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JANUARY 2018

DECLARATION

I, Omar Faruque Prince, declare that this thesis is the result of my own work and it has not been submitted or accepted for any degree to others university or institution.

Signature

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Omar Faruque Prince

APPROVAL

This is to certify that the present project entitled "Assessment of Greenhouse Gas Emissions(particularly CO_2 Emission)from Households Fuel wood Consumption Adjacent to the Sundarbans Reserved Forest and Vawal National Park" has been carried out by Omar Faruque Prince (Student Id: 130524) under my direct supervision at the Forestry and Wood Technology Discipline of Khulna University, Khulna-9208, Bangladesh.

I recommend that the content of the project report can be accepted in the partial fulfillment of the requirement for the Degree of B.Sc. (Honors) in Forestry.

Supervisor

13/5/18

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Dr. Md. Nazmus Sadath

Professor

DEDICATED

TO MY

BELOVED PARENTS AND MY

SISTER

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First, I want to admire to Almighty ALLAH, the supreme creator and ruler of the university from the deepest corner of my heart for His blessings that keeps me alive and enable me to accomplish this project work successfully. I want to express my sincere gratitude to my beloved parents who brought me to this earth and helped me in every step of my life.

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Omar Faruque Prince

Abstract

Now a day's greenhouse gas emission is an important topic of concern. Fuel wood consumption is one of the source of greenhouse gas emission in Bangladesh. This research has been conducted to determine the amount of CO_2 gas emission from fuel wood consumption near to natural forest of Bangladesh. In this study, three regions of world largest single tract mangrove forest Sundarbans and one region of Vawal National Park of Gazipur have been chosen for data collection. The result of this study shows that the amount of greenhouse gas emission is different in case of parameters likes source of fuel wood consumption, type of forest, income range etc. Highest CO_2 emission (265.14432ton/year) from Mangrove forest Sundarbans and lowest CO_2 emission (58.59126 ton/year) from Sal forest in Vawal National Park. This study found that income level (100001-200000) of respondent showed highest CO_2 emission (247.78368 ton/year) but lowest CO_2emission (46.16352 ton/year) from (300000-above) income level. Highest percentage of CO_2 emission was found from fuel wood collection from forest than fuel wood collect from non-forest.

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Chapter-1

Introduction

1. Introduction

1.1 Background of the study

Households are accountable for nearly three quarters of global carbon emissions and thus understanding the drivers of these emissions is important if we are to make progress towards a low carbon future. This is important for using an appropriate consumption perspective accounting framework for assessing the carbon footprint of households. This contrasts from the more commonly used production perspective, as, for many Western countries in particular, once responsibility for emissions embedded in imported goods and services are taken into account, consumption emissions are often higher than production emissions.

Adam Smith stated that "consumption is the sole end and purpose of all production" (Smith 1904), thus putting consumption firmly in the field of industrial ecology. In present study special focus on the carbon emissions caused by household consumption, as these have been estimated to be accountable for around 72 % of carbon emissions on a global basis (Harwich and Peters 2009; Wilson et al. 2013). Thus the study of households and how the environmental impacts for which they are responsible may be reduced is key to achieving a low carbon future.

Accounting perspective required to scrutinize the carbon emissions for which household consumption is responsible. The evidence concerning the determinants of household carbon emissions. We introduce the 'rebound effect' – a phenomenon that confounds attempts to reduce carbon footprints, making reducing emissions more of an uphill task than often acknowledged.

Household consumption is a wide ranging topic and inevitably there are many limitations to this chapter. One of these is that we focus here on consumption by Western households and the driving forces behind household consumption or the ways that household consumption may be reduced. And a third limitation is our focus on 'carbon' emissions. However carbon is defined , use of carbon emissions as a single indicator can lead to policies that, while beneficial in terms of reducing global warming, may lead to unexpected and unintended detrimental consequences in terms of other environmental impacts. For example, Benders et al. (2012) analyzed five environmental impact categories: global warming potential, acidification, eutrophication, summer smog and land use. Combined analysis of the five impact categories found that food has the largest environmental impact, whereas analysis of greenhouse gas emissions alone indicated that housing has the largest impact. Climate change caused by anthropogenic carbon emissions is currently accepted as the most urgent environmental threat IPCC (2014) and is thus considered a useful indicator for GHGs emission measurement.

Linkages between household energy technology, indoor air pollution, and greenhouse gas (GHG) emissions have become increasingly important in understanding the local and global environmental and health effects of domestic energy use. Policy implications and options for environment and public health are discussed. The implications of wood fuel use for the global environment can be evaluated by estimating the associated greenhouse gas emissions. As CO_2 is the main greenhouse gas, it only (carbon-dioxide) will be considered here, leaving aside gases like methane and other carbon-hydrogen's. Any emissions caused by wood fuels can be compared with emissions from alternative fuels.

Obviously, if wood fuels were not utilized, some alternative energy source would be required and used. For most applications and in most countries, the hypothetical alternative would be a fossil fuel, i.e. coal, gas, or oil products. For few applications and in few countries, hydro and wind power could be the hypothetical alternative, whereas within the next 15 years or so the option of other renewables like solar photo-voltaic is likely to be negligible in terms of energy quantity. The effects of fossil fuel use on the global atmosphere have been well documented. Typical data for the emission of CO_2 per fuel and per unit of energy are available from the LEAP Environmental Database (SEI, 1995). Furthermore, the other renewable energy sources are considered to be carbon neutral, like wood.

The implications of wood fuel use in Asia for the global environment can then be evaluated by estimating how much CO_2 emission from hypothetical alternatives is avoided by wood fuel use. The most likely (or least unlikely) mix of alternative energy sources varies per country. For the purpose of the present study, LPG can be considered the alternative. Switching between wood and other biomass fuels like agro-residues is ignored, because carbon neutrality applies to the other biomass fuels for the same reasons as for wood.

