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Impact of Environmental Change on Natural Resource-based Food System of Tribal Communities of North-Western Region in Bangladesh

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Impact of Environmental Change on Natural Resource-based Food System of Tribal Communities of North-Western Region in Bangladesh

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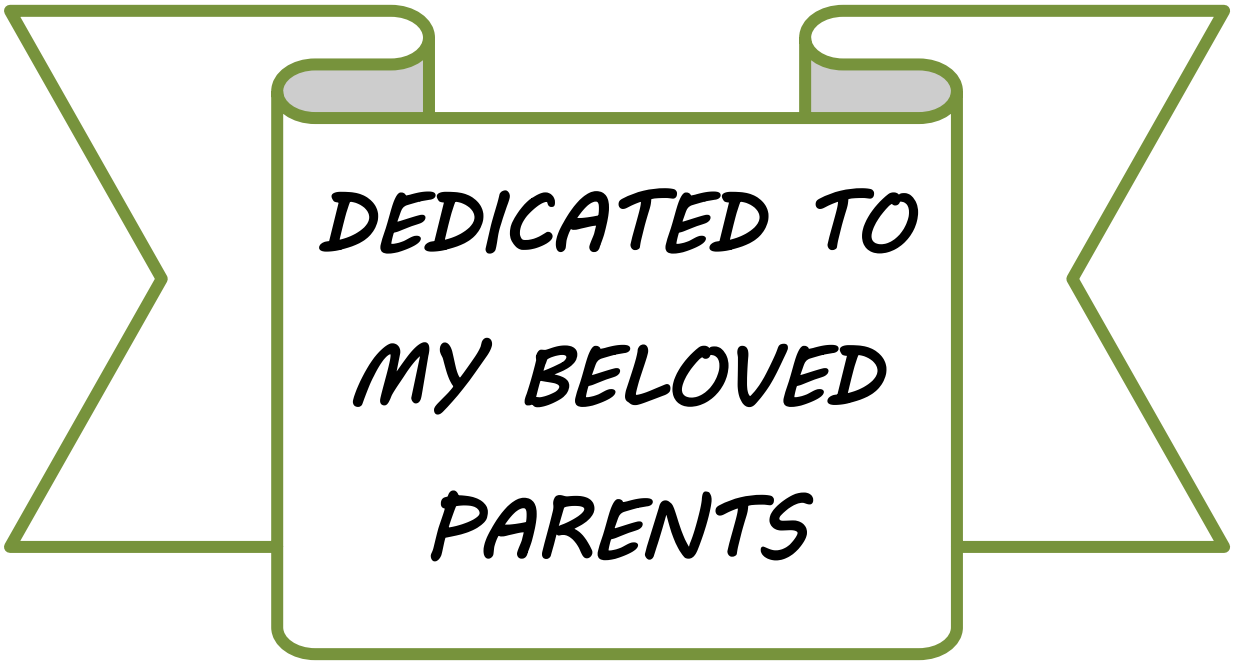
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DECLARATION

I, hereby declare that I have completed my Ph.D. Thesis work on **"Impact of Environmental Change on Natural Resource-based Food System of Tribal Communities of North-Western Region in Bangladesh"** at the Institute of Environmental Science (IES), University of Rajshahi, Bangladesh in the Academic Year 2010-11, ID no.10112 and Registration no. 3365. The information submitted here by me is true and original to the best of my knowledge. I further declare that the work embodied in this thesis has not been submitted in substance for any degree and has not been concurrently submitted as a submission for any other degree. This research was carried out under the guidance of Dr. Md. Redwanur Rahman, Associate Professor and supervisor, Institute of Environmental Science, University of Rajshahi of Bangladesh.

Arook Toppo

CERTIFICATE

This is to certify that the dissertation entitled, **"Impact of Environmental Change on Natural Resource-based Food System of Tribal Communities of North-Western Region in Bangladesh"** submitted by Mr. Arook Toppo in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Environmental Science, University of Rajshahi of Bangladesh, is an authentic work carried out by him under my supervision.

This interdisciplinary approach, in explaining the above title is a novel venture, so far researches are considered in our country. Hopefully, it would usher a light in our domain of knowledge and wisdom.

To the best of my knowledge, the matter embodied in the dissertation has not been submitted to any other University or Institute for the award of any Degree or Diploma.

I therefore, forwarding this thesis submitted for the degree of Doctor of Philosophy to the Institute of Environmental Science (IES), University of Rajshahi, Bangladesh.

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The author

ABSTRACT

In my study, I have tried to show the biological resources and diversity form on the basis of both the ecology and economy of Bangladesh. Most of the essential sectors related to human life are heavily depend directly or indirectly on these biological resources. As my understanding, it is found from the researches done by scholar biologist the world biodiversity may be divided into three. These are species diversity, genetic diversity and ecosystem diversity.

According to the government survey report (BBS 1991), the total number of Adivasi was 12, 05,978 which is only 1.03 percent of the total population. In the last census of Bangladesh government (BBS, 2011), total tribal population is 1586,141 which is 1.10 per cent of the total population.

In my study I tried to find out the socio-economic status of the tribal people in northwestern region in Bangladesh. In the study area basically there are three major tribal groups. These are Santal, Oraon, and Pahan. The others are Munda, Barman, Rabidas and Mahali are living with their culture, customs, tradition and social values. Moreover, some tribes like Mahali, Rabidas has their traditional occupation.

It is found that among tribal people, 60.94% households are involved in agricultural day labor activities. Around 22.14% household depend on their own cultivable land for production, 5.99% in various formal and non-formal service sectors (Offices support staff, Security guard and Garments factory), 2.34 % of total sample HHs are involved in livestock rearing. 2.86% tribal households were found involved with small business activities (Petty shop, tea stall). Among the Mahali and Roabidas tribal community have their own

tradition occupation *e.g.* shoe making and repairing, bamboo material etc. Regarding average monthly income of the households, majority (50.26%) of the households are up to 4000.00 BDT (U$ 50) per month. Only 3.13% reported that their income is more than 6000.00 BDT (≤ U$50).

The Santal is the major tribal population in the North Bengal of Bangladesh. Other tribal are Oraon, Mahali, Pahan, Munda, Pahari *etc.* who have unique culture and food habit. The main food of the tribal eat rice. Vegetable, meat of wild birds and animals, fruits and different species of fish are their favorite food. They also like cow meat, buffalo, sheep, goat and chicken's meat. They fond of some unconventional wild animals *e.g*. Wild rabbits, mongooses, tortoise, eels, crabs and snail. The pork is very favorite meat of the Santal. As traditional drinks they use a homemade alcohol. They called it Hundi (A kind of rice beer). In any occasion it is mandatory and social accepted.

Food habit of the tribal people is more or less same. Conventional item like rice, pulses, fresh fish, dry fish, meat, milk, egg, leafy vegetables, other vegetables (brinjal, bitter gourd, sweet gourd, white gourd, bottle gourd, country bean, cauliflower, cabbage, yard long bean, okra, plantain stem, radish and arum) potato, tomato, fruits (banana, apple, bitter plum, guava, grapes and papaya), tea, cigarette and tobacco were the intake of the tribal people. It is observed that tribal people ate rice of an amount of 580 g/capita/day which was 24.20% higher than the national average. The tribal people in the study area, mostly ate a very low quantity of meat (14.84 g/capita/day) and fresh fish (25 g/capita/day). Their consumption basket contained very little quantity of pulses (10 g/capita/day), milk (3.84 ml/capita/day), egg (0.1 no./capita/day), sugar/molasses (2.94 g/capita/day) *etc.* They consumed pulses, fish, milk, egg, oil, and sugar/molasses far below

the national average. They consumed edible oil (10.45ml/capita/day) close to national average (9.4 ml/capita/day) that is bellow than national average.

Land, fisheries and forest resources are economically, ecologically, culturally and aesthetically important to the nation. From the global perspectives, the main issues facing by the international tribal community generally are exploitation of these natural resources. It was observed that over use of natural resources is mainly responsible for the loss of bio- diversity that is main food source of tribal people. Destruction of wetlands has a negative impact on poor people especially the tribal people in the study area. The tribal people capture indigenous fisheries items (snail.) that is the main source of protein for the poor tribal. Again loss or depletion of animal and plant species limits the productive opportunities of rural area.

To find out the perception on environmental changes in the study area, 10 no's of Focus Group Discussion (FGD) were conducted. In those FGDs a total of 133 tribal people whose age was between 40 to 60^{+} years. Among them, 90.98% participants said that the environment is changing. Very few percentage participants (9.02%) answered negative.

In the study area a total 56 number of fish species were found. Among them 28.57%(16) fish species were found commonly available, 33.93% (19) were moderately available, 23.93 (13) fish species were found rarely available in the study area. On the other hand, 7.14 (4) fish species were critically endanger and 1.14 (4) fish species are endanger. The declining of the fish biodiversity leads to the tribal food insecurity.

The study found that average per capita calorie intake among the tribal people is 2153 Kcal that is lower than national average (2318.3Kcal). Besides, among

the farm land holding tribal families (28.2%) daily calorie intake is 2582.36 kcal that is upper than the recommended by FAO. Based on calorie intake, most of the sample households (62.6%) were found food insecurity since their per capita per day calorie intake ≥2153. It was high among the tribal who have farm land, service holder and engaged in rather than agriculture daily labor is more food secure since their per capita calorie intake ≤2582.36Kcal.

From the field study, it is found that due to the devastating natural calamities like drought, flood, cold wave, heat wave and tornedo. As a result, the agriculture, fisheries and livestock sectors are affected. These situation leads to decline major crop production even livestock sector also damages. Moreover, the waterbodies in the study area was dried due to drought, therefore, fish production failure.

The tribal people faced several risk factors and constraints in improving their livelihood. These factors were lack of modern technology, education, agricultural land, reduction of land productivity due to drought and natural calamities like flood, drought, and low rainfall. They identified some other problems in their livelihood. These were: loss of biodiversity, loss of wetland resource and forest resources.

