapacity. *The world's ability to regenerate resources and absorb waste in a limited time period*.

Smeets, E., & de Kruijf, H. (1999). The Ecological Footprint of Benin, Bhutan, Costa Rica and the Netherlands. *RIVM Rapport 807005004*.

Strbac, M. (2012). *Ecological Footprint And Biocapacity.* Paper presented at the Third International Scientific Symposium" Agrosym 2012", Jahorina, Bosnia and Herzegovina, 15-17 November, 2012. Book of Proceedings.

Sutcliffe, M., Hooper, P., & Howell, R. (2008). Can eco-footprinting analysis be used successfully to encourage more sustainable behaviour at the household level? *Sustainable Development, 16*(1), 1-16.

Tinsley, S., & George, H. (2006). Ecological footprint of the Findhorn Foundation and community. *Sustainable Development Research Centre, Moray, UK*.

UNDP. (2013). *World population prospects: the 2012 revision, key findings and advance tables*. Retrieved from

Venetoulis, J., & Talberth, J. (2008). Refining the ecological footprint. *Environment, Development and Sustainability, 10*(4), 441-469.

Victoria, E. (2008). Food and our ecological footprint. In E. V. I. Center (Ed.), *Xyris Software (Australia) Pty Ltd*. Australia: FoodChoices® Curriculum Resource.

Victoria, E. I. C. (2008). ECOLOGICAL FOOTPRINT TIPS (FOOD). *1219.* Retrieved from http://www.epa.vic.gov.au/~/media/Publications/1219.pdf

Wackernagel, M. (1998). The ecological footprint of Santiago de Chile. *Local Environment, 3*(1), 7-25.

Wackernagel, M. (2001). Advancing sustainable resource management: using ecological footprint analysis for problem formulation, policy development, and communication.

Wackernagel, M., Monfreda, C., & Deumling, D. (2002). Ecological footprint of nations: November 2002 update. *Redefining Progress. Sustainability Issue Brief. November*.

Wackernagel, M., Onisto, L., Linares, A., & Ina Susana, L. (1997). ópez Falfán, Jesus Méndez Garcıa, Ana Isabel Suárez Guerrero, et al. *Ecological footprint of nations. Toronto: International Council for Local Environmental Initiatives*, 10-21.

Wackernagel, M., & Rees, W. (1998). *Our ecological footprint: reducing human impact on the earth*: New Society Publishers.

Walsh, C., McLoone, A., O'Regan, B., Moles, R., & Curry, R. (2006). The application of the ecological footprint in two Irish urban areas: Limerick and Belfast. *Irish Geography, 39*(1), 1-21.

Wiedmann, T., Wood, R., Barrett, J., Lenzen, M., & Clay, R. (2008). *The ecological footprint of consumption in Victoria*: EPA Victoria.

Wilson, J., & Anielski, M. (2005). *Ecological footprints of Canadian municipalities and regions*: Canadin Federation of Canadian Municipalities.

Wilson, J., & Anielski, M. (2011). City of Saskatoon Ecological Footprint Analysis. *The City of Saskatoon, Community Services Department, Planning and Development Branch,Anielski Management Inc.*

Wilson, J., & Grant, J. (2009). Calculating ecological footprints at the municipal level: what is a reasonable approach for Canada? *Local Environment, 14*(10), 963-979.

Zhiying, G., & Cuiyan, L. (2011). Empirical analysis on ecological footprint of household consumption in China. *Energy Procedia, 5*, 2387-2391.

Zuzana Hudeková, A. L. K., Arch. Patrik Martin, Dr. Eva Pauditšová, PhD, Tamara Reháčková, PhD. (2007). Ecologicalfootprint, climate change and cities. *„URBECO – Sustainable Urban Development and Mitigating Adverse Impacts of Climate Change on Quality of Life and the Environment in Cities“*.

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 miles

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
    - Fridge or freezer
    - Washing machine
    - Dish washer
    - Mobile phone
    - Camera
    - Mp3 player
    - 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 2001 to present
    - Toilet age 1990 to 2001
    - 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 Government recommends 30 minutes at least 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:

2. Size of Family:

3. Education:

4. Type of your job:

5. Do you have your own business?

Yes No

6. Is your house being single story?

Yes No

7. In your house the appliances are energy efficient?

Yes No

8. Do you have any gaseous appliances?

Yes No

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

Yes No

10. Do you purchase commercially packed products?

Yes No

11. Do you use public bus for transportation?

Yes No

12. Do you use own car for transportation?

Yes No

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

Yes No

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

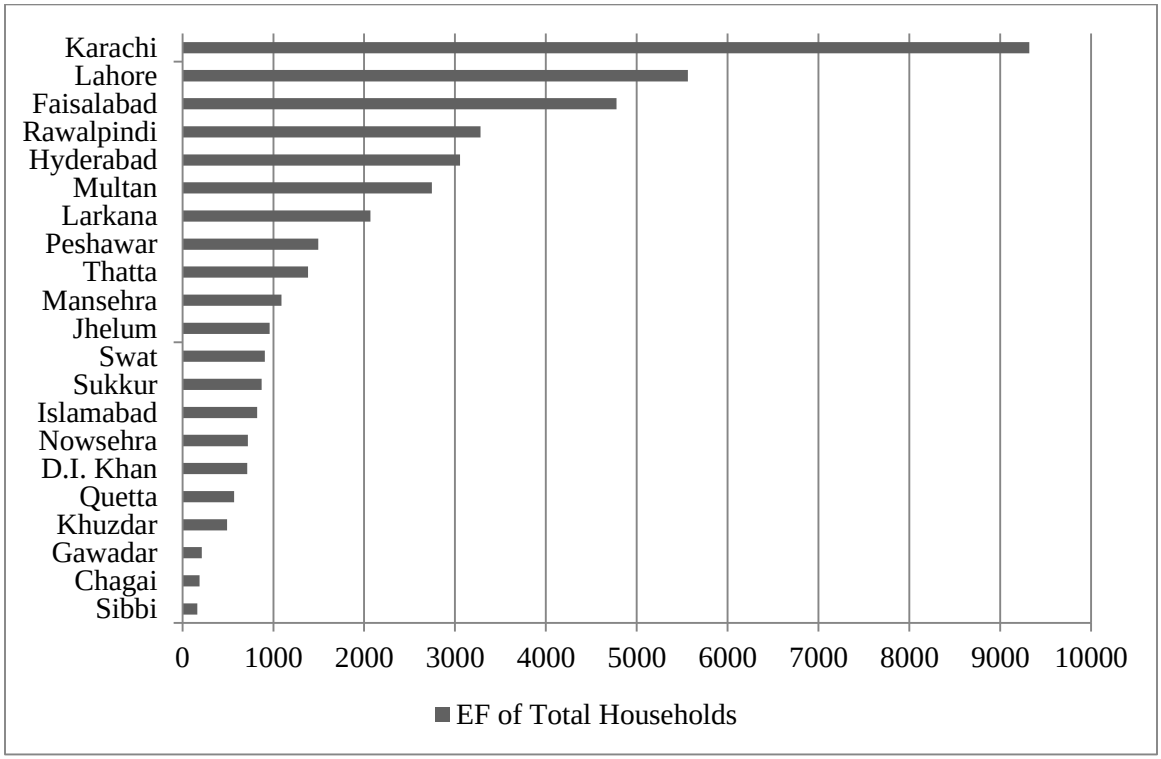
Yes No

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

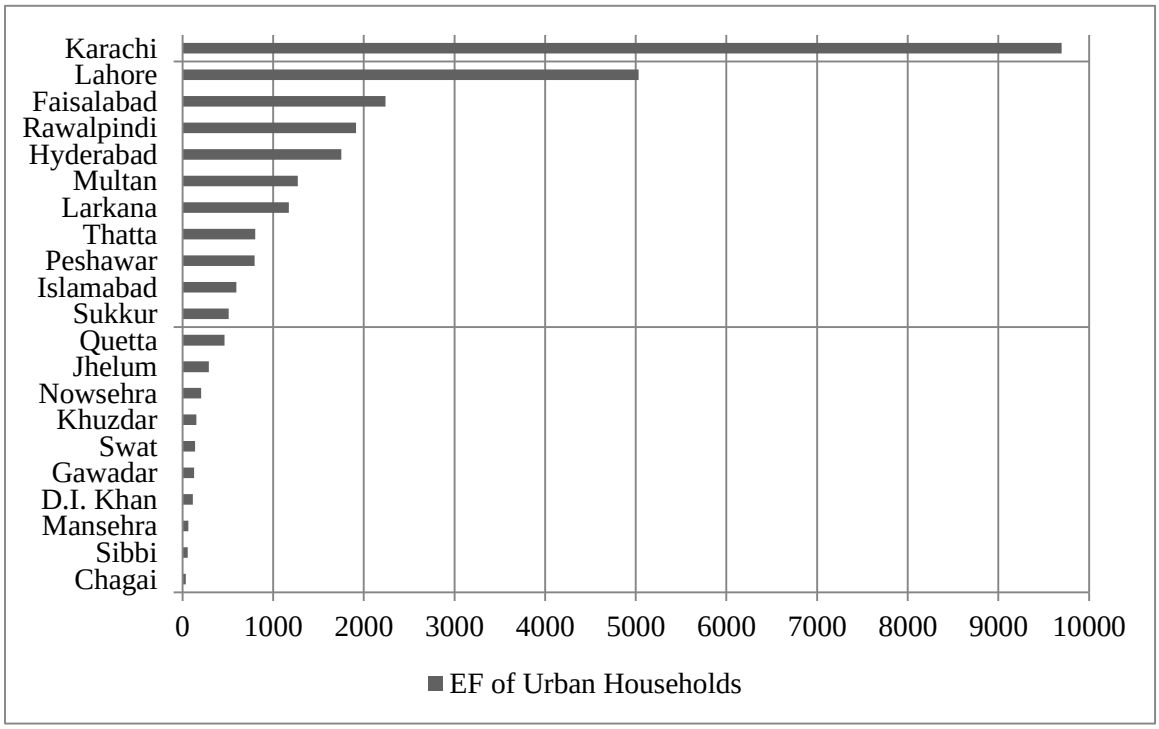
1 bag 2 bag 3 bag 4 or more

Appendix B:

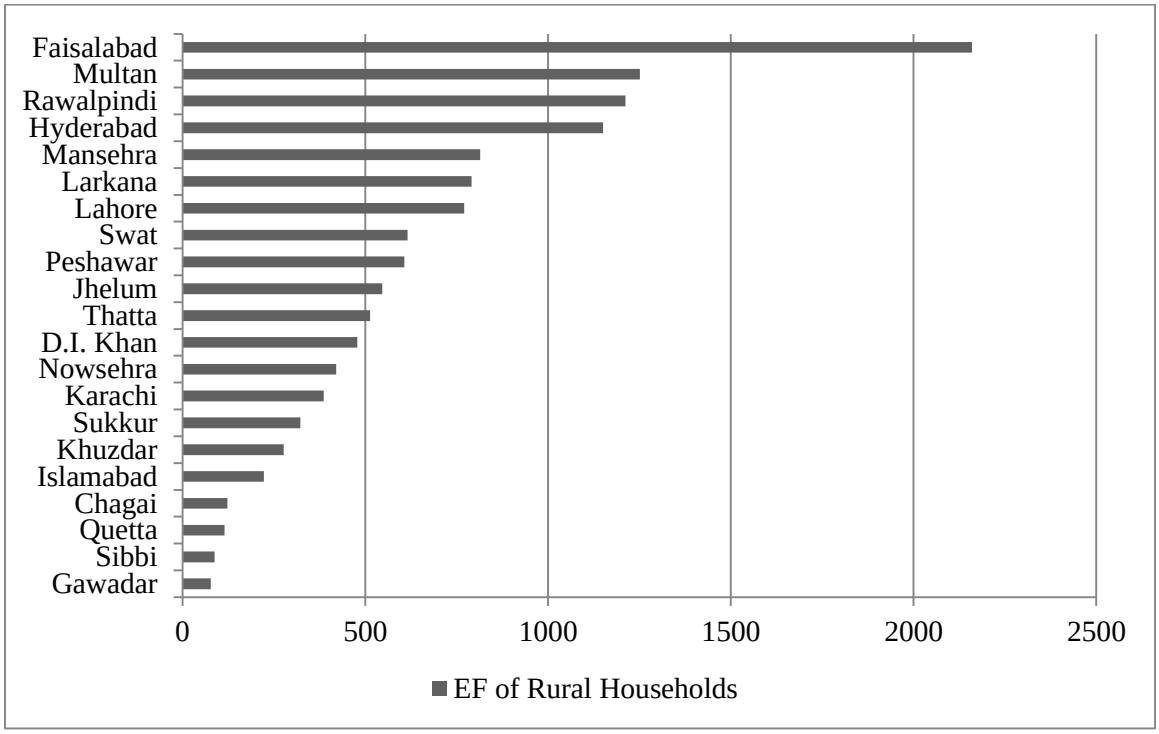
B-1. Ecological Footprint of Households of cities of Pakistan:



B-2. Ecological Footprint of Urban Households of cities:



B-3. Ecological Footprint of Rural Households of cities:



Appendix C:
Correlation Matrix

	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

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).