The economic benefit of current wood fuel use in Asia for the global environment can be appreciated by estimating the cost which would otherwise be required for avoiding or recapturing the emitted CO_2 from the atmosphere. The above estimates allow us to evaluate the benefits of a wood energy development programme like RWEDP for the global environment. RWEDP incorporates, amongst others, various activities in wood energy conservation, e.g. the promotion of improved stoves. This is being achieved in cooperation with government institutions, NGO's and donor agencies. When conservation is achieved, the ever increasing energy demand in the region can partly be met by available wood fuels, rather than fully resorting to additional fossil fuel with their associated CO_2 emissions. Many general policies regarding wood energy and environment are still based on the exceptional cases, i.e. the relatively few areas where wood fuel use is not sustainable. This even leads to donor policies for promotion of fuel transition, i.e. away from wood fuel towards fossil fuels or towards expensive forms of renewable energy. As far as carbon sequestration through reforestation, afforestation and/or forest rehabilitation is an objective of present global environmental policies, it is obvious that such forest-related activities will be economically more feasible when the new or upgraded forest resource base will be available for sustainable use of wood and non-wood products. Sustainable wood fuel use qualifies as one of the prime applications in this context.

This study will focus on the assessment of greenhouse gases from household at four different sites of Bangladesh including three adjacent areas of mangroves and Vabanipur at Gazipur district.

Considering above mention issue/research problem the study focus on the following research objective.

1.2 Objective of the Study

- To assess the CO_2 gas emissions from households fuel wood consumption Adjacent to the SRF and Vawal National park.
- To assess fuel wood consumption from forest and non-forest.

Chapter-2

Literature Review

2. Literature Review

2.1 What is greenhouse Gas?

A greenhouse gas is a gas in an atmosphere that absorbs and emits radiant energy within the thermal infrared range. This process is the fundamental cause of greenhouse effect.

2.2 What is Greenhouse Effect?

The "Greenhouse Effect" is a term that refers to a physical property of the Earth's atmosphere. If the Earth had no atmosphere, its average surface temperature would be very low of about -18°C r ather than the comfortable 15°C found today. The difference in temperature is due to a suite of ga ses called greenhouse gases which affect the overall energy balance of the Earth's system by abso rbing infra-red radiation. In its existing state, the Earthatmosphere system balances absorption of solar radiation by emission of infrared radiation to space. Due to greenhouse gases, the atmosphe re absorbs more infrared energy than it re-radiates to space, resulting in a net warming of the Eart h-atmosphere system and of surface temperature. This is the "Natural Greenhouse Effect". With more greenhouse gases released to the atmosphere due to human activity, more infrared radiation will be trapped in the Earth's surface which contributes to the "Enhanced Greenhouse Effect".

2.3 Types of Greenhouse gases

Greenhouse gases comprise less than 1% of the atmosphere. Their levels are determined by a bal ance beween"sources" and "sinks". Sources and sinks are processes that generate and destroy gre enhouse gases respectively. Human affect greenhouse gas levels by introducing new sources or b y interfering with natural sinks.The major greenhouse gases in the atmosphere are carbon dioxide (CO_2), methane, (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs) and ozone (O_3). Atmo spheric water vapour (H_2O) also makes a large contribution to the natural greenhouse effect but i t is thought that its presence is not directly affected by human activity.

2.4 Contribution of CO2 emission for Greenhouse Gas

IN the past few years, many workers have noted that the combined effect on climate of increases in the concentrations of a large number of trace gases could rival or even exceed that of the increasing concentration of carbon dioxide[1–3]. These trace gases, principally methane, nitrous oxide and chlorofluorocarbons, are present at concentrations that are two to six orders of magnitude lower than that of carbon dioxide, but are important because, per molecule, they absorb infrared radiation much more strongly than carbon dioxide. Indeed a recent study[4] shows that trace gases are responsible for 43% of the increase in radiative forcing from 1980 to 1990 (Fig. 1). An index to compare the contribution of various 'greenhouse' gas emissions to global warming is needed to develop cost-effective strategies for limiting this warming. Estimates of relative contributions to additional greenhouse forcing during particular periods do not fully take into account differences in atmospheric residence times among the important greenhouse gases. Here we extend recent work on halocarbons[5,6] by proposing an index of global warming potential for methane, carbon monoxide, nitrous oxide and CFCs relative to that of carbon dioxide. We find, for example, that methane has, per mole, a global warming potential 3.7 times that of carbon dioxide. On this basis, carbon dioxide emissions account for 80% of the contribution to global warming of current greenhouse gas emissions, as compared with 57% of the increase in radiative forcing for the 1980s.

2.5 Global Warming Potential (GWP)

Different greenhouse gases exert different effects on the Earth's energy balance. In order to assist policymakers to measure the impact of various greenhouse gases on global warming, the concep t of Global Warming Potentials (GWPs) was introduced by the Intergovernmental Panel on Clim ate Change (IPCC) in its 1990 report. GWP reflects the relative strength of individual greenhous e gas with respect to its impact on global warming. It was defined as the cumulative radiative for cing* between the present and some future time caused by a unit mass of greenhouse gas emitted now, expressed relative to CO_2.

Global Warming Potentials take into account the differing atmospheric lifetimes and abilities of various gases to absorb radiation. Derivations of GWPs require knowledge of the fate of the emit ted gas (typically not well understood) and the radiative forcing due to the amount remaining in t he atmosphere (reasonably well understood). Hence, GWPs encompass certain uncertainty, typic ally 35% relative to CO_2 reference.

2.6 Potential Impact on human life

a) Economic Impact

Over half of the human population lives within 100 km of the sea. Most of this population lives i n urban areas that serve as seaports. A measurable rise in sea level will have a severe economic i mpact on low lying coastal areas and islands, for examples, increasing the beach erosion rates alo ng coastlines, rising sea level displacing fresh groundwater for a substantial distance inland.

b) Agricultural Impact

Experiments have shown that with higher concentrations of CO_2, plants can grow bigger and fast er. However, the effect of global warming may affect the atmospheric general circulation and thu s altering the global precipitation pattern as well as changing the soil moisture contents over vari ous continents. Since it is unclear how global warming will affect climate on a regional or local s cale, the probable effects on the biosphere remains uncertain.

c) Effects on Aquatic systems

The loss of coastal wetlands could certainly reduce fish populations, especially shellfish. Increas ed salinity in estuaries could reduce the abundance of freshwater species but could increase the p resence of marine species. However, the full impact on marine species is not known.

d) Effects on Hydrological Cycle

Global precipitation is likely to increase. However, it is not known how regional rainfall patterns will change. Some regions may have more rainfall, while others may have less. Furthermore, hig her temperatures would probably increase evaporation. These changes would probably create ne w stresses for many water management systems.