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ABBREVIATION

BBS= Bangladesh Bureau of Statistics

BCAS= Bangladesh Center for Advance Studies

BMI= Body Mass Index

BNH= Bangladesh National Herbarium

CA= Commonly Available

CBN= Cost of Basic Need

CHT= Chittagong Hill Tracts

CR= Critically Endangered

DCI= Direct Calorie Intake

DD= Data Deficient

DoF= Department of Fisheries

EN= Endangered

EX= Exotic

FAO= Food and Agricultural Organization

FCD= Flood Control and Drainage

FCDI= Flood Control Drainage and Irrigation

FGD= Focus Group Discussion

GDP= Gross Domestic Product

GECAES= Global Environmental Change and Food Security Systems

GHI= Global Hunger Index

GoB= Government of Bangladesh

HDI= Human Development Index

HES= Household Expenditure Survey

HYV= High Yielding Variety

IES= Institute of Environmental Science

ILO= International Labor Organization

IUCN= International Union for Conservation of Nature

KII= Key Informant Interview

MA= Moderately Available

MDG= Millennium Development Goal

MoEF= Ministry of Environment and Forest

NEMAP= National Environment Management Action Plan

NO= Not Threaten

PRSP= Poverty Reduction Strategy Papers

RA= Rarely Available

SSNP= Social Safety Net Program

UFO= Upazila Fisheries Office

UN= United Nations

UNDP= United Nation Development Program

USA= United Stated of America

VAM= Vulnerability Analysis and Mapping

VU= Vulnerable

WB= World Bank

WFP= World Food Program

WFS= World Food Summit

WHO= World Health Organization

Chapter One

Introduction

The country report of *Human Development Report* (*1995*) in Bangladesh focuses on the recent environmental problems of the country. It reported that in the past, the development strategies and programs in Bangladesh have pursued the economic growth without acknowledging the cost to the environment and the poor people. The result has been undermining of the environment and already fragile natural resources base, up on which a majority of the country's population directly depend for their livelihood and well-being. The growing population of the country puts serious pressure on land, water, forest and other natural resources. The report listed the major environment problems facing the country which include: degradation of land and forest, erosion of soil (riverbank erosion and hill cutting) and decline of soil fertility, air pollution, creeping salinity intrusion, extraction and depletion of ground water, water pollution and water logging, drought, flood and cyclone. Many of the problems have effects on the rural environment and on eco-system; few are urban-environment related. Population of a country at a period of time has a number of quantitative and qualitative characteristics including age-structure, health, education, skill, income and consumption patterns which have both negative and positive impacts on natural resources, production systems and on environment.

Bangladesh faces number of environmental problems due to its geographical location and setting, high density of population, poor socio-economic development and inefficient resources management and institutional framework. The Ministry of Environment and Forest (MoEF) through a nationwide public consultation, identified the major

environmental problems facing the country and categorized them into four broad groups which included sectoral issues, location and eco-specific issues, long-term issues and institutional issues. The elements of natural environment are land, living things (biosphere), water and air.

People depend closely on the natural resource-base for their basic needs, such as food, energy, water, and housing. Their livelihood is closely tied to the well-being of resource base they have. Food production systems interact with land resources, forest ecosystems, and biodiversity. Maintaining the fertility and multi-functionality of soils, preserving genetic diversity, adopting effective water resources management and protection measures, and adapting to climate change are critical to enhancing agricultural production that ensuring food security. More than 1.3 billion people depend on fisheries, forests, and agriculture for employment close to half of all jobs worldwide (FAO, 2004)

Land degradation arises due to soil exhaustion, salinization and desertification. Similarly, due to population growth with poverty, multiple cropping with a shorter fallow period was done to increase food supply. To increase land productivity, farmers use fertilizers, pesticides and herbicides heavily. These methods of intensive land use may be effective in increasing agricultural output in the short term. However, in the long run the soil would gradually lose its nutrients, land is degraded and desertification creeps in. Though irrigation is helpful in ensuring stable water supply for crops all year around, mismanaged irrigation due to lack of knowledge of rural farmers could result in reverse osmosis and accumulation of salt (Duraiappah, 1996).

Poverty contributes to air pollution. The poor depend on biomass and firewood for fuel. The burning of these fuels degrades the air quality and

can cause respiratory problems. Although there are substitute fuels which are less harmful to the environment, the poor have yet to gain access to them and may not be able to afford.

The marine water bodies are also remarkable in biodiversity, harboring 442 species of fish and at least 36 species of marine shrimps. About 336 species of molluscs, representing 151 genera have been identified from the Bay of Bengal. In addition, several species of crabs and 31 species of turtles and tortoises, of which 24 live in freshwater are found in Bangladesh. In addition, the IUCN Bangladesh Red Data Book (2000) has described 22 amphibians, 126 reptiles, 628 birds in total (388 residents and 240 migratory) 110 inland mammals, as well as 3 species of marine mammals in Bangladesh.

The importance of edible wild plants has been shown that these plants can often provide better nutritional quality than conventionally eaten plants (Grivetti *et al.*, 2000).

Bangladesh was very rich in natural resources with fertile land, various crops, vegetables and fruits, fishes and forest with enriched biota. The people particular the tribal people had lot of livelihood support (*e.g.* food, nutrition, water, fodders, fuel *etc*.) from their own homestead, common property and natural resources grown around them. Many unwise human interventions in the recent decades backed by rapid population growth, growing demand of food and eco-systematic services, commercial interest of the rich and powerful elites, unequal and unjust economic and social development have destructed the once rich natural resources base and ecosystems, which again puts incredible strain on the livelihoods and wellbeing of the vast majority the poor and tribal people.

Since the ancient time, many tribal communities have been living in the in Bangladesh. Majority of these tribal people are landless. They belong to different groups like Santal, Oraon, Mahali, Pahan *etc*. These communities have own distinct identities, unique languages, separate culture and food habit.

The important linkage between poverty reduction, livelihood promotion of tribal and natural resources conservation is well recognized by the development thinkers, researcher. Poverty reduction efforts must consider and address the poverty-environment and natural resources issues simultaneously because natural resources and environment give the essential basis and elements for economic activities and livelihood option of the population of a society.

Traditionally, the livelihoods of these tribal groups are based on their access to the surrounding natural environment and its resources. Now their livelihoods are being damaged due to market economies. Ethnic communities are a part of the ultra-poor and live in highly food insecure areas. According to the WFP (2004) report, more than 80 percent of the ethnic population live in rural areas and depends on agriculture and natural resources for their survival.

Foods, Fodders, Medicine and other forest products have made a traditional economy of the tribal communities of the world (Miah, 2003).

Foods, Fodders, Medicine and other forest products have made a traditional economy of the tribal communities of the world. Tribal people are the ecosystem people who live in harmony with the nature and environment (Sajem and Gosai, 2006).

The livelihoods of tribal and forest dwellers are mainly dependent on the forest which has built up their socio-economic and culture life. So, the

socio-economic and cultural life of the tribal and forest dwellers is closely associated with forest to a great extent. The forest has been playing a vital role in the economy of the tribal in Bangladesh. The religious, cultural and economic activities of them also depend on forest (Khisa, 1998).

In Bangladesh, ethnic or indigenous people like Chakma, Marma, Garo, Monipuri, Santal and others consume some molluscs species as food sources.

A tribal economy should always be characterized by the collection of their social, institutional, technological and finally economic arrangements through which the community seeks to enhance their materials and social well-being. There is always an interaction between the environment in which the community lives and their practices that led to sustain their livelihood. Natural environment, surrounding the people, provides several goods, services and amenities to them.

The researcher stated that some extent is conscious about the environmental and climate changes, decreasing water availability, deforestation, decrease in open water fish production. So environmental change and impact of human activities can be profoundly damaging the natural resources based food security of the ethnic or indigenous groups of Bangladesh.

There are some report and research on food security, food habit of tribal of Chittagong Hill Tracts but no authentic literature on food security of tribal on north-western region of Bangladesh.

Although, many study were carried out on the food security issues. Recent studies carried out in coastal areas of Mexico, Nicaragua and Vietnam; show that aquatic species, such as clams and oysters, that are important components of the diet of riverine population, may contain relatively high

concentrations of DDTs, lindane, HCHs, endosulfan, toxaphone, chlorpyrofos amongst other crop protection chemicals (Carvalho, 2006)

1.1 Tribal or Indigenous People

1.1.1 Who are Tribal, Indigenous, Upazati, Khudra Nregrosti?

The term "tribe" originated around the time of the Greek city- states and the early formation of the Roman Empire. The Latin term, "tribus" has since been transformed to mean "a group of persons forming a community and claiming descent from a common ancestor" (Fried, 1975). The meanings tribes is any systems of social organization comprising several local villages, bands, districts, lineages, or other groups and sharing a common ancestry, language, culture and name, common occupation, interest, habitat.

Gregory (2003) said that a group of persons with a common occupation, interest, or habit referred them as a one family.

Fried (1975) said that tribes are the people with special attachments to land, kinship ties, a unique culture, certain religious beliefs, particular activities or material possessions that differentiated and separated them from the mainstream.

Different terms are used by sections of the population throughout Bangladesh to refer to its indigenous peoples. These differences have sometimes led to sharp disagreements, particularly between government officials and members of the indigenous peoples. In referring to the peoples concerned, some officials of the Government of Bangladesh (GOB) prefer the term "*upajati"* (literally "sub nation").

The Tribal people in Bangladesh are identified in different other name or term such as Tribal, Upazati, Adivasi, Khudra Nre-gosthi, ethnic group. Khudra Nre Gosthi meaning to 'small ethnic groups' was introduced in a recent law '*Khudra Nre-gosthi Sangskritik Pratisthan Ain* 2010'.

1.1.2 Tribal People in Global Context

According to Goehring (1993) there are approximately 263,891,000 indigenous people distributed over 6 continents and in more than 85 countries, and representing about 4 percent of the world's population. By far the largest representation of indigenous peoples live in Asia. However, there are only a few places where indigenous people find themselves to be a majority in their traditional homeland.

Another sources (Culturalsurvival.org) said that there are approximately 370 million Indigenous people in the world, belonging to 5,000 different groups, in 90 countries worldwide. Indigenous people live in every region of the world, but about 70% of them live in Asia. Among the indigenous peoples constitute about 5% of the world's population, yet account for about 15% of the world's poor. Today, Indigenous people speak some 4,000 languages.

1.1.3 Tribal People in Bangladesh

Bangladesh of the home of many tribal communities. There is no exact number and names of the tribal people with population. There are confusions about the number of tribal groups in Bangladesh. As Kabir (1972) State Acquisition and Tenancy Act 1950 considered following twenty-two tribal communities in Bangladesh.

Table 1. Tribal People in Bangladesh as Tenancy Act 1950.

1) Santal	8) Hadis	15) Maghs
2) Banais	9) Hajangs	16) Mal Paharias
3) Bhuiyas	10) Hos	17) Sauria Paharias
4) Bhumijes	11) Kharias	18) Maches
5) Dalus	12) Kharwars	19) Munda
6) Garos	13) Khoch	20) Mundia
7) Gonds	14) Koras	21) Oraons
		22) Turis

The accurate number of tribal people in Bangladesh is uncertain. According to the Bangladesh *Khudra Nre Gosthi Ain Sankskritic Ain* (2010) officially declared that there are 27 different tribal groups spread out across the national territory with the north, north-west and north-east, southeast region.

Bangladesh is the home of many tribal communities. There is no exact number and names of the tribal people with population. According to the Bangladesh Poverty Reduction Strategy Paper (PRSP) 2009, there are 45 different indigenous communities was mentioned.

According to the Census 1991, there was 27 numbers of tribal communities in Bangladesh. Rafi (2006) claimed in his book named *Small Ethnic Groups of Bangladesh: A mapping Exercise* that a total of 73 small ethnic groups living in Bangladesh.

From time immemorial tribal people have lived beside the forest that, with its multiple uses, is intimately connected with their life. Such services from the forest have played a vital role in the economy of the tribes in Bangladesh. Their religious, cultural and economic activities depend on

their forests. The Chittagong Hill Tracts comprising the three hill districts: Rangamati, Khagrachari and Bandarban, have a population of 1.1 million (Chowdhury, 2007). The region constitutes 10% of the total land area of Bangladesh (Raihan *et al.*, 2009) and 76% of the total hilly region of the country (Khisa, 1998). Banik (1998) have recorded 12 types of tribal people living in the CHTs.

