Khulna University
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Title: Assessment of Greenhouse Gas Emission (particularly CO_2) from household's fuelwood consumption adjacent community of cox's Bazar north and south forest division

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Course Title: Project Thesis

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A Project Thesis has been prepared and submitted in partial fulfillment of the requirement for four years professional B. Sc. (Hons.) in Forestry.

Supervisor

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July 2018

DECLARATION

I, Rakibul Hasan, 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

Rakibul

.....

Rakibul Hasan

APPROVAL

This is to certify that the present project entitled **"Assessment of Greenhouse Gas Emission (particularly co_2) from Household's Fuelwood Consumption Adjacent Community of Cox's Bazar North and South Forest Division"** has been carried out by Rakibul Hasan (Student Id: 140545) 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. (Honours) in Forestry.

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DEDICATED

TO MY

BELOVED PARENTS AND

LATE GRANDFATHER

Acknowledgment

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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Abstract

Now a day's greenhouse gas emission is an important topic of concern. Fuelwood consumption that we consume in our daily life is mainly responsible for greenhouse gas emission. This research has been done to determine the amount of greenhouse gas emission from fuelwood consumption. The focus of this study is to assess the CO_2 gas emissions from household's fuelwood consumption and fuelwood consumption from forest and non-forest. In this study, three regions of Teknaf, Dulahazra, and Fasiakhali 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 fuelwood consumption, type of forest, income range etc. Highest CO_2 emission from Non-Forest and lowest CO_2 emission from Natural Forest. This study found that income level (100001-200000) of respondent showed highest CO_2 emission (148.94 ton/year) but lowest CO_2 emission (38.66 ton/year) from (300000-above) income level. The highest percentage of CO_2 emission from fuelwood collect from forest than fuelwood collects from Non-Forest. Those people live in the adjacent area to the forest.

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Chapter-1

INTRODUCTION

1. Introduction

1.1 Background of the study

Greenhouse gas concentrations have been particularly high during warm periods and low during cold periods. Any gas that has the property of absorbing infrared radiation emitted from Earth's surface and reradiating it back to Earth's surface, thus contributing to the greenhouse effect. Carbon dioxide, methane, and water vapour are the most important greenhouse gases. Greenhouse gases have a profound effect on the energy budget of the Earth system despite making up only a fraction of all atmospheric gases. Concentrations of greenhouse gases have varied substantially during Earth's history, and these variations have driven substantial climate changes at a wide range of time scales. The effect of each greenhouse gas on Earth's climate depends on its chemical nature and its relative concentration in the atmosphere. Some gases have a high capacity for absorbing infrared radiation or occur in significant quantities, whereas others have considerably lower capacities for absorption or occur only in trace amounts. The implications of fuelwood 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. (Harwich et al. 2009)

Fuelwood consumption of households is significantly correlated with household size, ownership of cultivated irrigated terraces and number of livestock per household. Fuelwood consumption varies significantly between seasons. Among various sources of biomass energy. Though combusting wood emits CO_2 into the atmosphere, regrowth of wood captures CO_2 from the atmosphere. As a first approximation it can be stated that fuelwood use is carbon neutral, i.e. there is no net emission of carbon into the environment. The approximation is supported by the evidence of two dominant mechanisms. First, most fuelwood use takes place on a sustainable basis. This applies to the use of virtually all fuelwood originating from non-forest land (e.g. agriculture land, plantations, and home gardens), and to the use of most of the fuelwood from forest land. Sustainability implies carbon neutrality, because the same amount of CO_2 emitted by wood combustion, is recaptured from the atmosphere by regrowth of wood. Second, leftovers from non-sustainable logging and land conversion, if not used as fuel (or for other purposes) would simply decompose by natural processes, and lead to the same amount of carbon emitted in the

atmosphere if the woody material were to be combusted (though not necessarily distributed among CO_2, methane and other greenhouse gases in the same way). (Akhter, J. 2002)

Most of the available literature on fuelwood in Bangladesh is mainly focused on the extent of use of fuelwood by households rather than estimation of the actual amount of Fuelwood consumption. For example, in national level data, only the extent of use of Fuelwood is available but there is no information on the amount of fuelwood consumption. The Population and Housing Census Report of Bangladesh (BBS 2011) provides information on the percentage of households using various kinds of cooking fuel. It provides information on the proportion of households using Fuelwood by districts, region and tenure status of housing. Other nationally representative database on energy consumption only provides the information on several households using fuelwood. However, only a handful of studies focused on the amount of fuelwood consumption in Bangladesh. (Andrew et al. 2013

Adam Smith (1904) stated that "consumption is the sole end and purpose of all production", 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. 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. Fuel is not equal to fuel - at least if we consider carbon dioxide emissions. The burning of lignite emits nearly 100 % more carbon dioxide with respect to the energy content than burning of natural gas. Even natural fuels such as wood or peat have high specific emissions if they are not used sustainable. Hence, deforestation has a high impact on climate change. On the other hand, if we only use as much wood as can grow again, it is carbon dioxide neutral because it binds as much carbon dioxide during growing as is emits during burning.