2.7 Carbon dioxide emission

Carbon emission is the release of carbon into the atmosphere. To talk about carbon emissions is simply to talk of greenhouse gas emissions; the main contributors to climate change. Since greenhouse gas emissions are often calculated as carbon dioxide equivalents, they are often referred to as "carbon emissions" when discussing global warming or the greenhouse effect. Since the industrial revolution the burning of fossil fuels has increased, which directly correlates to the increase of carbon dioxide levels in our atmosphere and thus the rapid increase of global warming.

2.8 Effects on carbon dioxide emission

Carbon emissions contribute to climate change, which can have serious consequences for humans and their environment. According to the U.S. Environmental Protection Agency, carbon emissions, in the form of carbon dioxide, make up more than 80 percent of the greenhouse gases emitted in the United States. The burning of fossil fuels releases carbon dioxide and other greenhouse gases. These carbon emissions raise global temperatures by trapping solar energy in the atmosphere. This alters water supplies and weather patterns, changes the growing season for food crops and threatens coastal communities with increasing sea levels

2.9 Fuel wood

Fuel wood refers to various forms of wood that are used as fuel for cooking, heating or to drive steam-powered engines or turbines for electricity generation.

Fuel wood remains the primary source of fuel for much of the world's population. The use of wood as a fuel source is older than recorded history, and is believed to be one of the primary innovations that allowed for development of civilization as we know it. Unfortunately, overconsumption of fuel wood has led to deforestation and habitat loss, and unless wood is burned in efficient furnaces, its combustion contributes to emissions. Fuel wood can include firewood, charcoal, polluted sawdust and wood chips

2.10 Traditional Fuel Consumption in Bangladesh

According to BBS (2010) about 77% of the population resides in rural areas and they need energy for their everyday life like cooking, crop processing, lighting, agricultural industries, social welfare and commercial purposes. The first National Energy Policy (NEP) of Bangladesh was formulated in 1996 by the Ministry of Power, Energy and Mineral resources to ensure proper exploration, production, distribution and rational use of energy resources to meet the growing energy demands of different zones, consuming sectors and consumers groups on a sustainable basis. NEP has some objectives and one objective is to ensure energy needs of different zones & socio-economic groups. Eventually it tried to serve all income groups but low income people of the study area had limited reflection of it. Biomass fuels are the predominant sources of energy supply in rural areas contributing over 90% to the primary total energy supply. Sometimes people of a single location are specified to a fixed fuel. They reported that there were some factors that decided their fuel choice such as income, fuel availability etc. This fuel was called in different local name such as chute which is made of cow dung. Sometimes people bind this dung with jute stick which is called Gobornari. Besides, some people use biogas by using cow dung, straw, and kitchen waste through a coordinated manner.

Bala (1998) stated that biomass fuels are mainly consisted of firewood, leaves and twigs, agricultural crop residues such as rice straw, rice husk, jute stick, sugarcane bagasse, and cow dung. Rural households use biomass fuels mainly for domestic cooking, rice parboiling and to some extent for food preparation for livestock. The consumption pattern of biomass fuels depend on regional availability as well as household size, education status, income, socio-economic categories and land ownership etc. According to Government statistics of 2002 supply of 331674 thousand Giga Joule from different type of traditional fuel was consumed in the country in 2002-2003. The highest amount of traditional fuel comes from rice husk, 25% following cow dung 20% A considerable amount also comes from leaves, twins and rice straw. However it is seen that rice husk constitute highest portion as it is an agro based country. For the last ten year use of traditional fuel remain almost same in the country.

2.11 Fuel Use in Urban and Rural Areas of Bangladesh

Akhter (2002) observed that a wide variety of fuels are used in households in Bangladesh for cooking and heating. Solid fuels refer to biomass fuels. The most common fuel used for cooking and heating is wood, followed by other solid biomass fuels, such as charcoal, dung, agricultural residues and sometimes even leaves and grass. These fuels are often collected from the local environ1ment in rural areas and are purchased through markets in urban areas. Urban and rural households use energy for multiple purposes from different sources. On the existing sources of energy supply, it has been found that households collect energy from various sources: animals, forest land or open land surrounding of their villages, local retailers, local agents, wholesalers, and electrification board. Some of them also buy energy in the open market.

Eusuf (2005) revealed that traditional energy consisting of fuel wood, agricultural residues and dung dominate the primary source of energy production and supply in Bangladesh. Generally, rural households get their children collect biomass such as dung, leaves etc., while the adults collect as firewood, kerosene etc. from market. Firewood collection is perceived as an increasingly difficult task, and many people are walking lengthy distances for wood. Usage of fuel wood or charcoal is mostly an urban phenomenon. Wood fuel is the dominant energy source for most fuel consuming cooking in urban area. Secondary fuels such as crop residues, rice husk, saw dust and dung are used very little. From the literature cited above, it revealed that consumption pattern of the primary fuel is directly dependent on respondent's income. It is also evident that use of fuel is affected by locally available material and it varies from region to region. The literature reviewed above were carried out in different years—corresponding to different social setup and in areas with different energy availability and varying levels of energy use. Despite these differences, certain common features emerge. These common features help highlight these similarities and differences. These literatures indicate considerable variation among the countries surveyed. The share allocated to energy was more than 5 percent for the lowest-income groups, indicating its direct importance in household budgets. In the majority of countries where information was available, the share of expenditure on energy was higher for urban households than rural households. A common finding in all countries that the share of expenditure on biomass fuel declined at higher income levels. The share of household energy at different income levels did not show a common tendency to increase or decrease, but it was varied from region to region. Therefore a study may be conducted to observe the energy use variation in different locality.