For the centuries, these tribal communities have been living on slash-and-burn agriculture (locally called Jhum), fishing, hunting and harvesting of forest products (Mustafa *et al.*, 2002). The Mro or Murung are one of the ancient ethnic minorities of the CHTs region (Roy, 1996), and they exhibit a different socio-political organization compared to other tribal groups (Ahmed, 2002). In exploiting forest products, the Mro apply their own knowledge traditionally transmitted from their precursors (Miah and Choudhary, 2004).

Indigenous knowledge (IK) refers to that knowledge which is generated and transmitted by communities over time, in an effort to cope with their own agro-ecological and socio-economic environments (Alam and Khisa, 2000; Mohiuddin *et al.*, 2002 and Alam, 2002).

According to the government statistics the total number of tribal is 12, 05,978 which is only 1.03 percent of the total population. However enough doubts remain about this number of Adivasis (BBS, 1991). In the last census of Bangladesh government (2011), total tribal/indigenous population is 1586,141 which is 1.10 per cent of the total population.

1.1.4 Food Habit of Tribal People in Bangladesh

The tribal are not only distinct as regard to their religious practices, belief and totemic division, but they a different way of living too. The freshwater molluscs play a vital role in the economy and tradition.

In Bangladesh, snails are used as supplementary feed of prawns. The importance of these snails in mitigating the protein deficiency of the tribal people. Accordingly, the present study is an attempt to focus the possible use of freshwater edible snails in Bangladesh as a food of human and domestic animals as well as a supplementary feed for shrimp culture in Bangladesh.

The food habit of a community depends on their culture and tradition. The tribal people is always sensitive to their culture. Rice is the staple food of all types of tribal people living in the plane land are fond of rice. They also take vegetable, meat, different types fish, egg *etc*. They also eat meat of ducks, hens, pigeons, goat, ram *etc*. The food habits of some major tribal community is given bellow.

a. Santal: The Santal is the major tribal population in the North Bengal of Bangladesh. The main food of the Santal is rice. Vegetable, meat of wild birds and animals, fruits and different species of fish are their favorite food. They also like cow meat, buffalo, sheep, goat and chicken meat they eat. They are fond of some unconventional wild animals *e.g.* wild rabbits, mongooses, tortoise, eels, crabs and snail. The pork is very favorite meat of the Santal. As traditional drinks they use a homemade alcohol. They called it Hundi (A kind of rice beer).
b. The Oraon is the second largest tribal community in North Bengal of Bangladesh. They have own language, culture, tradition and unique food habit. Rice is their staple food. They also eat meat of animals, birds, fruits and roots. They eat different types of fish. Wild mushroom is their very favorite food menu. Like Santal they eat the meat of wild rabbit, porcupines, aquatic animal like tortoise, eel, crabs, shells *etc*.

c. Other tribal community *e.g.* Mahali, Mahato, Munda, Pahan *etc.* have distinct language, culture but food habit is more or less same.

Majority of the tribal population of Bangladesh lives in the borderland in Bangladesh. hilly area that is forest ecosystem, many lives in the wetland ecosystem, and some are plan land ecosystem and has its own socio-culture pattern, tradition and typical food practices. Most of these tribal has small farm land holding.

Tribal mostly eat vegetables of leafy varieties, which grow as wild weeds (Maikhuri, 1996) and depend on such natural products for their food. In time to scarcity of when the staple food is in short supply, peoples are mostly depending upon various species of wild plants.

Some areas like *Barind* Track that is known as drought area where have only single crop farming. The rest season, they depend on forest or natural wetland sources for food. Mostly their nourishment comprises variety of unconventional foods, vegetable, edible forms of flowers, fruits, tubers, leaves, stems, seeds, and wild mushrooms *etc*.

1.2 Environmental Situation in Bangladesh

1.2.1 The Environment

Environmental science is an interdisciplinary study of human relationship with other organisms and the non-living physical environment. It uses and contains information from many disciplines, such as biology (particularly ecology), chemistry, geology, physics, economics, sociology, anthropology, environmental psychology, natural resources management, agriculture, engineering, law and political science.

1.2.1.1 Component of Environment

Biotic and abiotic are the main component of the environment. Biotic component includes world's living organism *e.g.* animals, plants. On the other hand, abiotic component comprises non-living things *e.g.* land, water, air *etc*.

1.2.1.2 Environment of Bangladesh

Bangladesh is a country of about 147,570 square kilometers, including inland and estuarine water. 6.7% of the country is rivers and inland water bodies. The congruence of the three mighty Himalayan rivers – the Ganges, the Brahmaputra and Meghna drain into the Bay of Bengal and the alluvial deposits carried down mostly by these mighty rivers for thousands of years have formed Bangladesh. It is the largest delta in the world.

Bangladesh harbors a diverse and extensive fauna and flora. Joadder *et al*. (2015) reported 266 species of freshwater fish species and 442 marine species. The fauna, especially the wildlife includes 125 species of mammals, 750 species of birds, 500 species of fishes, 125 species of reptiles and 9 species of amphibian. The number of species, especially the flora and invertebrates, of Bangladesh are not known for certain. Mustafa *et al*. (2002) reported that Chittagong zone alone possess over 2,259 species of flowering plants. Rana *et al.,* (2009) stated that there are over 700 species of flowering plants, 500 species of medicinal plants, 300 species of mangrove and mangrove associate plants and 300 species of wetland plants in Bangladesh.

1.2.1.3 Rural Environment and Degradation

Poverty, growth and environmental sustainability are inextricably bound together in Bangladesh. Half the population depends on an over-exploited and degrading natural resource base. Industrial and urban growths are

contributing economic livelihoods but already are serious threats to environmental and human health because of inadequate attention to environment and sustainable development.

1.2.1.4 Wetland Resources in Bangladesh

Bangladesh possess enormous wetland areas out of which the principal ones are rivers and streams, fresh water lakes and marsh including *haors, baors and beels*, water storage reservoir, fishponds, flooded cultivated fields and estuarine systems with extensive mangrove swamps. There are about 700 rivers in Bangladesh the estimated length of which is 24,140 km (Rahman, 1994). The major wetlands of Bangladesh are vast floodplains and delta of the Ganges, Meghna and Brahmaputra rivers. The total areas of the wetlands in the country have been variously estimated at seven to eight million hectares, about 50% of the total land surface. But the resources have suffered considerably from the impact of burgeoning human population. Millions of hectares of wetlands have been lost due to flood control, drainage and irrigation development. The demand for land is enormous considering the density population at over 1222 persons per square km (World Bank, 2014). Erosion in the catchment areas is causing increased situation and having major impacts on the key wetland areas which are being continuously lost or degraded primarily because of the recent development and lack of awareness on wetland functions and values (BCAS, 1995).

1.2.1.5 Wetland Environment

Wetlands in Bangladesh have great ecological, economic, commercial and socio-economic importance. It contains very rich biodiversity of local, national and regional significance. Among the estimated 5,000 species of flowering plants and 1,500 of vertebrates in the country up to 300 plant species and some 400 vertebrate species are judged to be dependent on

wetlands for all or part of their life span. Wetland also provide habitat for a variety of resident and migratory waterfowl along with a significant number of commercially important ones. The inland capture fishery is based on the vast freshwater resources with some 284 species finfish and shellfish (DoF, 2005).

1.2.1.6 Multiple Environmental Changes and Their Effects on Human Well-Being

Humans have had the ability to change their environment for thousands of years. Today this ability is greater than ever. This is because more people living now than ever before and human activity is concentrated in huge cities. Also, science and technology allow interfering with natural processes in more direct ways. Years of thoughtless exploitation of nature by man has resulted in the effects staring right in our face now. The truth, that in the bid to improve our lives, we have put our own survival to stake, has finally hit us hard. Now as more and more studies and researches are being carried out to understand how humans affect the environment, an increasing number of people are awakening to the fact that the well-being of the environment and survival are intricately woven into each other.

Anthropogenic activities creating impact on the environment includes impacts on biophysical environments, biodiversity and other resources. The term *anthropogenic* designates an effect from human activity. Human impact on biodiversity is significant; humans have caused the extinction of many species including the dodo and perhaps even many of the large mega faunal species during the last ice age. Though most experts agree that human beings have accelerated the rate of species extinction, the exact degree of this impact is unknown, perhaps 100 to 1000 times the normal background rate of extinction.

1.2.1.7 Environmental Pollution

Pollution involves introduction of undesirable and harmful material in an ecosystem. Most of these pollutants adversely affect the biotic community. The hardy and stronger ones survive. Weak and susceptible species are eliminated. As a result, the structure and function of the entire ecosystem are disturbed and a number of species suffer.

1.2.2 The Biodiversity

Biodiversity in simple terms refers to the variability among life forms on earth, including genes, species and ecosystems (Groombridge, 1992).

In both cases of declining biodiversity and altered weather, food security becomes a key issue (UNDP, 1995). Destruction of biodiversity through deforestation has been blamed as one of the key factors in exacerbating the impact of extreme weather events such as hurricanes and droughts.

Food security depends not only on having enough food to eat, but also having quality food with sufficient nutritional value. Addressing dietary diversity therefore requires a multi-dimensional approach focusing on nutritional and health status, social and cultural traditions, income generation and biodiversity conservation.

1.2.2.1 Bio-diversity at Global Context and Depletion

As millennium ecosystem assessment report Bio-diversity loss is one of the gravest environmental concerns in the world. The Bio-diversity resources in the world are decreasing at a rapid rate. The same report reflected that the last 50 years have been the biggest biodiversity upheaval in the human history. Over half of the world's biomes (vegetation types) have experienced about 20-50% conversion to human use. The rate of change has been greatest in tropical and sub-tropical dry forest. Some 35% of mangroves and about 20% of cords have gone (Alam, and Khisa, 2000).

One- third of all amphibians, a fifth of mammals and an eight of all birds are now threatened with extinction. It is thought 90% of the large predatory fish in the oceans have gone since the beginning of industrial trawling.

Biodiversity is an expression of the variety of living things, at genetic, species, and ecosystem level (Harper, 1994). Life as we know it will not be the same if our rich biodiversity heritage is altered in at great extent.

1.2.2.2 Biodiversity Vulnerable

Species are becoming extinct at an alarming rate. The current threat to biodiversity and thus to exquisite tapestry of life, stems primarily from rapidly expanding human populations (particularly in the developing world) and increasing consumption of natural resources (in the developed world). The question of protection of the earth's rich biodiversity has now become not only a matter of ethics, but of the very survival of the human race. Biodiversity loss will severely limit our quality of life, not to mention the potential to feed, cloth, shelter and treat future generations.

The depletion of earth's biodiversity is one of the most pressing environmental and developmental issues. The developing counties loss potential for sustainable development with the loss of each species (Agarwal, 1996). Biodiversity convention has adopted in the "Earth Summit" held in Rio De Janeiro, Brazil, 1992 included three components (i) Conservation of biodiversity, (ii) Sustainable uses of resources and (iii) Equitable distribution of profits from diversity. How fast the genetically distinct populations and species of organisms are disappearing remained unknown but the rates are far too high now and are accelerating (Agarwal, 1996). A Harvard biologist, Edward Wilson estimated that nearly 140 species are being extinct every day (Kapoor, 1994).