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 the 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. 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. Furthermore, other renewable energy sources are considered to be carbon neutral, like wood. (Bala B.K. 1998)

The economic benefit of current woodfuel 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 exceptional cases, i.e. the relatively few areas where woodfuel use is not sustainable. This even leads to donor policies for the 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. (Ahmad, N., & Wyckoff, A. 2003)

This study will focus on the assessment of greenhouse gases from the household at four different sites of Bangladesh including three adjacent areas of Teknaf, Fasiakhali and Dulahazra range at Cox's Bazar district.

1.2 Problem Statement

Create environmental and aesthetic damage in our communities and scenic areas – like national parks. No enough data in Bangladesh is a major problem in the case of this study. CO_2 emission from fuelwood which comes from Forest source and non-forest source. High impact on Climate change.

1.3 Objectives of the Study

- To assess the CO_2 gas emissions from household's fuelwood consumption Adjacent to the Teknaf, Fasiakhali, and Dulahazra.
- To assess fuelwood 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 the Greenhouse Effect?

Greenhouse gases in the earth's atmosphere absorb IR from the sun and release it. Some of the heat released reaches the earth, along with heat from the sun that has penetrated the atmosphere. Both the solar heat and the radiated heat are absorbed by the earth and released; some is reabsorbed by greenhouse gases to perpetuate the cycle. The more of these gases that exist, the more heat is prevented from escaping into space and, consequently, the more the earth heats. This increase in heat is called the greenhouse effect. (Benders et al. 2010)

2.3 Types of Greenhouse gases

In general, greenhouse gases constitute just almost 1% of the total gases present in the atmosphere. Their concentrations are dependent on the balance between the "sources" and "sinks" that function to create and destroy these gases respectively. Anthropogenic activities tend to increase these concentrations by either introducing new types of gases in the air or intervening with the sinks.

- The most abundant greenhouse gases in the Earth's atmosphere are carbon dioxide, methane, nitrous oxide, ozone, and chlorofluorocarbons. Additionally, atmospheric water vapor also contributes to the occurrence of the greenhouse effect. Fortunately, its cause is believed to be non-anthropogenic.
- Since the industrial revolution, the levels of greenhouse gases in the atmosphere have increased significantly. Alarmingly, the increase has resulted in a so-called radiative-forcing effect where heat is trapped inside the Earth's atmosphere, thereby contributing to the increase in global temperature.
- The increase in the amount of carbon dioxide (CO_2) accounts for more than half of this effect, compared with other gases like methane (CH_4), nitrous oxide (NO), ozone (O_3), and chlorofluorocarbons (CFCs) which account for 16%, 5%, 12%, and 12% respectively.

- However, according to scientific studies, methods to reduce the production of greenhouse gases and emission of aerosol should not be assumed to decrease the impacts of climate change rapidly. (Asaduzzaman et al.2010)

2.4 Global Warming Potential (GWP)

All greenhouse gases have what is called a Global Warming Potential (GWP). This value is used to compare the abilities of different greenhouse gases to trap heat in the atmosphere. GWPs are based on the heat-absorbing ability of each gas relative to that of carbon dioxide (CO_2), as well as the decay rate of each gas (the amount removed from the atmosphere over a given number of years). GWPs can also be used to define the impact greenhouse gases will have on global warming over different time periods or time horizons. These are usually 20 years, 100 years and 500 years. For most greenhouse gases, the GWP declines as the time horizon increases. This is because greenhouse gas is gradually removed from the atmosphere through natural removal mechanisms, and its influence on the greenhouse effect declines. Some of the CFCs however, have long atmospheric lifetimes, and the 100-year GWP may be greater than the 20-year GWP. (Atkinson et al. 2011)

2.5 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 liv es in urban areas that serve as seaports. A measurable rise in sea level will have a severe econ omic impact on low lying coastal areas and islands, for examples, increasing the beach erosio n rates along coastlines, rising sea level displacing fresh groundwater for a substantial distanc e in the land. (Baiocchi et al. 2010)

b) Agricultural Impact

Experiments have shown that with higher concentrations of CO_2, plants can grow bigger and faster. However, the effect of global warming may affect the atmospheric general circulation and thus altering the global precipitation pattern as well as changing the soil moisture content s over various continents. Since it is unclear how global warming will affect climate on a regi

onal or local scale, the probable effects on the biosphere remain uncertain. (Baiocchi et al. 2010)

c) Effects on Aquatic systems

The loss of coastal wetlands could certainly reduce fish populations, especially shellfish. Incr eased salinity in estuaries could reduce the abundance of freshwater species but could increas e the presence of marine species. However, the full impact on marine species is not known. (Baiocchi et al. 2010)

d) Effects on Hydrological Cycle

Global precipitation is likely to increase. However, it is not known how regional rainfall patte rns will change. Some regions may have more rainfall, while others may have less. Furtherm ore, higher temperatures would probably increase evaporation. These changes would probabl y create new stresses for many water management systems. (Baiocchi et al. 2010)

2.6 Carbon dioxide emission

Carbon emission is the release of carbon into the atmosphere. To talk about carbon emissions is simply to talk about 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. (Baiocchi et al. 2010)

2.7 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. (Baiocchi et al. 2010)

2.8 Fuelwood

Fuelwood 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.