2.12 Factors Affecting Fuel wood Consumption

Among the considered variables, only family size hada significant correlation (this was also negative) with fuel wood consumption with the increase of family size, the per capital fuel wood consumption decreased. Other studies have indicated different factors are also responsible for fuel wood consumption. The relationship between poverty and fuel wood dependency has been documented in Brazil and other countries at local scales (Hoekstra van der Horst and Hookah, 2009; Mastica*te al*., 2013; Top *et al*., 2006). deMederios*et al*., (2012) found that socioeconomic characteristics of rural communities in the same region explained up to 31% of fuel wood consumption, with monthly income the most important. We also found that a socioeconomic characteristic (i.e., family size) was related to fuel wood consumption: with an increase of one family member, the per capita fuel wood consumption decreased about 0.09 kg. But the unique point is among the social characteristics only family size influences the fuel wood

Consumption So rich or poor, educated or non-educated the fuel wood consumption is same for every household except if the family size differs. This also points to the over dependency of fuel wood which is a threat to the existing forests.

2.13 Household Energy Consumption Pattern in Rural Areas of Bangladesh

In Bangladesh, the rural households mainly depend on biomass fuels, kerosene, electricity, candle and LPG (liquid petroleum gas) for their primary sources of energy supply (Asaduzzaman et al., 2010; Miah et al., 2010). However, the contribution of biomass fuels to total primary energy supply in Bangladesh is about 60% (LGED & FAO, 2006; MoPEMR, 2008). The country is one of the most densely populated countries in the world. Population density is about 990 persons per km2 and the population growth rate is 1.54% per annum (BBS, 2010). Due to the increasing population growth, per capita arable land area decreased from 0.07 ha in 1990 to 0.05 ha in 2009 (BBS, 2010). Nevertheless, per capita energy consumption increased from 5 GJ (giga joules) in 1977 to 6.2 GJ in 2009 (Kennes et al,. 1984; IEA, 2009). The combination of high population growth with decreasing arable land as well as growing energy demand put immense pressure on biomass resources. Likewise, low per capita income and slow economic growth are considered to be the major impediments in transforming biomass energy into more modern energy forms in the near future (Bari et al. 1998). Therefore, the country is expected to remain heavily dependent on biomass resources for energy supply in the near future. Energy use variation not only subsists in rural and urban regions, but also varied in lower and higher earner groups within a country and between national and international levels (Pachauri, 2004).

2.14 Trend of CO2 Emission

The concentration of greenhouse gases (GHGs) in the earth's atmosphere has been increased markedly due to human activities since 1750. While the concentration of all types of GHGs has increased in the atmosphere, the focus is always on the CO_2 emission, as it constitutes large share of GHG emission. In the Climate Change Synthesis Report 2007, the Intergovernmental Panel on Climate Change (IPCC) has mentioned that the energy sector contributed 25.9% towards global anthropogenic CO_2 emissions (IPCC, 2007). Bangladesh produces a very small share of global CO_2 emission. But, the country's emission scenario has marked a rapid increase of CO_2 emission over time. CO_2 emission and per capita CO_2 emission in Bangladesh have escalated with increasing trend. The total CO_2 emission was estimated by 57.07 motels in 2011 which was increased by 140.67% compared to the 1991 emission of 15.94 motel. This indicates an average yearly increase of CO_2 emission by 6.70% over the period of 1991-2011. The per capita emission has also increased by more than two times which was 0.15 metric ton in 1991 and 0.37 metric ton in 2011.

2.15 Initiatives for Reduction of CO_2 Emission

As the global temperature is increasing with the increase of CO_2 emission, most of the world's leaders have recognized the need to limit and ultimately reduce global CO_2 emissions, leading to the 15th United Nations Climate Change Conference (COP15) in Copenhagen, held from December 7-18, 2009.The increasing rate of CO_2 emissions calls for effective mitigation strategies to reduce the CO_2 emission and global warming. Though Bangladesh is a low emission producer, the country is one of the most affected due to climate change. Thus, the country is trying to implement several programs, initiatives and projects to reduce emission and tackling climate change impacts. Bangladesh has developed Climate Change Strategy and Action Plan pressure on biomass resources. Likewise, low per capita income and slow economic growth are considered to be the major impediments in transforming biomass energy into more modern energy forms in the near future (Bari et al. 1998). Therefore, the country is expected to remain heavily dependent on biomass resources for energy supply in the near future. Energy use variation not only subsists in rural and urban regions, but also varied in lower and higher earner groups within a country and between national and international levels (Pachauri, 2004).

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2.16 The Land Use, Land-Use Change, and Forestry (LULUCF)

The Land Use, Land-Use Change, and Forestry (LULUCF) sector is important for climate Change mitigation as it has the potential to reduce greenhouse gas (GHG) emissions and Sequester carbon. Land use and forestry are intricately linked to how and where people live And sustain themselves, and LULUCF measures can provide global environmental benefititsWhile addressing community benefit its. The Global Environmental Facility (GEF) helps developing and transition countries address LULUCF concerns by investing in projects to help conserve, Restore, enhance and manage the carbon stocks in forest and non-forest lands. The purpose of this brochure is to document the GEF's efforts in the LULUCF sector. The Brochure presents strategies for reducing GHG emissions and increasing carbon sequestration.1 the brochure also presents the means of calculating carbon benefit it's associated With LULUCF projects. Terrestrial vegetation and soils account for major pools of carbon. These carbon stocks inland-based ecosystems are mostly concentrated in forest ecosystems and wetlands, and are distributed irregularly between tropical and northern latitudes as shown in Figure 1. Tropical Forests play a particularly important role in sequestering (if Xing into organic matter) 1 Gig atone (Get) of carbon every year, or about 40 percent of the total for land-based absorption (Britton et al. 2007). On a global scale, terrestrial ecosystems trap about 2.6 Get of Carbon dioxide equivalent (CO2 eel) per year (World Bank 2012), and illustrates how important Terrestrial carbon sequestration can be.

2.17 REDD

The overall development goal of the Programme is "to reduce forest emissions and enhance carbon stocks in forests while contributing to national sustainable development. The UN-REDD Programme supports nationally led REDD+ processes and promotes the informed and meaningful involvement of all stakeholders, including indigenous peoples and other forest-dependent communities, in national and international REDD+ implementation.[1] The Programme has expanded steadily since its establishment and now has over 60 official Partner Countries spanning Africa, Asia-Pacific and Latin America-Caribbean.[3] In addition to the UN-REDD Programme, other initiatives assisting countries that are engaged in REDD+ include the World Bank's Forest Carbon Partnership Facility, Norway's International Climate and Forest Initiative, the Global Environment Facility, Australia's International Forest Carbon Initiative, the Collaborative Partnership on Forests, and the Green Climate Fund.