In the recent times, the government of Bangladesh is planning some concrete measures to protect our beleaguered environment and our living resources. Good number of national and international groups is working to reduce the biodiversity depletion.

1.2.2.3 Species on the Earth

Cunningham (2001) has shown tha estimated number of present species that is 2.1 million (Appendix 1). Taxonomists estimate that there may be somewhere between 3 to 50 million different species alive today. About 70 percent of all known species are invertebrates.

Every moment, billions of components of biodiversity is being death and extinct from the earth planet. The elimination of a species is a normal process of the natural world. Species die out and are replaced by others, often their own descendants, as part of evolutionary change.

Smith *et al.* (1998) has suspicioned that human impacts on population and ecosystems have accelerated the extinction of hundreds or even thousands of species, subspecies and varieties become extinct every year. If present trends continue, we may destroy millions of kinds of plants, animals and microbes (Appendix 2) in the next few decades.

1.2.2.4 Major Causes of Depletion of Biodiversity

Usually, disturbances of any type in an ecosystem tend to reduce its biological diversity. As human pollution rises, an ever increasing demand for raw material, food and space is placed on natural ecosystem while enormous quantities of wastes and spoils are introduced into the environment. The pressure of human demands and pollution of environment collective damage the biotic component of natural systems either partially or completely major causes of depletion in biological diversity can be summarized as follows:

1.2.2.4.1 Destruction of Natural System

The requirement of space, food and raw materials for expanding human establishment is one the most important cause of such a rapid decline in biological biodiversity.

1.2.2.4.2 The Boreal Coniferous Forest of the North

The northern most belts skirting the arctic sea are probably the only habitat in the world where losses of biological diversity are modest. This region is very thinly populated and possesses little diversity in its species composition due to the harsh and severe climatic conditions.

1.2.2.4.3 Temperate in Sub-Tropical Region

These two regions support extensive agriculture and cattle ranching. The tall grass prairies of North America and the hardwood forests of Europe are disappearing or have already disappeared. The temperate rain forests are also endangered ecosystems of the original 31 million hectares nearly 18.7 million have already been cleared (Asthana, 2001).

1.2.2.4.4 Tropical Region

The tropical regions are designated as mega diversity countries and are endowed with richest flora and fauna of the world. The population is rising rapidly in this region. To make up food crisis and improve their living conditions, these countries are forced to expand agriculture, modernize it, over-exploit natural resources and tastily set up industries.

1.2.2.4.5 Wetlands

Wetland ecosystems are important store houses for biological diversity. They are provided suitable habitats for a large number of species. In many parts of the world, the wetland ecosystems are being drained and dried for agriculture use of for human settlements or are converted to aqua-culture ponds. Almost 90% of the wetland systems have been lost in industrialized countries, like Australia, USA *etc*. (Asthana, 2001).

1.2.2.4.6 Mangroves

Mangroves are important buffering zone between the land and sea. It possesses a rich flora and fauna. This zone protects the coastline from erosion by ocean waves. Almost half of mangrove forests have been cleared in Ecuador. Thailand has lost nearly three-fourth. Elimination of mangrove ecosystem could cause a significant reduction in biological diversity such as erosion of coastline and decrease in fish production.

1.2.2.4.7 Overexploitation of Natural Resources

Humans are responsible for the depletion or extinction of many large animals by overexploiting them. Overexploitation is responsible for depletion of many species. The so-called mega herbivores are vulnerable and profitable and an annual harvest level of greater than about 10% is likely to be unsustainable (Owen-Smith, 1987). Sharks provide an interesting example. Amongst the most feared of species, large numbers are for sport; many others to make shark-fin soup, whilst a large proportion of the estimated annual 200 million sharks kill are accidental by-catches of commercial fishing. Evidence is mounting that many species of shark have been declining in abundance (Manire and Gruber, 1990). Overexploitation is not restricted large vertebrates. The freshwater mussel was once widespread in the large rivers of Western Europe and Morocco. Now, there is only one known population, in the lower Ebro River in Spain (Altaba, 1990). Iceland, Japan and Norway kill hundreds of whales each year mostly under the guise of scientific research, although the meat and blubber of animals taken in these programs are still sold at a handsome profit. Fish stocks have been seriously depleted by over harvesting in many parts of the world.

1.2.2.4.8 Habitat Disruption

Habitat may be degraded by pollution to the extent that conditions become untenable for certain species. Habitat may be disturbed by human activities

to the detriment of some its occupants. Destruction of forests, wetlands and other biological rich ecosystems around the world threatens to eliminate thousands or even millions of species in a human-caused mass extinction. By destroying habitat, but also many obscure ones of which we may not even be aware.

1.2.2.4.9 Introduction of Exotic Species

Species introduced into habitats where they are not native are considered as an exotic species. Introduction of exotic species has caused extensive damaged to natural biotic community of the ecosystem. *Eucalyptus (Myrtaceae)* plants are introduced in Bangladesh from Australia. The remarkably fast growth of these plants has made them valuable as a source of rough timber. But, these plants appear to be ecological harmful as they tend to suppress the inhabitants of the locality. This plants also cause for desertification as they uptake excess soil water than their requirement. A good example of Ucaliftus plants which found in Sirajgonj district which accelerated desertification in the area.

The seeds of wheat imported to India from USA under PL-480 scheme were contaminated with *parthenium hysterophorus*, the congress grass. The plant has spread throughout India as a pernicious weed in wheat field. Alien species from around the world now threaten native species.

1.2.2.4.10 Predator and Pest Control

Some animal population have been greatly reduced or even deliberately exterminated, because they are regarded as dangerous to humans or livestock or because they compete with our resources. Every year, US government animal control agents trap, poison, or shoot thousands of coyotes, bobcats, prairie, dogs and other species considered threats to people, domestic livestock or crops. Many others are killed unintentionally

by poisoned bait or misplaced traps or intentionally by private individuals for bounty or sport.

1.2.2.4.11 Natural Calamities

Natural calamities such as flood, drought, forest fires, earth-quakes, volcanic eruptions, cyclones *etc*. sometimes take a heavy toll of plants and animals life. Floods are inundated much of the ground vegetation in the study area of Sirajgonj, trapped a large number of animals and leached away soil nutrients to make soil poorer. Due to the leached away of soil nutrients by floods, soils of the study area became stilt rated. Droughts are also affected ground vegetation of the area. Forest fires reduce to ashes a large number of plant and animal species which is a common phenomenon in Australia and many Latin American countries. Volcanic eruptions may completely destroy plant and animal life in its surrounding areas. Cyclone, like Sidr, sometimes destroy large portions of flora and fauna which is also a common picture in many parts of Bangladesh.

1.2.2.4.12 Genetic Consideration

Many plants genetic resources which are important for future agricultural development and food security are threatened today. It is well recognized that recent losses of diversity have been large and enormous**.**

Incentive cereal cultivation forced by food demand of the increasing population (especially since the introduction of HYV rice and wheat), changes in cropping patterns in favor of cereal (especially rice) monoculture, constructions of numerous flood control embankments and polders that prevented annual deposit of silts and in many cases water stagnation which has change the ecosystem.

1.2.3 Bio-diversity in Bangladesh

Due to geographical setting and climatic characteristic, Bangladesh is a transitional zone of flora and fauna.

In Bangladesh, biodiversity contributes significantly to the country's economy. It influences people's economic, social and cultural development and hence their quality of life; the knowledge, cultural traditions, innovations, and management practices of indigenous communities, and the traditional practices of indigenous communities, and the traditional practices of farmers, and rural communities concerning biodiversity constitute the basis for sustaining both biodiversity and human life. However, biodiversity is being threatened in Bangladesh by the destruction of natural habitats due to the failure to identify the social, economic and cultural value of biodiversity. This threat and the concomitant destruction are possible to increase as population growth continues. It is believing that the problem may minimized through effective implementation of ecosystem based conservation of biodiversity involving community peoples.

1.2.3.1 Biodiversity and Livelihood

The people of Bangladesh depend on biodiversity for their day-to-day sustenance as well as overall livelihood security. According to the report of Daily Star, over 60 million people are dependent on aquatic resources every day. One million people are full-time fisher folk and another 11 million have taken to part-time fishing in the country. Fifty to sixty-five per cent of the country's protein requirement is met by the consumption of fish. The fisheries sector contributes about 3.3% of the GDP of Bangladesh, earning more than 11% or more of the total export revenue, and employs 5% of the country's total work force. The agriculture sector provides 63.5% of the country's employment, contributing a considerable

24% to the GDP. Of the sector's contribution to the GDP, approximately 7.1% is covered by the forestry. The various forestry-related projects in the country together generate 90 million person-days of job opportunities every year. The Sundarbans provides livelihood and employment to an estimated 112,000 people (Islam et al., 2014). With more than 130 million people, a population growth rate of 1.48%, and a population density of 834 people per square kilometer, the pressure on the nation's natural resources is tremendous.

1.2.3.2 Status of Biodiversity in Bangladesh

This country is rich in fish and aquatic resources, and other biodiversity Bangladesh's inland water bodies are known to be habitat of 266 species of indigenous fish, 13 exotic fish, 56 prawns, about 26 fresh water mollusks, and 150 birds. The marine water bodies (200 nautical miles along the cost) are also remarkable for being habitat of 442 species of fish. There are at least 36 species of marine shrimp. About 336 species of molluscs, covering 151 genera have been identified from the Bay of Bengal. In addition, several species of crabs, and 31 species of turtles and tortoises, of which 24 live in fresh water, and found in Bangladesh (Ali, 1997) and (Ali and Ahmed, 2001) published a species list of 168 seaweeds, 3 sponges, 15 crabs, 3 lobsters, 10 frogs, 3 crocodiles, 24 snakes, 3 otters, 1 porcupine, 9 dolphins, and 3 species of whale found in Bangladesh.

There are numerous invertebrates in the country that are yet to be identified. Various authors have recorded about 70 species of bees, and many species of wasp (Alam, 1967).

In Bangladesh, only about 8-10 per cent of the land area is under good canopy cover. It supports approximately 5000 species of angiosperms, out of which about 300 species are being cultivated. The list of medicinal

plants is currently being revised at the Bangladesh National Herbarium (BNH), and is expected to exceed 500 Species. (Mia and Huq, 1986) showed that there are 224 species of timber-yielding plants found in Bangladesh. (Khan and Mia, 1984) described 130 species of indigenous fiber plants.

The IUCN Bangladesh Red Data Book (2000) has described 266 species of inland fishes, 17 marine fishes, 22 amphibians. 109 inland retiles. 17 marine reptiles 388 resident bird, 240 migratory birds, 110 inland mammals, as well as 3 species of marine mammals in Bangladesh.

1.2.3.3 Biodiversity Extinction

According to the Red List of IUCN (2000), there are 54 species of inland fishes, 8 amphibians, 58 retiles, 41 resident birds, and 40 mammals, which are threatened throughout the county. Among the marine and migratory species of animals, 4 fishes, 5 reptiles, 6 birds, and 3 mammals are threatened. So far, so far, the Red Data Book on plants which is under preparation at BNH (Bangladesh National Herbarium), lists 96 seed-bearing plant species that are threatened.