Fuelwood 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 the development of civilization as we know it. Unfortunately, overconsumption of fuelwood has led to deforestation and habitat loss, and unless the wood is burned inefficient furnaces, its combustion contributes to emissions. Fuelwood can include firewood, charcoal, polluted sawdust, and wood chips. (Alfredsson, E. C. 2004)

2.9 Sources of Fuelwood

- Forest
- Plantations
- Customary land
- Others

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 a 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 in a coordinated manner.

Bala (1998) stated that biomass fuels mainly consist 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 depends 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 GigaJoule from a 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 the highest portion as it is an agro-based country. For the last ten-year use of traditional fuel remain almost the 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 environment 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 ain the open market.

Eusuf (2005) revealed that traditional energy consisting of fuelwood, 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 the market. Firewood collection is perceived as an increasingly difficult task, and many people are walking long distances for wood. Usage of fuelwood or charcoal is mostly an urban phenomenon. Wood fuel is the dominant energy source for most fuel consuming cooking in the urban area. Secondary fuels such as crop residues, rice husk, sawdust and dung are used very little. From the literature cited above, it revealed that the consumption pattern of the primary fuel is directly dependent on the respondent's income. It is also evident that the 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. This literature indicates 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 a different locality. (Eusuf, M. 2005)

2.12 Factors Affecting Fuelwood Consumption

Among the considered variables, only family size had a significant correlation (this was also negative) with fuelwood consumption with the increase of family size, the per capital fuelwood consumption decreased. Other studies have indicated different factors are also responsible for fuelwood consumption. The relationship between poverty and fuelwood dependency has been documented in Brazil and other countries at local scales found that socioeconomic characteristics of rural communities in the same region explained up to 31% of fuelwood consumption, with monthly income the most important. We also found that a socioeconomic characteristic (i.e., family size) was related to fuelwood consumption: with an increase of one family member, the per capita fuelwood consumption decreased by about 0.09 kg. But the unique point is among the social characteristics only family size influences the fuelwood

Consumption So rich or poor, educated or non-educated the fuelwood consumption is the same for every household except if the family size differs. This also points to the over dependency of fuelwood which is a threat to the existing forests. (Peters et al. 2008)

2.13 Household Energy Consumption Pattern in Rural Areas of Bangladesh

Asaduzzaman. (2010) Stated that 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. However, the contribution of biomass fuels to total primary energy supply in Bangladesh is about 60%. The country is one of the most densely populated countries in the world. Population density is about 990 persons per km^2 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 (gigajoules) in 1977 to 6.2 GJ in 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. 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 CO_2 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 a 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 in CO_2 emission over time. CO_2 emission and per capita CO_2 emission in Bangladesh have escalated with an 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 motels. 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. (Ahmad, N., & Wyckoff, A. 2003)

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 a Climate Change Strategy and Action Plan towards mitigation and low carbon development along with other strategic areas. Ministry of Power, Energy and Mineral Resources (2008) has published the National Renewable Energy Policy aiming for developing renewable energy resources (solar, wind, hydro) to meet 5% of the total power demand by 2015 and 10% by 2020. It promotes the use and development of renewable energy by encouraging and facilitating both public and private sector investment which further promote the appropriate, efficient and environmentally friendly use of renewable energy and clean energy. The National Adaptation Program of Action (NAPA) for Bangladesh has been developed by the Ministry of Environment and Forest (MOEF) to address adverse impacts of climate change and extreme events and to promote sustainable development of the country. National Adaptation Plan (NAP) Global Support Program is another initiative of Bangladesh which would promote a common understanding of the UNFCCC (United Nations Framework Convention on Climate Change) NAP guidelines among ministries of Environment, Planning, Finance and key sectoral ministries. Bangladesh government has also taken initiative to develop Nationally Appropriate Mitigation Activities (NAMA) for the steel sector. The NAMA project would facilitate to identify a technological need, capacity building, policy and financial needs to enhance energy efficiency actions and development in the steel sector which would reduce CO_2 emission. Some other projects such as enhancing capacity for low emission development strategies (EC-LEDs) and USAID low emissions Asian Development (LEAD) Program are also implementing in Bangladesh for reducing emission from climate, energy, and land. Summarizes the initiatives taken in Bangladesh for addressing emission and climate change. (Harwich et al. 2009)

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 benefits While addressing community benefit its. The Global Environmental Facility (GEF) helps to develop and transition countries address LULUCF concerns by investing in projects to help conserve, Restore, enhance and manage the carbon stocks in the 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 1 Gig atone (Get) of carbon every year, or about 40 percent of the total for land-based absorption. On a global scale, terrestrial ecosystems trap about 2.6 Get of Carbon dioxide equivalent (CO_2 eel) per year and illustrates how important Terrestrial carbon sequestration can be.

Activities in the LULUCF sector can provide a relatively cost-effective way of offsetting emissions, either by increasing the removals of greenhouse gases from the atmosphere (e.g. by planting trees or managing forests), or by reducing emissions (e.g. by curbing deforestation). However, there are drawbacks as it may often be difficult to estimate greenhouse gas removals and emissions resulting from activities of LULUCF. In addition, greenhouse gases may be unintentionally released into the atmosphere if a sink is damaged or destroyed through a forest fire or disease. (Benders et al.2010)

Chapter-3

Methodology

3. Methodology

3.1 Research method:

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

3.2 Selection of study area

To assessment of fuelwood consumption from households, the three locations were selected purposively. The Teknaf adjacent area was Nila and the Teknafand other was Dulahazra and Fasiakhali.