2.18 Emission from forest

Deforestation is the second largest anthropogenic source of carbon dioxide to the atmosphere, after fossil fuel combustion. Following a budget reanalysis, the contribution from deforestation is revised downwards, but tropical peat lands emerge as a notable carbon dioxide source

2.19 Forest Reference Emission Level (FREL)

To participate in REDD+, countries must develop a Forest Reference Emission Level and/or Forest Reference Level. These are benchmarks for assessing their performance in implementing

REDD+ activities. Countries that implement REDD+ and reduce carbon can report REDD+ results to the UNFCCC. These REDD+ results compare greenhouse gas (GHG) emissions during REDD+ implementation against the reference level. Countries also develop national GHG inventories and regularly report on emissions to the UNFCCC. FAO aims to support countries in developing these inventory systems that can generate consistent estimates for forest reference levels and REDD+ results reporting.

A national forest reference emission level and/or forest reference level or, as an interim measure, subnational forest reference emission levels and/or forest reference levels, is one of the elements to be developed by developing country Parties implementing REDD+ activities (according to paragraph 71 of decision 1/CP.16). The COP recognized the importance and necessity of adequate and predictable financial and technology support for developing such reference levels. Reference levels are expressed as tones of CO2 equivalent per year for a reference period against which the emissions and removals from a results period will be compared. Thus, reference levels serve as benchmarks for assessing each country's performance in implementing REDD+ activities. Reference levels need to maintain consistency with the country's greenhouse gas inventory estimates.

Reference levels should be transparent, taking into account historic data and be flexible so as to accommodate national circumstances and capabilities, while pursuing environmental integrity and avoiding perverse incentives. Developing country Parties implementing REDD+ can use a stepwise approach to construct reference levels, incorporating better data, improved methodologies and, where appropriate, additional pools. They should also update their reference level periodically, taking into account new knowledge, new trends and any modification of scope and methodologies. Developing countries aiming to implement REDD+ activities are invited to submit a reference level to the secretariat, on a voluntary basis and when deemed appropriate. The information contained in the submission should be transparent, complete, consistent with guidance agreed by the COP and accurate. The information provided should be guided by the most recent IPCC guidance and guidelines, as adopted or encouraged by the COP.

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Chapter-3

Methodology

3. Methodology

3.1 Research method:

The survey was conducted through a semi-structured questionnaire on assessment of fuel wood consumption including various types of question related to my study.

3.2 Selection of study area

In order to assessment of fuel wood consumption from households, the four locations were selected purposively .three of them were Sundarbans adjacent area and left was Vawal National Park. The Sundarbans adjacent area was Shyamnagar of Satkhira, Chadpai, Soronkholaand another was Vawal National park.

Range	Union	Respondent no
Chadpai	Chadpai	4
	Chila	28
Satkhira	Gabura	25
	Padmapukur	7
Gazipur	Vabanipur	6
	Bhawalgor	19
	Mirzapur	2
Sarankhola	Rayenda	19
	Southkhli	10

A total of 32 respondent interviews should be done in Chadpai and Chila Union under Chadpai range. Respondent opinion should prefer first for this study. InSatkhira range a total of 32 respondent interviews should be done randomly which including Gabura and Padmapukur Union in Satkhirarange. A total of 27 respondent interviews should be done in Gazipur district which including Vabanipur, Bhawalgor and Mirzapur Union. In case of Sorankholarange, total number of 29 interviews carried out randomly which cover Rayenda and Southkhli union.

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3.4 Map:

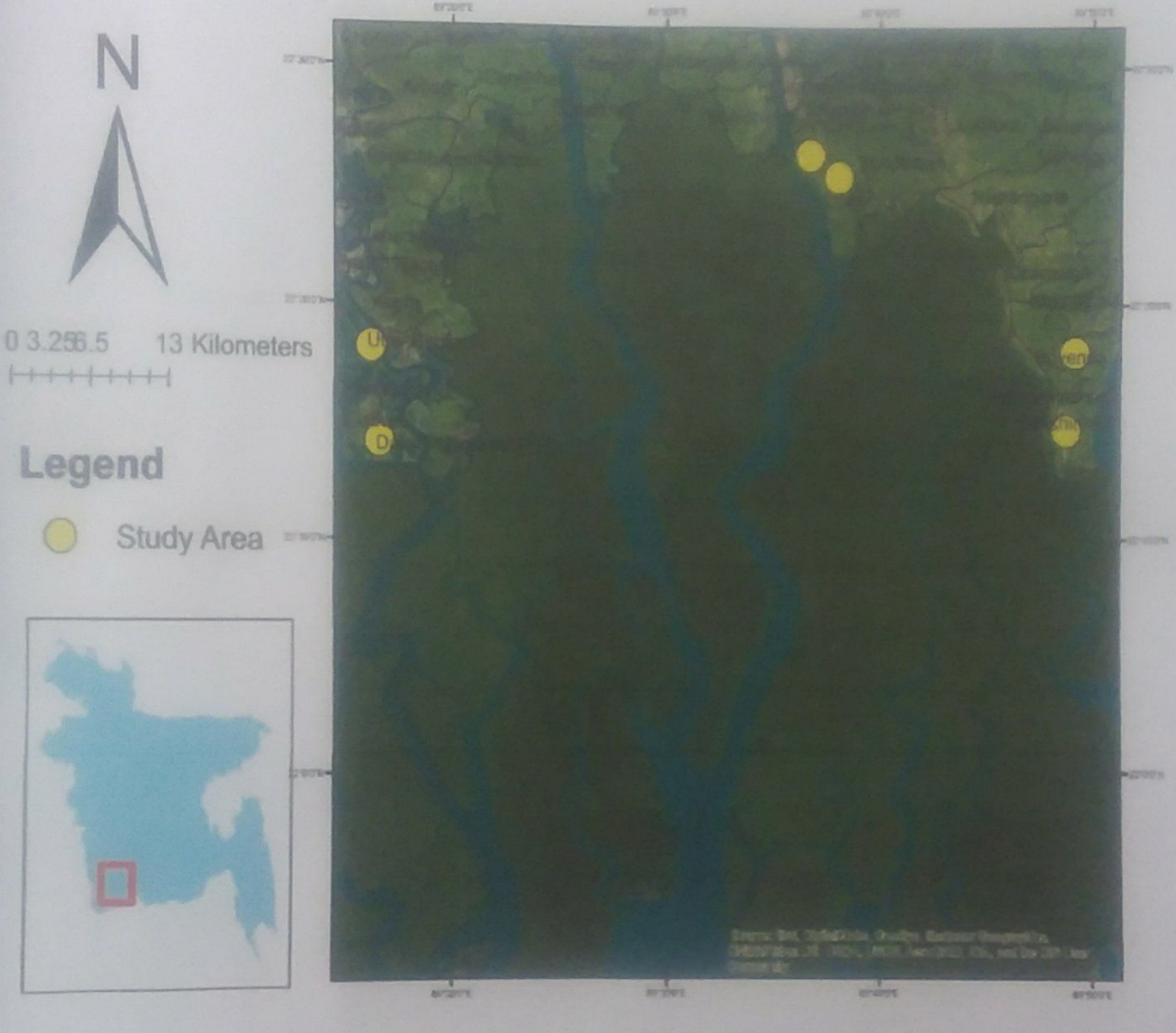


Fig2: Map showing the area from where field data were collected

Fig3: Map showing the area from where field data were collected.

3.3Sampling Designs

A sampling design is defined plan for obtaining a sample for a given population. It shows the sampling technique followed to select the samples.

At first four different sites were selected purposively. Then two unions were selected from each sites and a direct interview was conducted for assessing farmer's perception on fuel wood consumption.

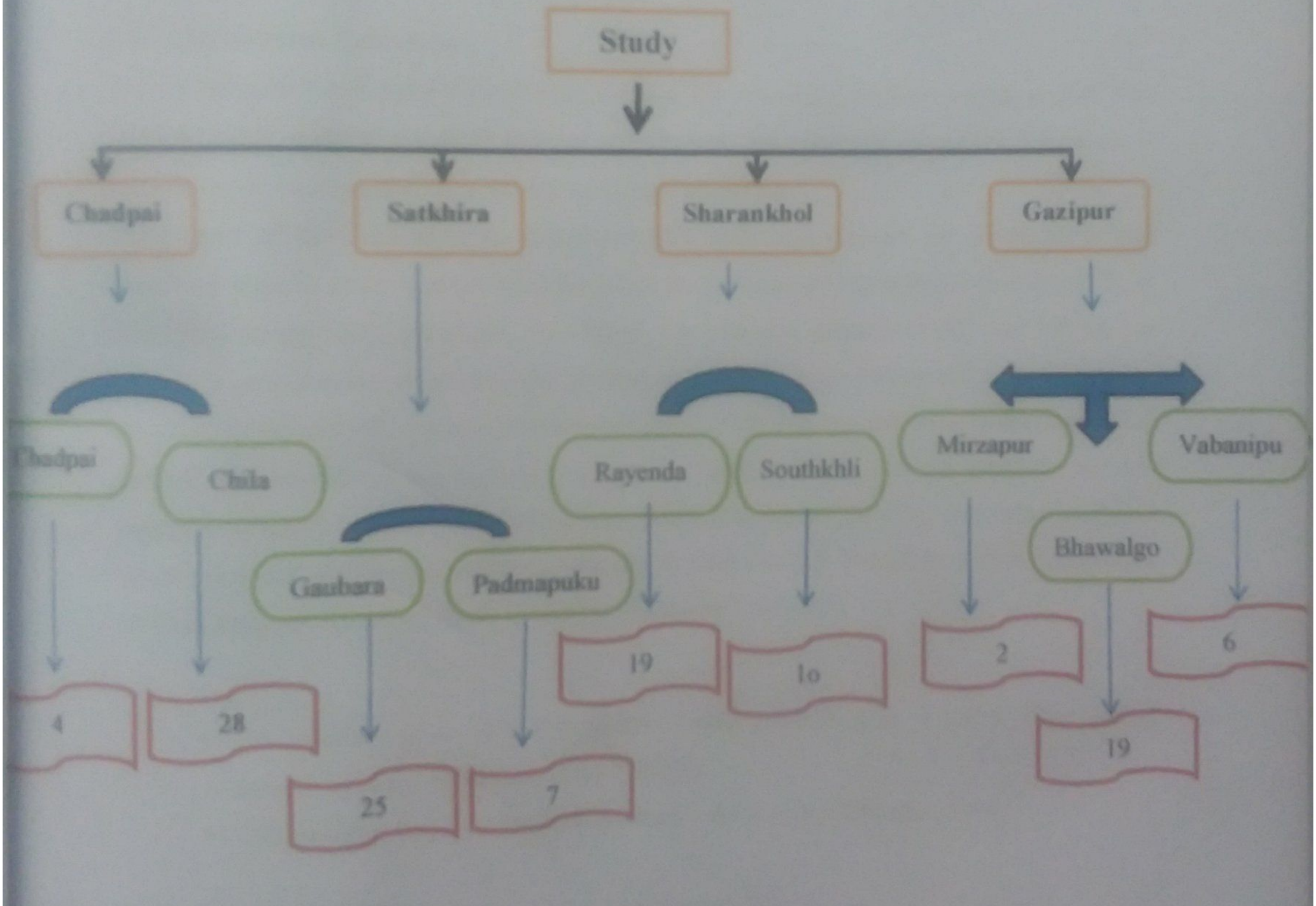


Fig1: Sampling design

3.5 Data collection

3.5.1 Household survey

The household survey was carried out in 3 different sites adjacent to the Sundarbans and near to Vawal National Park. The survey was conducted through a semi-structured questionnaire on assessment of fuel wood consumption including various types of question related to my study. The survey was conducted during September to December, 2017.

3.5.2 CO_2 emission Calculation

The Greenhouse Gas Equivalencies Calculator uses the Avoided Emissions and generation Tool (AVERT) U.S. national weighted average CO_2 marginal emission rate to convert reductions of kilowatt-hours into avoided units of carbon dioxide emissions.