1.2.3.4 Depletion of Biodiversity

The depletion of biodiversity is the result of various kinds of human development interventions and activities, especially in the areas of agriculture, forestry, fisheries, urbanization, industries, chemicals, minerals, transport, tourism, and energy.

Both flora and fauna are threatened by the loss habitat resulting from increasing human populations, and unwise bio-resource utilization. Increasing demand for timber and fuel-wood, encroachment for other purposes, and *Jhum* (shifting) cultivation in the hilly district, might be the aggravating factors in the annual rate of deforestation and degradation. The

unplanned rapid urbanization and industrialization are leading to waste and pollution problems that affect natural ecosystems. As the land and water-based ecosystems are environmentally compromised, the flora and fauna populations are being seriously affected.

1.2.4 Habitat Depletion and Over Exploitation

1.2.4.1 Fish

The people of Bangladesh largely depend on fish to meet their protein needs, especially the poor in rural areas; several decades ago there was an abundance of fish in this country. But recently, capture fish production has declined to about 50 per cent, with a negative trend of 1.24 per cent per year (Ahmed, 1995). Despite the constant depletion of the river, canal, and flood plain habitats for years, Bangladesh still holds the world's most diverse and abundant inland fisheries. But the availability of many species that were very popular locally has been drastically decreased, and some are no longer found in the country.

1.2.4.2 Amphibians

A total of 32 species of amphibians were recorded under six families. Family Dicroglossidae comprised the highest number of species (12) where Bufonidae the lowest (1 species). Among these species 34% were uncommon, 31% common, 19% rare and 16% very common (Rahman, 2015). Alpha diversity was the highest in Dudpukuria-Dhopachari Wildlife Sanctuary (28) and the lowest in Sitakunda Eco-park (13). Beta diversity was the highest (11) between Inani Protected Forest and Sitakunda Eco-park and the lowest (3) between Dudpukuria-Dhopachari Wildlife Sanctuary and Teknaf Wildlife Sanctuary. Fifty percent of the species were found to use more than two habitats, while only 16% species were restricted to a single habitat. Significant number of the species (20 species) were found to use forest edges, aquatic environment (19 species), forest

floor (15 species), agricultural land (13 species), bushes (7 species) and tree habitats (3 species).

1.2.4.3 Reptiles

The depletion of reptilian fauna in the country is noteworthy. Retiles are environment friendly as they eat agricultural pests, and help control their numbers. However, turtles, tortoises, snakes, lizards, and crocodiles are exploited economically because of a tradition of making useful commodities from their body parts, *e.g.*, bones, skins, *etc*. therefore, most of them are in high demand by traders in these items, and are over-exploited.

1.2.4.4. Forest Bio-diversity

Population pressure is often cited as a primary reason for encroachment of forest areas and conversion to crop lands. It is true that there are many example of people especially tribal people living in harmony with forests while protecting and consuming them. Unfortunately, such traditional practices have been lost and a more commercial approach to forest exploitation has led to large-scale deforestation in Bangladesh over the last several decades.

1.3 Food Security and Food System

Food is a basic necessity and one of the five constitutional fundamental needs to be ensured to all people at all time by the state. It shall be a fundamental responsibility of the State to secure its citizens to the provision of basic necessities of food ("Constitution of The People's Republic of Bangladesh").

The Government of Bangladesh is strongly committed to ensure food security for all that defined at the 1996 World Food Summit as: "Food security exists when all people, at all times, have physical and economic

access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life".

1.3.1 Food Consumption and Poverty Situation in Bangladesh

According to FAO (2014), per capita food supplies have increased from 2,309 kcal per day equivalent in 2000, to 2,435 kcal in 2004, and 2,481 kcal in 2009 in Bangladesh, which is higher than several South Asian countries including India, Pakistan, Nepal, and Sri Lanka. On the other hand, as the report of WFP (2005) the direct calorie intake method has defined 2,122 kcal per day or below defines "absolute poverty," while "hard-core poverty" refers to a calorie intake of less than 1,805 kcal per capita per day.

As the repot of Bangladesh Planning Commission, 2013, there has been a rapid decline in the proportion of population declining below the upper poverty line, from 48.9% (31.7 million people) in 2000 to 34.5% (15 million) in 2010. The incidence of extreme (lower) poverty cut down from 34.3% (22.2 million people) in 2000 to 17.6% (8.4 million) in 2010. The poverty reduction between 2000 and 2010 (1.7% per year for upper poverty) was faster than the previous decade (Goehring, 1993). The decline in poverty is attributed to increased farm incomes; a greater share of the population reaching working age, which has led to lower dependency ratios; and a tripling of migrants' remittances. In addition to the poor and extremely poor, another vulnerable group are those that fall into the income category that is 25% above the poverty line, which accounts for 19% of the population (about 30.1 million people). Many if not most of this group are one major shock away from falling below the poverty line. Adding this group to the poor and extremely poor indicates that about 50% of the country's population is poor, extremely poor, or very vulnerable to falling below the poverty line.

1.3.2 Food Systems and Food Security

1.3.2.1 Food Systems

Food systems is the entire series of activities involved in the food production, processing, marketing, consumption and disposal of goods that originate from agriculture, forestry or fisheries, including the inputs needed and the outputs generated at each of these steps. Food systems also involve the people and institutions that initiate or inhibit change in the system as well as the socio- political, economic and technological environment in which these activities take place (FAO, 2012).

The outcomes also contribute to environmental and other securities (*e.g.*, income). Interactions between and within bio-geophysical and human environments influence both the activities and the outcomes.

Another study by Gregory *et al.* (2005) expresses the complexity of food systems and their link to food security as follows: "Dynamic interactions between and within the bio-geophysical and human environments lead to the production, processing, preparation and consumption of food, resulting in food systems that underpin food security".

1.3.2.2 Concept of Food Security

Food security was defined in that Summit as "availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices". In 1983, FAO expanded its concept to include securing access by vulnerable people to available supplies, implying that attention should be balanced between the demand and supply side of the food security equation "ensuring that all people at all times have both physical and economic access to the basic food that they need".

In 1986, the highly influential World Bank report "Poverty and Hunger" focused on the temporal dynamics of food insecurity. It introduced the widely accepted distinction between chronic food insecurity, associated with problems of continuing or structural poverty and low incomes, and transitory food insecurity, which involved periods of intensified pressure caused by natural disasters, economic collapse or conflict. This concept of food security is further elaborated in terms of "access of all people at all times to enough food for an active, healthy life".

World Food Summit, (1996) adopted a still more complex definition "Food security, at the individual, household, national, regional and global levels is achieved when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". Essentially, food security can be described as a phenomenon relating to individuals. It is the nutritional status of the individual household member that is the ultimate focus, and the risk of that adequate status not being achieved or becoming undermined. The latter risk describes the vulnerability of individuals in this context.

1.3.2.3 Household Food Security

A household is food secure when it has access to the food needed for a healthy life for all its members (adequate in terms of quality, quantity, and safety and culturally acceptable) and when it is not at undue risk of losing such access. Food security at global or national level may not usually address the household level food security problem. The relationship between national food security and household food security is less prominent in developing countries than in developed ones. Therefore, specific policies are required to address household level food insecurity and these policies should be contextual and problem-specific.

1.3.2.4 Dimensions of Food Security

Food security is the outcome of food system operating efficiently. Efficient food system contributes positively to all dimensions of food security. Following are the dimensions of food security:

1.3.2.4.1 Food Availability

This dimension of food security reports about supply side of the food security and expects sufficient quantities of quality food from domestic agriculture production or import. This is simple mathematical calculation weather the food available in certain territory/country is enough to feed the total population in that particular territory and calculated from the level of local agriculture production at that territory, stock levels and net import/export.

1.3.2.4.2 Food Access

Having sufficient food at national level or at certain territory cannot be taken as the proof that all the household or individuals in the country have enough food to eat. Food access is another dimension of food security which encompasses income, expenditure and buying capacity of households or individuals. Food access addresses whether the households or individuals have enough resources to acquire appropriate quantity of quality foods.

The indicator of the food access is food price, wage rate, per capita food consumption, meal frequency, employment rate *etc*. and the dimension can be assessed, Food Access Survey, Food Focus Group Discussion, Intra-household food frequency questionnaire *etc*.

1.3.2.4.3 Food Utilization

Food utilization is another dimension of food security which addresses not only how much food the people eat but also what and how they eat. It also covers the food preparation, intra-household food distribution, water and

sanitation and health care practices. The nutritional outcome of the food eaten by an individual will be appropriate and optimum only when food is prepared/cooked properly, there is adequate diversity of the diet and proper feeding and caring practices are practiced.

1.3.2.4.4 Stability

This dimension addresses the stability of the other three dimensions over time. People cannot be considered food secure until they feel so and they do not feel food secure until there is stability of availability, accessibility and proper utilization condition. Instability of market price of staple food and inadequate risk baring capacity of the people in the case of adverse condition (*e.g.,* natural disaster, unexpected weather *etc*.), political instability and unemployment are the major factors affecting stability of the dimensions of food security.

This dimension of food security can be assessed by Global Information Early Warning System, Anthropometric survey, weighing chart of pregnant women *etc*. against certain indicators like food price fluctuation, women's BMI, pre-harvest food practice, migration *etc*. Interventions to address this dimension are saving and loan policy, inter-household food exchange, grain bank, food storage *etc*.

1.3.2.5 Relationship between Food Systems and Food Security

The Food and Agriculture Organization (FAO, 2007) envisions,

> *"vision of a world without hunger is one in which most people are able, by themselves, to obtain the food they need for an active and healthy life, and where social safety nets ensure that those who lack resources still get enough to eat."*

FAO (2005) stressed that "food security depends more on socio-economic conditions than on agro-climatic zones and on access to food rather than

the production or physical availability of food". It stated that, to evaluate the potential impacts of climate change on food security, "it is not enough to assess the impacts on domestic production in food-insecure countries. One also needs to (i) assess climate change impacts on foreign exchange earnings; (ii) determine the ability of food surplus countries to increase their commercial exports or food aid; and (iii) analyze how the incomes of the poor will be affected by climate change".

1.3.2.6 Domestic Production

Food grain production, particularly rice production has tripled in the last 40 years with the use of Green Revolution technology (high yielding varieties, fertilizers, irrigation and pesticide) coupled with growth of institutional infrastructure and a positive shift in public policy and market forces. Rice thus occupies the central stage of food security and continues to draw major attention of the Government for further increasing the production. Rice production continues to increase, but wheat production is showing a declining trend in recent years. Remarkable progress has been made in rice production during the last ten years. In 2001-02, rice production was 24.30 million tons, which has steadily increased to 33.54 million tons in 2010-11 (see table 2). Wheat production also decreased from 1.6 million tons in 2001-02 to 0.97 million tons in 2010-11. Similarly, pulses and oilseed production steadily declined mainly because of the loss of areas under these crops to Boro rice and other remunerative winter crops. Production of vegetables and fruits has increased, but at a slow pace from 1.59 million tons and 1.47 million tons in 2001-02 to 11.19 million tons and 3.56 million tons in 2010-11 respectively. Spectacular success has been achieved in the production of potato. It has made a quantum jump from 2.90 million tons in 2001-02 to 8.30 million tons in 2010-11 (see table 2). Production of non-cereals such as pulses, oilseeds, vegetables and

fruits, which are the chief sources of protein, mineral and vitamin, still remains far below the actual requirements, making it difficult to provide balanced diet for all.