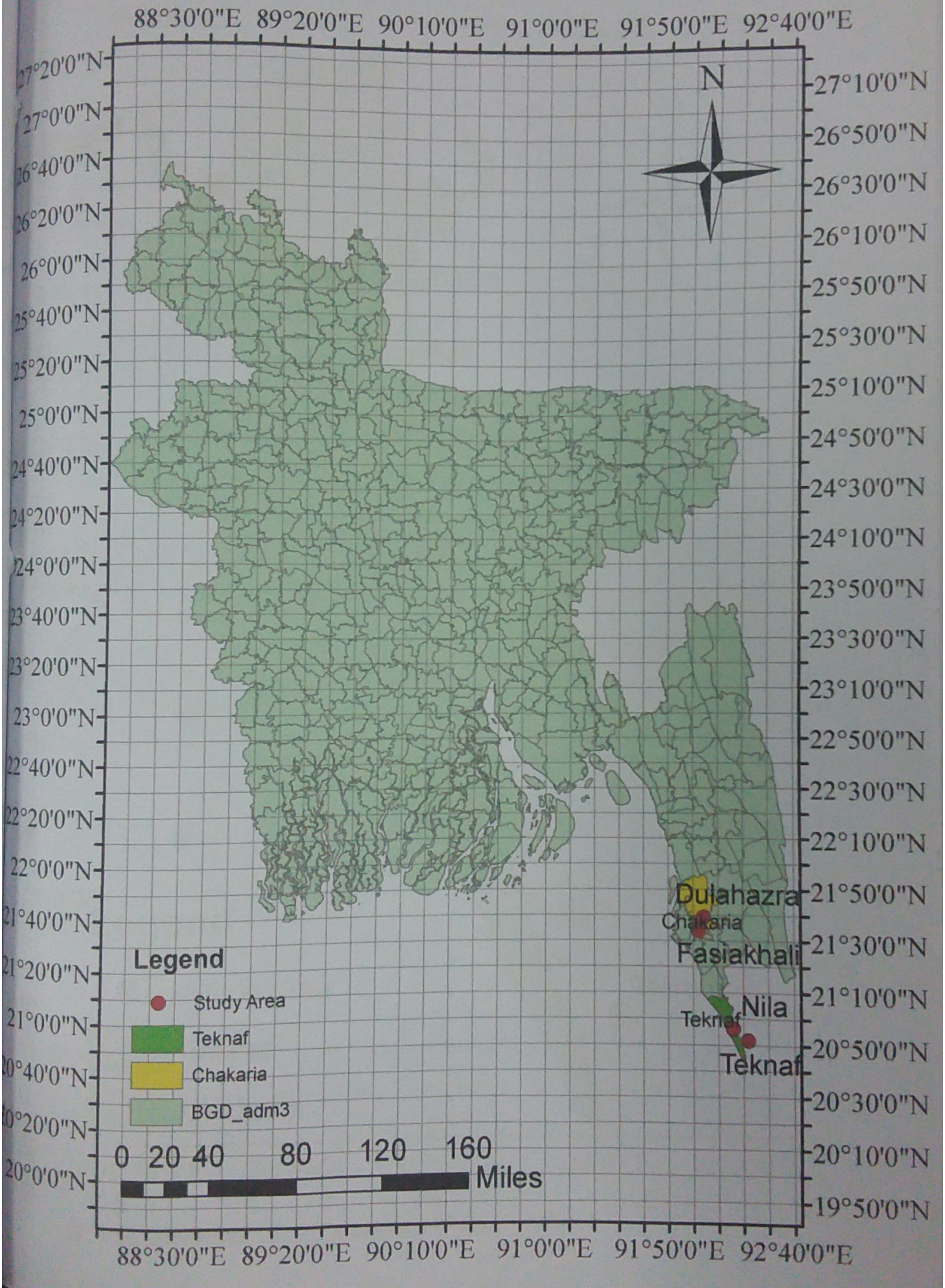
Range	Union	Respondent no
Teknaf	**Nila**	**33**
	Teknaf	11
Dulahazra	**Dulahazra**	**42**
Fasiakhali	**Fasiakhali**	**14**

A total of 44 respondent interviews should be done in Nila and Teknaf Union under Teknaf range. Respondent opinion should prefer first for this study. A total of 42 respondent interviews should be done randomly which including Dulahazra Union in Dulahazra range. In case of Fasiakhali range, a total number of 14 interviews carried out randomly including Fasiakhali union.