Most users of the Equivalencies Calculator who seek equivalencies for electricity-related emissions want to know equivalencies for emissions reductions from energy efficiency (EE) or renewable energy (RE) programs. Calculating the emission impacts of EE and RE on the electricity grid requires estimating the amount of fossil-fired generation and emissions being displaced by EE and RE. A marginal emissions factor is the best representation to estimate which fossil-fired units EE/RE are displacing across the fossil fleet. EE and RE programs are not generally assumed to affect base load power plants that run all the time, but rather marginal power plants that are brought online as necessary to meet demand. Therefore, AVERT provides a national marginal emissions factor for the Equivalencies Calculator.

- Net calorific value of non-renewable biomass ($NCV_{biomass}$) = 0.015 TJ/ton (IPCC default value for fuel wood) (Carter, 1996).
- CO_2 emission factor for the biomass fuel = 109.6 tCO_2/TJ (Carter, 1996).

3.3.3 Statistical Analysis

The field data collected from 4 sites was analyzed by one factor analysis of variance (ANOVA) by using SPSS.CO_2 emission Calculation was done by Microsoft excels.

Chapter-4

Result and Discussion

4. Result and Discussion

4.1 CO_2emission related with income

It is found that CO_2 emission by household greatly depends on the income of the family. Result shows that the people having moderate income are more responsible than poor or, higher income

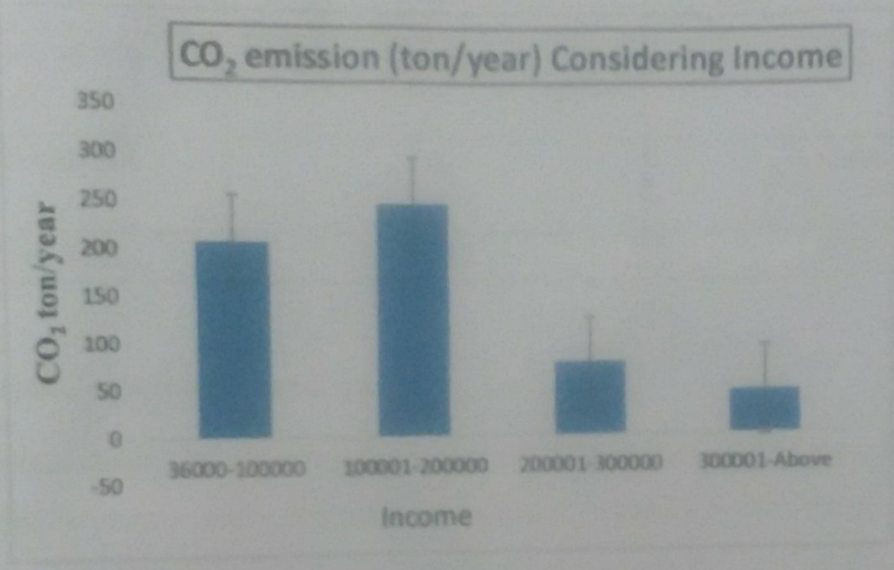
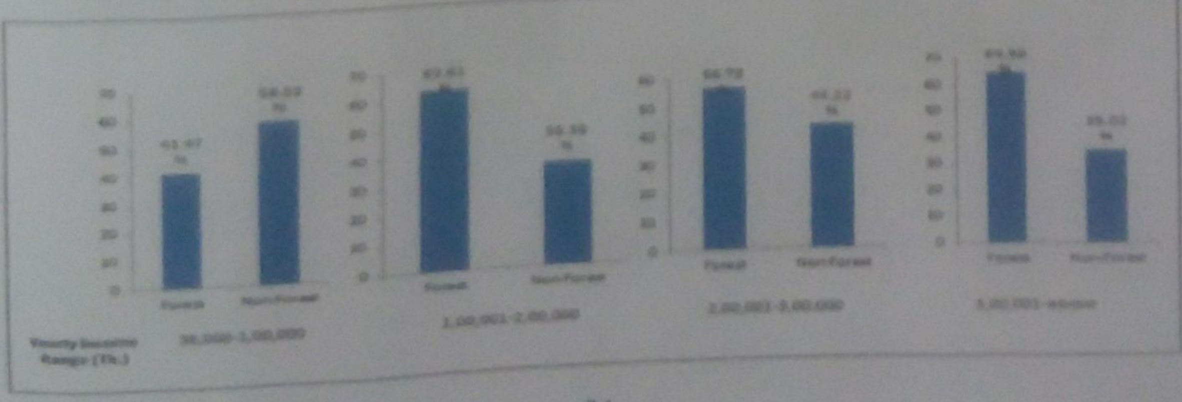


Figure4: CO_2 emission (ton/year) considering income

4.2 CO_2 emission percentage related with income and fuel wood source

The above figure shows that the amount of carbon dioxide emissions greatly vary with the income of respondents. From this figure it is seen that, the respondent having a low income emits a high amount of carbon dioxide. On the other hand the people having a high income emits low amount of carbon.



Income wise fuel wood consumption per household

Yearly Income Range (Tk.)	Fuel wood consumption per household (ton/yr)	
	Forest source	Non-Forest source
36,000-1,00,000	4.8	5.3
1,00,001-2,00,000	3.94	6.439
2,00,001-3,00,000	4.017	5.606
3,00,000-above	5.053	4.537

4.3 CO_2 Emission varied with forest type

Result shows that about 45% emissions due to fuel wood from non-forest sources i.e. homestead, roadside, social forestry or others plantation. And about 55% emissions form forest.