Table 2. Domestic Production (Gross) Trend of Food Grains, Potato, Pulses, Oilseeds, Vegetables and Fruits (2001-02 to 2010-11) (in Million MT).

Year	Food grain		Potato	Pulses	Oilseed	Vegetable	Fruits
	Rice	Whet	2.90	0.35	0.39	1.59	1.47
2001-2002	24.30	1.61	2.90	0.35	0.39	1.59	1.47
2010-2011	33.54	0.97	8.30	0.72	0.84	3.37	3.56
2011-2012	33.89	0.99	8.20	0.24	0.76	3.06	4.33
2012-2013	33.38	1.25	8.60	0.24	0.80	2.93	4.36
2013-2014	34.36	1.30	8.95	0.35	0.85	3.36	4.59

(Year Book of Agricultural Statistic- 20-14, 26th Series, BBS.)

Food insecurity is not only a result of insufficient food production and inadequate distribution, but also of the financial inability of the poor to purchase sufficient food. Bangladesh has made appreciable progress in reducing the percentage of population living below 1.25$ a day from 59% in 1991-92 to 31.5% in 2010. However, more than 17 percent of the population is still extremely poor.

1.3.2.7 High Food Price

The 2008 price hike went on to worsen the situation leading to the number of food insecure people (less than 2,122 kcal/day) to increase by 7.5 million and the number of severely food insecure people (less than 1,805 kcal/day) to increase by 6.9 million. During 2010-2011 periods, price of rice in Bangladesh has increased by close to 30%, flour by 50%, lentils by 15% and chicken by 37%. More recently, since last fall, food grain prices began shooting up again, reaching levels comparable to that of 2008 thus having implications for the health and wellbeing of households and communities particularly the poor and vulnerable groups of mothers and children (Hasan and Habiba, 2015). In 2011, consumer prices rose 11.97 percent in

September from a year earlier, after gaining 11.29 percent the previous month. Food inflation quickened to 13.8 percent in September from 12.7 percent in the previous month. When food prices increase, poor people purchase more of the lower cost staple food and less of the complementary sources of vitamins and minerals, which results in both chronic and acute malnutrition. A mid-1990 study Bouis and colleagues in rural Bangladesh has shown that a 50% increase in food prices results in a decrease in energy intake of 5-15% and a drop in iron intake of 10-30%. Street blockade by garments workers demanding better wages to meet high food prices has been a striking scenario in Bangladesh during last five years. The poor are hit hardest during these price shocks as they spend more of their income on food. The price of rice is mostly controlled by middle-men not by market factors such as demand and supply. Moreover, the structure of domestic rice market is very complex. The presence of restrictive business practices and other disruptive actions (such as deliberate supply shortage) in the rice market contribute to a significant gap between farm-gate price and consumer price of rice. Therefore, international speculation helped business elements make possible to create an artificial crisis in domestic rice market leading to a significant increase in food prices in recent years. The rural households suffer mostly from increased food price because they are net buyers of rice (Dey *et al.*, 2011).

1.3.3 Food Security in Bangladesh

Bangladesh has made strong progress in reducing poverty, which declined at an annual rate of 2.5% from 1991 to 2010, exceeding the Millennium Development Goal (MDG) target of 2.1%. The rate of reduction between 2000 and 2010 (1.7% annually for the upper poverty line) was faster than the previous decade. Other MDGs that have been reached include reducing the poverty gap indicator to 6.5, compared to the 2015 target of 8.0,1 and

reducing the population living under the poverty line from 57% in 1991 to 29% in 2012 (General Economics Division, 2013). Human Development Index, and large numbers of poor and vulnerable households are not food secure. They are unable to attain a minimum basket of food items through their own production, product sales, off-farm employment, and other resources.

Food security situation in Bangladesh has improved, especially on average per capita dietary energy supply has improved from 1800 Kcal in 70s to 3055 in 2009 (BBS, 2011), and further improvements on access and utilization, to be sustainable and large-scale, needs renewed efforts from the government, civil society (including media) and the development partners.

1.3.4 Natural Resource and Food Security

Bangladesh is popularly known as the land of rivers and being the deltaic nations at the mouth of the Bay of Bengal, it has huge coastal areas and islands those supporting a large number of people to survive. Due to anthropogenic pressure and activities the natural resources and environment affects the food security.

In Bangladesh more than 40% of the population lives below the international poverty line and are vulnerable to food insecurity and natural disaster (Doucouliagos and Paldam, 2009). Bangladesh faces a series of environmental problems including deforestation, land degradation, air pollution, water shortage and contamination, as well as loss of biodiversity. The poor play a vital role in influencing these aspects of environmental degradation.

1.3.4.1 Natural Resources

Natural resources play an important role in the life of the poor. More than 1.3 billion people depend on fisheries, forests, and agriculture for employment close to half of all jobs worldwide.

According to the Harriss (2002) described that 90% of the world's 1.1 billion poor those are living on less than $1 per day, depended on forests for at least some part of their income. In 2002, international development agencies estimated that more than 90 percent of the 15 million people working on the world's waters were small-scale fishers, most of them poor, not including the tens of millions of poor who fish inland rivers, lakes, and even rice paddies for protein. While all human societies are linked to ecological processes and healthy ecosystems that produce the requirements for life, rural poor people depend significantly more on natural capital than do other parts of the population. In Africa, more than seven in ten poor people live in rural regions, with most engaged in resource-dependent activities such as small-scale farming, livestock production, fishing, hunting, artisanal mining, and logging. Poor people rely on related harvests as a primary source of income and fall back on natural resources when other sources of income fail. The development agenda is being driven by a few key approaches and policies. These include the United Nations (UN) Millennium Development Goals (MDGs) and the World Bank Poverty Reduction Strategy Papers (PRSPs). Yet these approaches may not fully account for the links between resource management and poverty reduction, and subsequently fail to realize the full potential of natural resources (goods and services) as wealth-generating assets for the poor. This section characterizes the dependence of the poor on natural resources and reviews NRM-poverty linkages in the policies of leading development agencies

1.3.4.2 Natural Resources in Bangladesh

Bangladesh is bounded by India on the west the northeast, Myanmar on the southeast and the Bay of Bengal on the south. It forms the largest delta in the world. The land of Bangladesh is flat, with some up-lands in the northeast and the southeast. The great plain lies almost at sea level along the southern part of the country and raises gradually towards the north. Land elevation in the plain varies from 1 to 90 meters above the mean sea level. The maximum elevation is 1230 m at Keocradang Hill district. The population of Bangladesh is 160 million having an area of 147570 sq. km. and thus making a population density of 880 per square kilometer.

Majority rural poor of Bangladesh depend on Natural Resources (NR) for their livelihoods. Land, water, forests, and live stocks are the sources of livelihoods. The rural economy depends on productivity of the natural resources. Small trade and manufacturing process cannot replace dependency over agricultural and natural resources. People have been losing their entitlement to these resources. On the hand, degradation of land and other resources along with bio-diversity and eco-system are the prime concern for the entire population in Bangladesh.

Some natural resources are renewable as land, water, fisheries and forest and there are others like minerals and mineral oil, gas which are exhaustible and can be used any once. Consequently, sustainable development and management of the exhaustible resources and the quality of renewable resources like land water area since quadroon in the process of development.

1.3.4.3 Interaction Between Poverty and Natural Resources

There are several views of the interaction between poverty and natural resources management. Some view growing populations as adversely

affecting finite natural resources, with technology mitigating the type and degree of impact. In this context, poverty is sometimes seen as a source or "driver" of biodiversity loss and environmental degradation. Conservationists and government officials often see the poor as part of the natural resources problem and as the cause of deforestation, degraded landscapes, and dwindling wildlife populations. A poor person's inability to accumulate wealth from these resources may lead to overexploitation and environmental degradation. This study relates population growth and economic marginalization to worsening environmental quality and declining resources, resulting in long-term declines in food consumption, human health, and food security. This view assumes that poverty leads to cycles of further environmental degradation and ever-increasing poverty. Others view population growth as a source of economic expansion and innovation that leads to greater wealth and better resources management. Research findings describe a great deal of variability in the causes of environmental degradation, ranging from adverse or catastrophic natural events to corrupt local institutions. Evidence from the field also reports a wide range of environmental and social result where the poor exercise management control. Variability in poverty-environment interactions contributed to the development of the asset-based approach to poverty reduction. This approach defines poverty as a multidimensional phenomenon in time and space and proposes strategies to reduce the risks and vulnerability facing poor households, and to enhance their ability to participate in and benefit from new economic opportunities by focusing on their assets. The poor are most affected by environmental degradation.

The effect of human activities on ecosystems has been profound, particularly during the past century. Many critical thresholds of the earth's

biophysical systems have already been crossed as a result of human activities (Rockström *et al.,* 2009).

Though the consequences are complex, there is considerable evidence that ongoing and future climate change will have drastic impacts, especially in the poorest regions of the world. People living directly off the production from the earth's ecosystems are particularly affected by these changes. Forests are affected by increasing temperatures, variable precipitation, fragmentation, and deforestation, loss of biological diversity and spread of invasive species. These factors affect not only the extent of forest but also the structure and species composition within forests (and therefore, forest products) thus impacting on the avail-ability of food and nutrition. Environmentally induced changes affecting forest cover imply both direct and indirect consequences for food security and nutrition: direct consequences result from changes in the availability and quality of food and nutrition, while indirect consequences result from changes in income and livelihoods related to forest products (Vira *et al.,* 2015).

1.3.4.5 Natural Resource Tenure and Food Security

Access to productive resources is a crucial factor in the eradication of food insecurity and rural poverty. Rural landlessness is often the best analyst of poverty and hunger. The poorest are usually landless or land poor. Inadequate rights of access to land, and insecure possession of those rights, often result in entrenched poverty and are significant impediments to rural development and the assurance of food security. Improved access to land allows a family to increase household food consumption, thereby helping to ensure household food security. Improved access to land may enable the family to increase household income by producing a surplus for sale in the market and may improve the ability of a household to access credit. Secure access to natural resources often provides a valuable safety net as a source

of shelter, food and income in times of hardship, and a family's land may be the last available resort in the case of disaster. Natural assets associated with land include water, forests and natural pastures. Moreover, land rights often include collective rights held by social groups and rights of access to common property resources. Besides agricultural land, forests, rangelands, wetlands and wildlife resources are important sources of livelihood and food security (Maxwell and Wiebe, 1999).