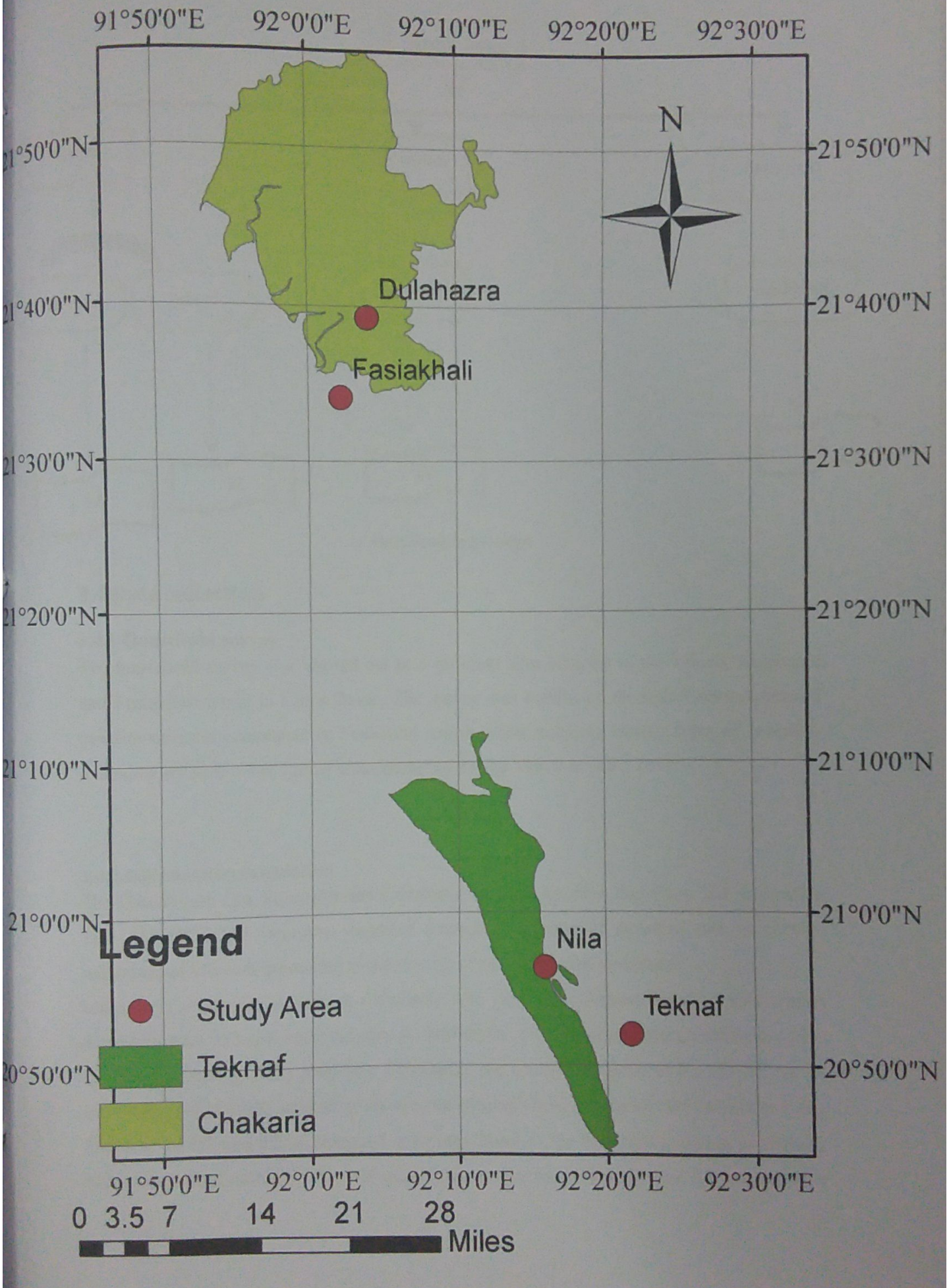
3.3 Sampling Designs

A sampling design is a defined a plan for obtaining a sample for a given population. It shows the sampling technique followed to select the samples. At first, three different sites were selected purposively. Then two unions were selected from one site and a direct interview was conducted for assessing farmer's perception of fuelwood consumption.