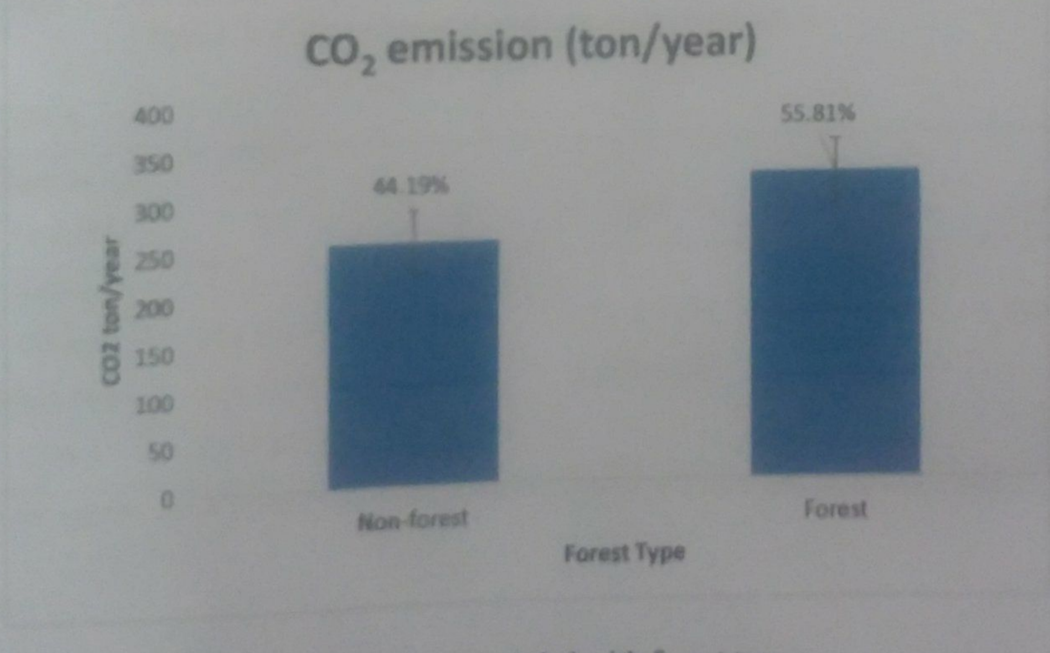


Figure 6: CO_2 emissions varied with forest type

4.4 Dependency on fuel wood by region

At Chadpai region, Mangrove are solely used as a source of fuel wood. But in Gazipur and Sorankhola region, Mangroves are not totally used. On the other hand, Homestead is solely used at Soronkhola. In Satkhira region, Mangroves are mainly used as fuel wood source.

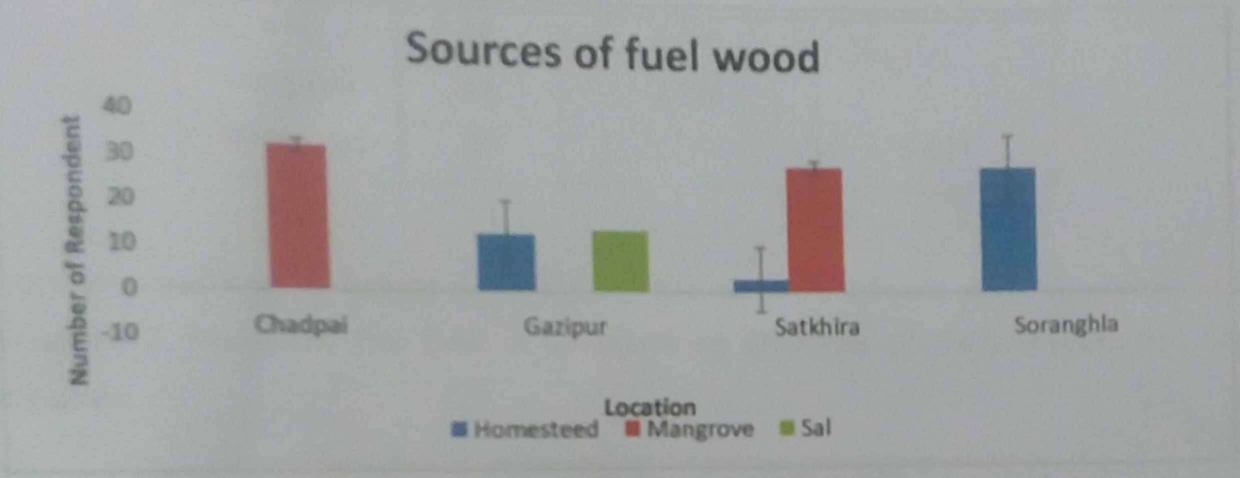


Figure 7: The number of respondent at different region.

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	624.365977	1	624.365977	259.105	6.14E-40	3.880827
Within Groups	573.509305	238	2.40970296			
Total	1197.87528	239				

There are significant difference ($P > 0.05$) between source of fuel wood in different regi

Source of fuel	N	Subset for alpha = 0.05	
		1	2
Sal	14	4.185	
Mangrove	61	4.346	
Homestead	45		5.697

There are significant difference (*P>0.05*) of CO2 emission between sal& Homestead and Mangrove & homestead But there is no significant difference (*P<0.05*) between Sal and Mangrove.

Range	N	Subset for alpha = 0.05	
		1	2
3	32	3.743	
2	27	4.621	
1	32	4.882	
4	29		6.176

There is no significant difference (*P<0.05*) between Chadpai, Gazipur, Satkhira but there are significant difference (*P>0.05*) of co2 emission among Sorankhola and others three.

Chapter-5
Conclusion

Conclusion

Carbon emission from households is an important contributor to overall carbon emissions and an integral part of carbon mitigation on the national, regional and municipal scales. The main contribution in this study is an increased understanding of the quantity and mechanisms for carbon emission on the households scale. This study estimates that average household carbon emission in the amounted to 580.10tones CO_2in 2018.A set of demographic, economic, behavioral, and spatial factors are key determinants of household carbon emission in the region. The age structure (i.e.; dependency ratio), household size, income, family fuel wood consumption. Carbon emission of households expected to maintain an increasing trend with the ongoing process of economic development in the next decade.it is of great significance and urgency to take action to control carbon emission, given the irreplaceable strategic significance of this region to maintain the sustainability of economic development and mitigate carbon emission in Bangladesh.

Recommendation:

This is the very first time that such type of research is done at a small scale in respect of Bangladesh ever. If we can continue this type of research for further precise assessment at a large scale that would be very helpful to fix the national FREL and also trigger to enlist Bangladesh as a UN-REDD+ readiness country of UN-REDD programmed through planning and implementing of UN-REDD+ national strategies.

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