1.3.4.6 Resource Tenure and Human Rights

In countries where agriculture and renewable natural resources are the main sources of income, sustainable livelihoods will generally entail the security of land and natural resources rights. Land and other natural resources are backed by different sources of public, international law, including international human rights law. Rights to natural resources can be examined through the lens of international human rights law in terms of the right to adequate housing, property, food, protection against forced evictions, non-deprivation of one's property, employment, an adequate standard of living, and the rights of indigenous and tribal peoples, women, pastoralists and other vulnerable groups (Heltberg, 2002). Non-discrimination is a central human rights principle, always to be respected (Article 26, International Covenant on Civil and Political Rights, 2013). Integrating human rights concerns while addressing resource tenure rights allows taking into consideration other concerns than merely economic; i.e. religious, cultural, and political. It will also help to identify power relations within a given society, which are usually crucial to understand the social and political dynamics around natural resources. When integrating the rights perspective into Swedish development cooperation the principles of non-discrimination, participation, accountability, transparency is central.

1.4 Rational of the study

1.4.1 Literature Review

Kashem *et al.,* (1997) conducted a research on Combating Environmental Degradation in Bangladesh: New Urge for Sustainable Agricultural Technologies. The findings of the study reveal that a lot of environmental changes occurred in Bangladesh during the last ten years; the cultivation of modern rice verities and vegetables has increased along with the use of chemical fertilizers and pesticides. They also stated that some extent is conscious about the environmental and climate changes, decreasing water availability, deforestation, decrease in open water fish production. But they did not find how the environmental change is impacting on food security. They also recommended developing appropriate technologies local situation and environmental variation.

Sinha and Lakra (2005) conducted a research on wild tribal food plants of Orissa and Edible weeds of tribal of Jharkhand, Orissa and West Bengal. They carried out survey among 10 ethnic communities and identified 141 numbers. of wild plants foods and 43 numbers. of edible weeds species that are commonly consumed by the tribal population as per their availability in the nature. These are the integral part of tribal died. Many of this unknown food can be exploited to meet the food and nutrition security of the nation. They assumed that these types of indigenous foods play a vital role for food security and nutritional security of the tribal community.

Butt *et al.,* (2005) conducted a research on the economic and food security implication of climate change in Mali. The findings of the study that Mali may experience moderate economic losses under the magnitude of climate change as projected by HADCM and CGCM models. The losses may be in the range from 70 to $142 million. The risk of hunger in Mali may increase from 34% of the population 44% due to land degradation and further to 64

and 72% due to climate change as projected by HADCM and CGCM models. Various economic, biophysical and policy adaptation can be pursued to mitigate climate change impact in Mali. The result of study suggests that investing in reversal of land degradation, developing heat resistant cultivars and promoting the adaption of improved cultivars may better equip Mali in meeting the changes created by climate change.

Mondal (2005) carried out a study on Economic condition and Nutritional Status: A micro level study among tribal population in rural West Bengal, India. The study addresses the nutritional status of some tribal households in rural West Bengal. They explained that household income is an important variable in determining the nutritional status of the household. The study examined the relationship between occupational groups of tribal households and their nutritional status. However, the study showed that availability of work is an important criterion in maintaining good nutritional status of a household.

Carvalho (2006) conducted a review study on agriculture, pesticide, food security and food safety. He stated that the use of agrochemical including pesticides that are environmentally persistent but remain popular in the developing country. As consequences, persistent residues of the agrochemicals contaminate food and disperse in the environment. Coordinated efforts are needed to increase the production of food but with a view to enhance food quality and safety as well as to controlling residues of food persistent pesticides in the environment.

Sinha and Lakra (2007) conducted a research on wild tribal food plants of Orissa and edible weeds of tribal of Jharkhand, Orissa and West Bengal. They identified 141 nos. of wild plants foods and 43 nos. of edible weeds species that are commonly consumed by the tribal population as per their

availability in the nature. They mentioned that these edible weeds play a significant role in the food security of tribal. But they identified that no systematic information is yet available to document such edible weeds of tribes with food security orientation.

Jahan *et al.* (2007) conducted a study on the commercial production of freshwater apple snail (*P. globosa*) have been playing a significant role in the national economy in Bangladesh. Every season in harvesting time (July to October), a total of 788883.90 bags of snails weighing 28,686.68 tons are being harvested from the hinterland areas of Rajshahi, Naogaon, Natore, Pabna, Sirajgonj, Meherpur, Kustia, Chuadanga, Jessore, Manikgonj, Khulna and Barisal.

Ford (2009) conducted a study on vulnerability of Inuit food systems to food insecurity as a consequence of climate change: a case study from Igloolik, Nunavut. He developed a conceptual model to examine the vulnerability of Inuit food systems to food insecurity as a consequence of climate change. The model demonstrates that food system vulnerability is determined by the exposure and sensitivity of the food system to climate related risks and its adaptive capacity to deal with those risks. The paper focuses on how extreme climate related conditions in 2006 interacted with the food system to affect food security.

Rana *et al.* (2009) carried out a research on Indigenous food habit of the Hajong tribal community in Bangladesh: Implication for Sustainable Extraction and Biodiversity Conservation in North-East Bangladesh. They conducted a survey which showing that various parts of the plants are used as food by the Hajong tribal. Beside those foods, the Hajong also consume wild animals like Pig by hunting. At the same time, the Hajong tribes and especially children of this community consume wild fruits as snack food.

The study reveals that Hajong tribe highly depends on forest for their food. The study shows a particular pattern of food habit of the Hajong tribe of Bangladesh

Baby *et al.* (2010) conducted a study on Nutrient analysis of some commercially important Mollusca of Bangladesh. They found that the importance of the snails in mitigating the protein deficiency in poor countries like Bangladesh can be overlooked. Accordingly, the study is an attempt to focus the possible use of freshwater edible snails in Bangladesh as a food of human and domestic animals as well as a supplementary feed for shrimp culture in Bangladesh. The study also finds out that gross harvesting of snail species is causing an environmental problem in the wetland ecosystem of Bangladesh.

Omotesho and Muhammad *(*2010) authors conducted a research study on optimal food plan for rural household's food security in Kwara state, Nigeria: The goal programming approach. They found that there is high incidence of food insecurity among the majority of rural households whose calorie consumption comprises about 70% carbohydrates. Optimal food plan for rural households in Kwara state is about 38% lower than the one U.S. Dollar World Bank poverty line per person per day. They recommended that farmers of should be assisted to go aboard on dry season farming. Moreover, local food processing should be improvement. The research study recommended that rural households should be educated on the need to diversify their source of income from agriculture.

Biswas and Rahmatullah (2011) conducted a study on a survey of Non-conventional plants consumed during times of food scarcity by the Chakma People of Hatimara village of Rangamatia district, Bangladesh. The result of the study showed that at least 15 plants or plants parts were consumed

by the Chakma people during the time of food scarcity. They recommended that proper nutritional analyses are to be conducted on the non-conventional edible plants consumed by the Chakma. It is expected that such analyses will contribute for finding a solution for the tribal people on the proper non-conventional plants to be consumed during shortage of their staple food.

Paul (2011) conducted a study on a survey of Non-conventional plants consumed during times of food scarcity by the Chakma People of Hatimara village of Rangamatia district, Bangladesh. The result of the study showed that at least 15 plants or plants parts were consumed by the Chakma people during the time of food scarcity. They recommended that proper nutritional analyses are to be conducted on the non-conventional edible plants consumed by the Chakma.

Many researchers have done work on the socio-culture of the tribal people of Bangladesh. From the literature review it is mentionable that most of the research worked on hilly tribal. No research work on the issues of tribal of North Western region in Bangladesh especially in the food security field. From the above literature reviewed it can be said that the present study has been conducted for those tribal people who are socially and economically disadvantaged, separated from the mainstream, and have been miserably suffering due to food related that they consumed from the nature. The above reviewed secondary sources and literature have assisted me in researching the livelihood of the tribal people along with their problems of natural resource access. On the other hand, some limitations and lack of comprehensive discussion among this literature influenced my research as well and in the same way in the future I hope that this research will be of use to future researchers and helps the tribal to solve their food security related problem.

1.4.2 Justification of the Study

Tribal people who are living in hilly forest areas depend on forest products for their livelihood. But many tribal communities living in the plan land also depend on wetland resources for their food and livelihood. Poor tribal colonies in the study region mainly depend on agriculture for their livelihood and earn substantial income from these products. Due over exploitation of wetland resources *i.e*. fishes and plants, degradation of natural habitat of fisheries and plant resources, the food sources are declining. As a result, the poor people, especially the tribal people are depriving from the adequate food.

1.5 Statement of the Problem

According to the report of Doucouliagos and Paldam, (2009) in Bangladesh more than 40% of the population lives below the international poverty line and are vulnerable to food insecurity and natural disaster among them 85% belong to the rural poor.

Bangladesh faces a series of environmental problems including deforestation, land degradation, air pollution, water shortage and contamination, as well as loss of biodiversity. The poor play a vital role in influencing these aspects of environmental degradation.

The existing natural forests in Bangladesh are decreasing at a rate varying from 2.1% per year to 3.3% per year (Rahman, 2012).

This is due to exploitation of forest resources for commercial logging, fuel wood collection as well as agricultural land expansion.

In Bangladesh, inland and coastal capture fisheries have declined and about 30% of inland fish species have become endangered.

The terrestrial and aquatic areas of the country support a large number of diverse biological populations, both plant and animal. It is believed that development practices have caused a significant depletion of terrestrial and aquatic species diversity. Over-exploitation of some very common species in an unwise manner has led to their being reduced to a vulnerable status.

1.6 Aim and Objectives

The important linkage between poverty reduction, livelihood promotion of tribal and natural resources conservation is well recognized by the development thinkers, researcher.

Keeping these in mind, an investigation was carried out following the bellow objectives:

1. To understand the status of socio-economic condition of tribal of North-west region in Bangladesh.
2. To find out the anthropogenic causes for Environmental degradation and tribal people's perception.
3. To identify the Natural resource-based foods of Tribal communities of Northwestern region in Bangladesh.
4. To identify the impact of environmental change on natural recourse base food systems and security in term of availability in the Northwestern region in Bangladesh.

Chapter Two

Materials and Methods

2.1 Study Area

The study was conducted purposively in Rajshahi and Naogaon districts of North-Western region of Bangladesh where large concentration of tribal groups is founded. Five *Upazilas* namely Godagari and Tanor *Upazil*a under Rajshahi district, Sapahar and Potnitola *upazila* under Naogaon district, and Gomostapur sub district under Chapai Nawabgonj district were selected purposively and where tribal community living.

The study area is under the *Barind* Tract that is a characteristic physiographic unit comprising a series of uplifted blocks of terraced land. It is covering 8,720 km^2 in northwestern Bangladesh between the floodplains of the and the Jamuna rivers. It is consisting of greater districts of Rajshahi, Dinajpur, Rangpur, and Bogra of Bangladesh.

2.2 Description of the Study Area

The study area is especially known as *Barind Tract* area of Bangladesh. It is a largest Pleistocene physiographic unit of the Bengal Basin; covering an area of about 7,770 sq. km. Geographically this area lies roughly between latitudes 24°20´N and 25°35´N and longitudes 88°20´E and 89°30´E. The Karatoya to the east, the Mahananda to the west, and the northern bank of the Ganga to the South and Punarbhaba rivers are the main of this area. The *Barind* Tract covers most parts of the greater Rajshahi Chapainawabgonj, and Naogaon districts of Rajshahi division.