Bangladesh's Map



Study Area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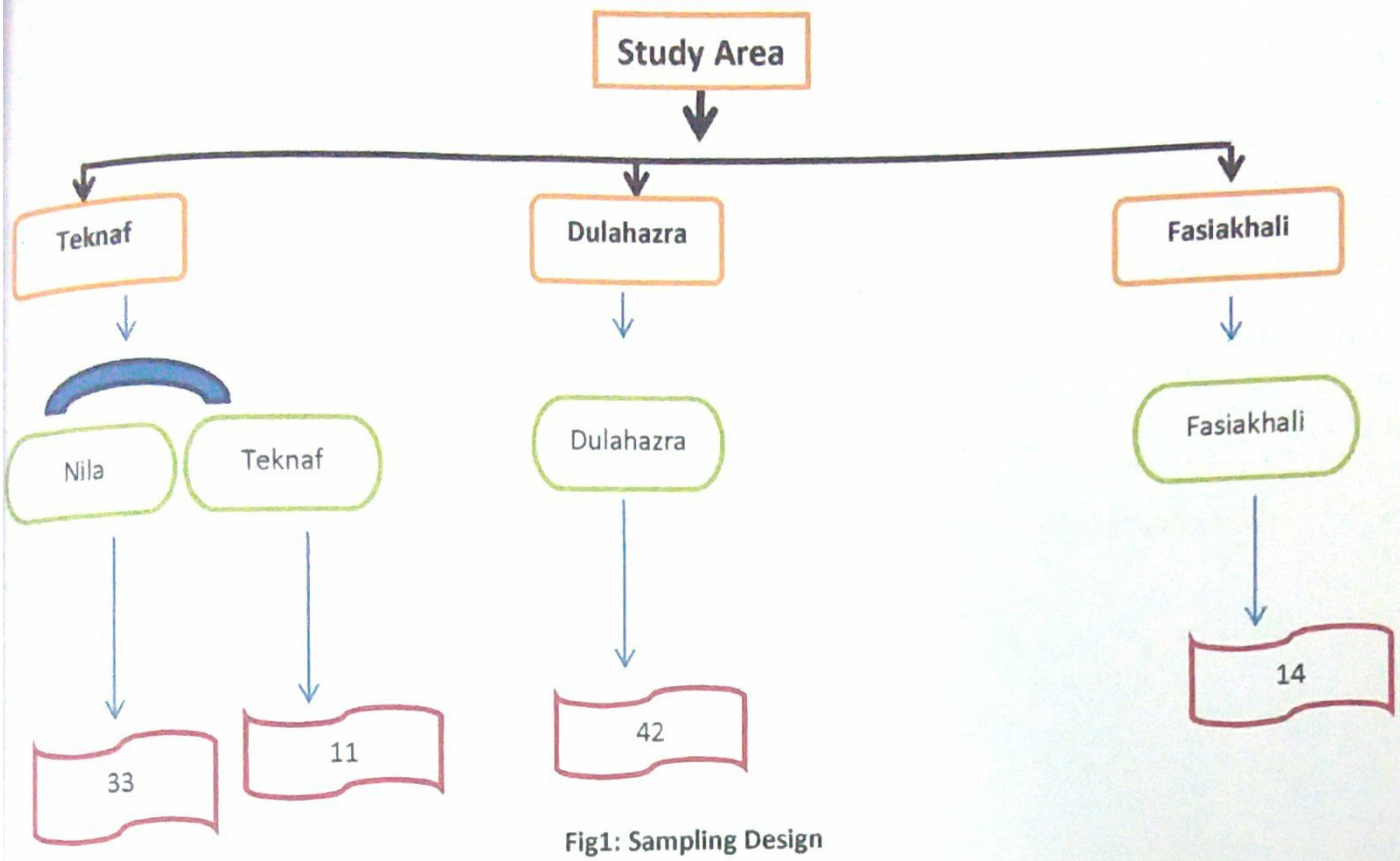

Fig1: Sampling Design

3.4 Data collection

3.4.1 Household survey

The household survey was carried out in 3 different sites adjacent to the Teknaf, Dulahazra and Fasiakhali range in Cox's Bazar. The survey was conducted through a semi-structured questionnaire on assessment of Fuelwood consumption including various types of question-related to my study. The survey was conducted during March to April 2018.

3.4.2 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 baseload 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 fuelwood) (Carter, 1996).
- CO_2 emission factor for the biomass fuel = 109.6 tCO_2/TJ (Carter, 1996).

3.4.3 Statistical Analysis

The field data collected from 4 sites.CO_2 emission Calculation was done by Microsoft excels.

Chapter-4

Result and Discussion

4. Result and Discussion

4.1 CO_2 Emission from household fuelwood consumption (forest and non-forest)

The result shows that about 44.78% CO_2 emissions from the forest. And about 55.22% CO_2 emissions due to fuelwood from the non-forest sources i.e. homestead, roadside. That area maximum family income level is low. In this area, women are main Fuelwood collector. They don't easily reach the forest area, so they maximum time collect Fuelwood from non-Forest. So, the amount of CO_2 emission high from non-forest than forest.

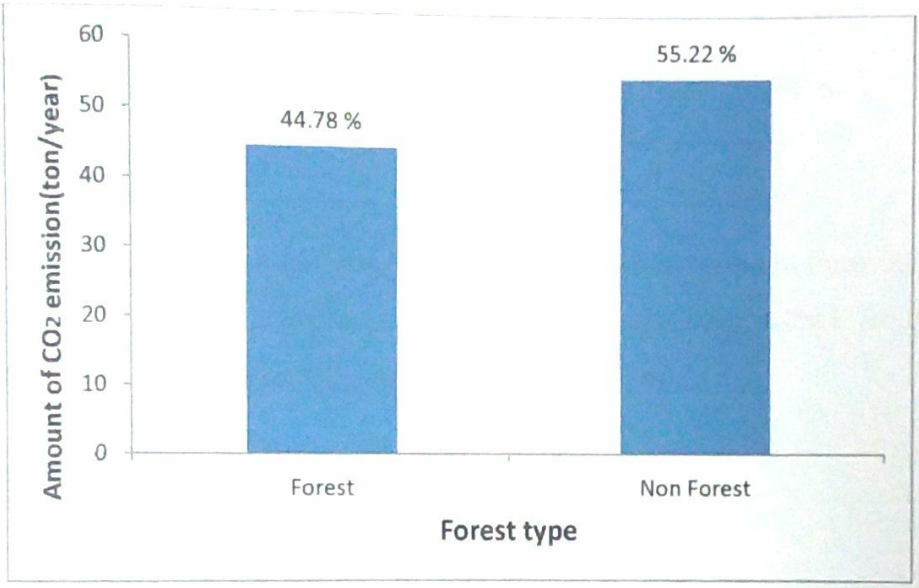

Figure 2: CO_2 Emission from household fuelwood consumption (forest and non-forest)

4.2 Dependency on Fuelwood by region

At Dulahazra region, Homestead and Roadside Plantation Forest are mainly used as a source of Fuelwood. But in Fasiakhali and Teknaf region, Natural Forest and Plantation Forest both are used as Fuelwood source.

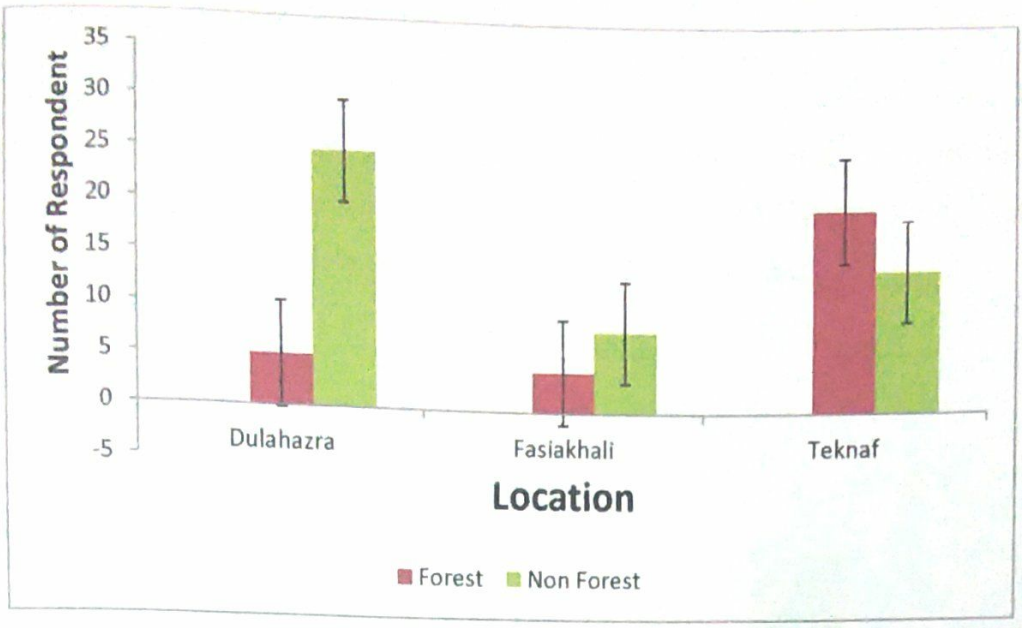

Figure 3: The number of respondents in a different region.

4.3 Amount of Fuel wood related to the family type

Single-family collects almost the same amount of fuelwood from natural forest and plantation forest. But in the case of joint family, high amount of fuelwood collects from plantation forest and low amount of fuelwood collect from natural forest.

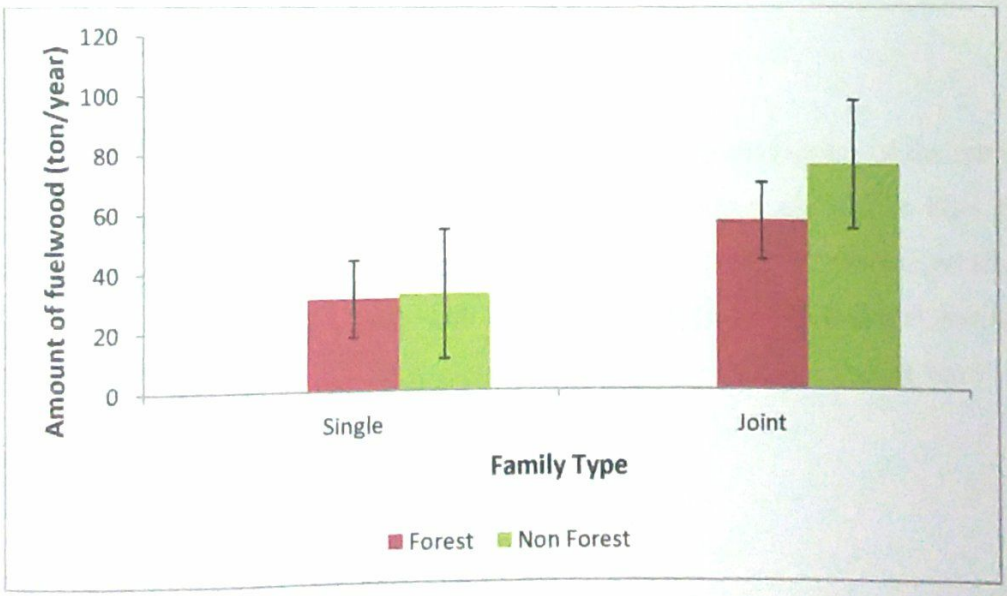

Figure 4: Amount of fuelwood varied with the family type

4.4 CO_2 Emission varied with the family type

The result shows that in single family, CO_2 emissions from forest and non-forest are almost the same, no highly difference. But in a joint family, CO_2 emissions from non-forest are high and CO_2 emissions from non-forest are low amount than forest. Normally a lot of members lives in a joint family, so the amount of CO_2 emission is high in a joint family.

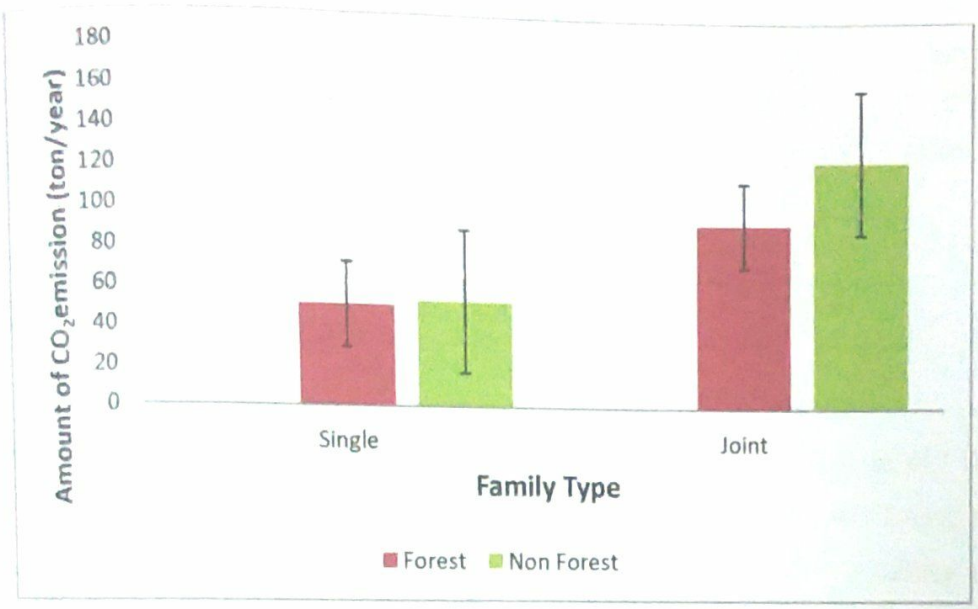

Figure 5: CO_2 emissions varied with the family type

4.5 CO_2 emission related to income

It is found that CO_2 emission by household greatly depends on the income of the family. The result shows that the people having moderate income are more responsible than poor or, higher income. This figure shows that the amount of carbon dioxide emissions greatly varies 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 a low amount of carbon.

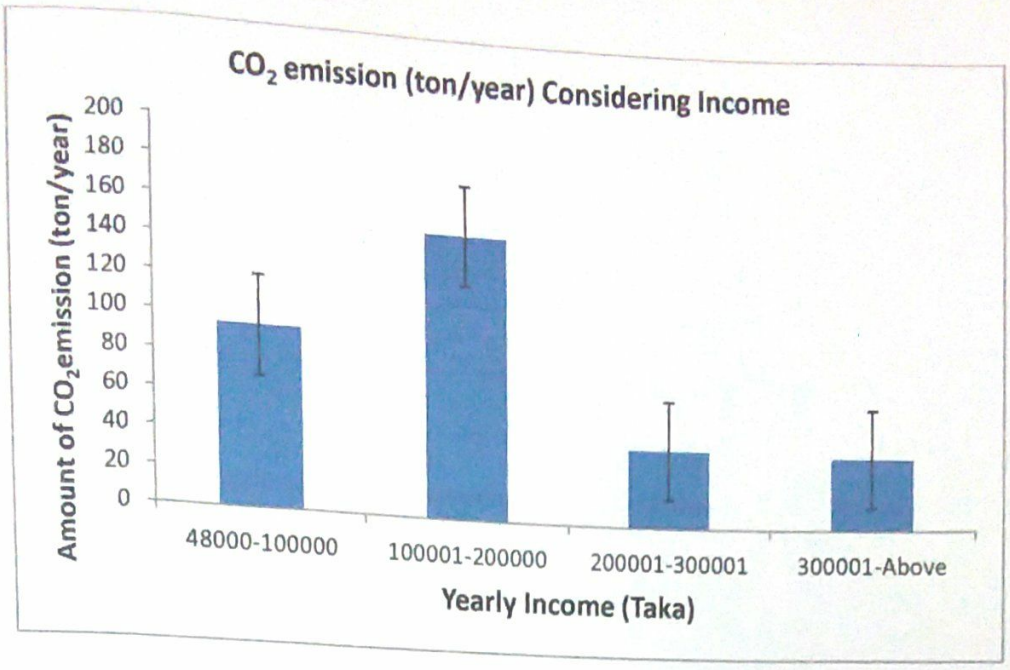

Figure 6: CO_2 emissions related to income

The above figure shows that the amount of carbon dioxide emissions greatly varies 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 a low amount of carbon.

Chapter-5

Conclusion

5. Conclusion

Climate change is a change in the statistical distribution of weather over periods of time that range from decades to millions of years. It can be a change in the average weather or a change in the distribution of weather events around an average. Climate change may be limited to a specific region or may occur across the whole Earth. Remaining scientific uncertainties include the amount of warming expected in the future, and how warming and acted changes will vary from region to region around the globe. Most national governments have the Kyoto Protocol aimed at reducing greenhouse gas emissions, but there is ongoing political and public debate worldwide regarding what, if any, action should be taken to reduce or reverse future warming or to adapt to, its expected consequences. 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 household's scale. This study estimates that average per capita household carbon emission in the amounted to 3.23-ton CO_2 in that community. A set of demographics, 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 fuelwood 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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