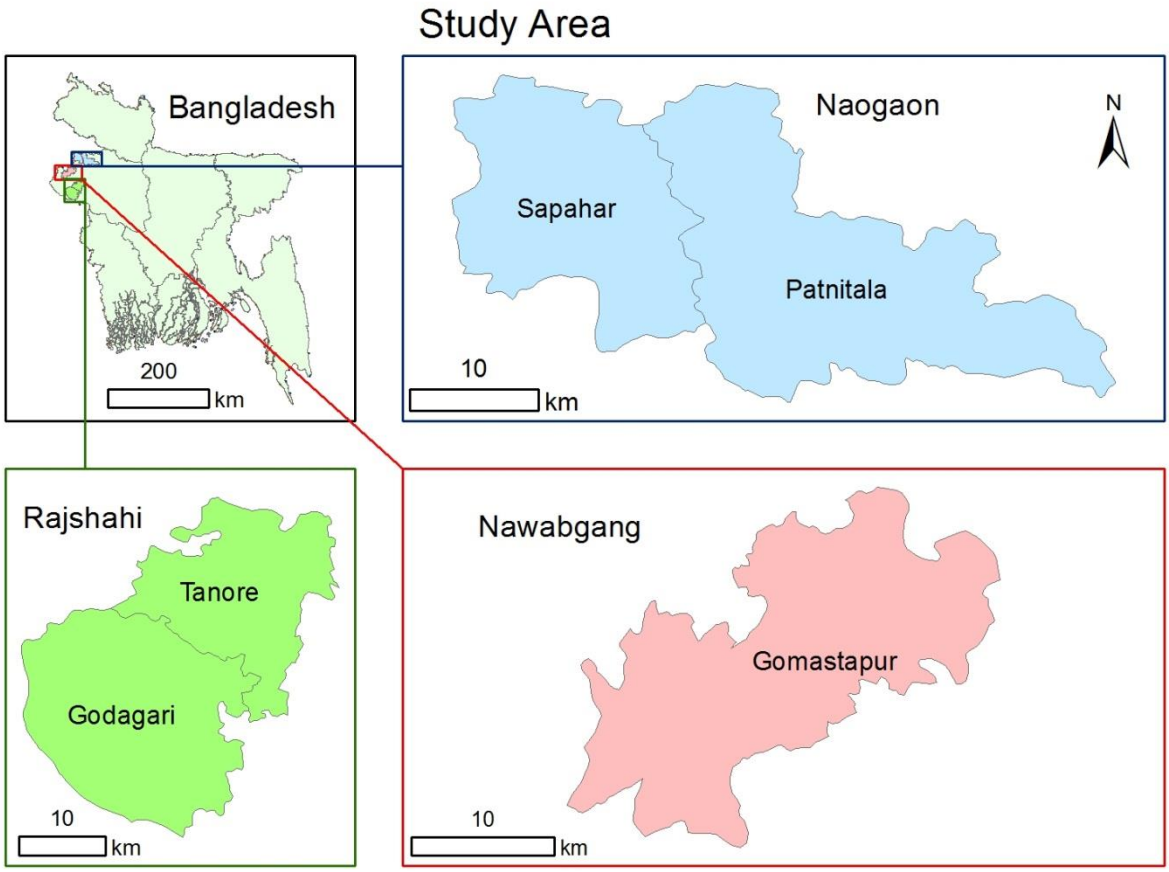

Figure 1. Map of the Sample Sites.

2.3 Weather and Climate of the Study Area

The weather of this area is summer dominant hemisphere and climate is generally warm and humid. Considering rainfall, humidity, temperature and wind pressure the weather condition is classified as, pre-monsoon, monsoon, post-monsoon and winter. The annual rainfall in this area varies from place to place as well as year to year. As example, the rainfall was recorded in 1981 was 1,738 mm, but in 1992 it was about 798 mm only. This region has already been designated as drought prone. The average temperature ranges from 25° to 35°C in the hottest season and 9° to 15°C in the coolest season (Islam, 2003).

The environment of this area is changing and being degrading due to rapid growth population. The climatic condition in this region has changed.

Since rainwater is the main source of groundwater recharge in this area, the climatic change that disfavors abundant precipitation has adversely affected the groundwater recharge system. The withdrawal of more groundwater than its recharge causes the successive lowering of the ground water table of this area. According to some reports from the British colonial times about 42% area of this Tract was covered by forests in early 19th century. Statistical reports of the land survey since 1849 showed that forests covered about 55% of the Barind lands. But by 1974, about 70% land of the region had been changed into cultivable landI (Islam, 2003).

2.4 Sample Size for Respondent for Survey

To determine the appropriate sample size, the researchers use different techniques for sampling. Considering the infinitive sample size, I have use the Cochran's formula for calculating sample size as bellow

$n_{0=}\frac{z2pq}{e2}$, n_0 Where, is the sample size, z is the selected critical value of the desired confidence level p is the estimated proportion of an attribute that is present in the population q = 1-p and e is the desire level of precision

Assuming the maximum variability which is equal to 50% (p =0.5) and taking 95% confidence level with ± 5% precision

The calculation for required sample size is bellow

P= 0.5 and hence q=1-0.5=0.5; e=0.05; z=1.96

So, $n_0 = \frac{(1.96)^2\ (0.5)\ (0.05)}{(0.05)^2} = 384.16 = 384$

2.5 Primary Data

Both quantitative and qualitative data have been collected on the both primary and secondary sources as per requirement of the study to address the objectives.

The quantitative data have been collected from the field survey where an appropriate questionnaire was prepared and used for collecting data from the tribal community of the study area.

For the qualitative data collection three methods *i.e.* Focus Group Discussion (FGD), Case study and Key Informant Interview (KII) have been used.

2.5.1 Focus Group Discussion

A total of 10 Focus Group Discussions (FGD) have been conducted with different stakeholders such as Tribal, farmer and agriculture daily labor with mixed group of community people, people from NOGs, Fisheries and Agriculture Department, Tribal community leader also been interviewed for the purpose. An FGD guideline developed on the basis of the objectives of the study was used for collection of data.

2.5.2 Case Studies

Case studies are also considered important tools for collecting if information from the local community people who provided with valuable information from their long observation and experiences of the particular aspect of the environmental changes, Natural resources, biodiversity of the study area. Case studies were also done in the light of the objectives of the research. A total of 10 case studies has been collected with people of different professions and ages who are the user of the natural biodiversity.

2.5.3 Key Informant Interviews (KII)

KII have been considered as an important method for collection of information on overall aspects of the study based on observations and experiences of the local community people. Where necessary and possible, Key Informant Interviews (KII) has been done with this view for collection of qualitative information on certain aspect as per requirement of the study. KII were conducted in the light of the objectives as well as with the help of the guideline used for FGDs.

A total of 20 Key Informant have been interviewed from the different profession and groups of the people those included community leaders, farmers, small traders, rickshaw / van puller, Local government members, NGO people *etc*.

2.5.4 Field Survey

The impact of environmental changes on food security of tribal households, and find out socio-economic condition of the tribal community in the study area was examined. Toward this purpose, a total of 384 HHs were taken from five *Upazila* (Sub-district) of three districts. On the other hand, a total of 10 Focus Group Discussion (FGD) also conducted for taking some information. The detail information was given bellow-

Table 3. Distribution of Sample Size in the Study Area.

Name of district	Name of Upazila
Naogaon	Potnitola
	Sapahar
Chapai Nawabgonj	Gomostapur
Rajshahi	Godagari
	Tanor

All these locations are facing environmental vulnerability like drought, flood, cold waves *etc*. Moreover, all villages have been selected because they provide a real picture on the various issues that relates to the environmental impact on tribal food systems and security.

In trying to assess the impact of environmental changed on these households following issues like population size, education, and land holding, labor forces, and income expenditure, and employment situation, access to social safety net program (SSNP) were consider. This study was conducted by the research himself. The survey was utilized to find out the research objectives of the study that relates the impact of environmental change on natural resources based food security of tribal community in Bangladesh. It will be the basis to draw an important implication that how environmental change affected tribal community of Bangladesh are facing various problems in terms of their overall life and livelihood and what measures can be taken at the micro-level to overcoming the barrier.

2.5.5 Questionnaire Survey

For the purpose of collection data on the above mentioned issues a preliminary questionnaire was prepared (Appendix 14). The preliminary questionnaires then pre-tested in the study area. Drawbacks, corrections and additional information and also feedbacks which were founded from the field test were reflected in the final preparation of the questionnaires. The study was carried out in period 2012-2015 for collecting the data from the study area and analysis. The head of HHs were interviewed for the data collection.

2.5.6 Secondary Data

Related publications, *i.e*. books, journals, research reports, articles published in the newspapers have been consultant for collection of relevant

secondary data and information of the study. Beyond these, secondary data have also been collected from different government sources like district and *upazila* statistics offices, Agriculture and Fisheries, land offices *etc*. for the study. The secondary data also collected from Bangladesh Bureau of Statistics (BBS website), International Union for Conservation of Nature (IUCN) Red Book.

2.5.7 Data analysis (Coding, Tabulation and Compilation)

Both coding and tabulation of the data were done manually as well as in computer. There was huge amount of qualitative data by FGD, Case Studies, KII, which mainly were compiled manually and compost later while coding of quantitative data was done in computer.

2.5.8 Determination of Food Security

In order to measure food security, a household food security index was constructed by defining a minimum level of nutrition necessary to maintain a healthy living. It also indicates the 'food security line' for the population under study (Omotesho *et al.*, 2006). Any household above this line was classified as food-secure. The food security line used in this study was measured using average recommended level of calorie intake of 2400 kcal as the desirable and cut off point (FAO, 2002)

Food security Index (K0) = X/Z

Where,

X = Household daily per capita calorie intake

Z = Household daily per capita calorie (Z) required

Thus, for a household to be food-secure K0 must be greater than or equal to one (K0≥1) otherwise, the household is considered food-insecure

Chapter Three

Result and Discussion

3.1 Socio-Economic Profile of Tribal People in the Study Area

Socio-economic characteristics of a household are important for ensuring food security. There are many interrelated and constituent attributes that characterize an individual and profoundly influence development of his/her behavior and personality. It was, therefore, assumed that production, consumption pattern and employment pattern of different households would be influenced by their various characteristics. Socio-economic characteristics of any individual influence their social and economic security. A number of socio-economic aspects of the tribal households were examined. These were family size, occupation, land ownership pattern, household assets, livelihood standard, access to government facilities, and access to natural resources of the study area.

3.1.2 Family Size

The bellow table 4 shows that the average family size among tribal is 4.21 that is more or less is same than the national figure.

Table 4 Family Size among the Tribal People of the Study Area

Variables	**Household Size**
Bangladesh	4.48
Study Area	4.35
Tribal	4.21

(Source: Population Census 2011, BBS and Author's Survey 2012-2015)

The above table 4 shows that the household size is 4.48 in nationally. In the study area, it was observed that the average family size 4.35 including tribal people. But, among the tribal family, their family size is 4.21 that are less than the national even the study area.

Plate 1. People of Different Ethnicity

Plate 1.1: Food Collection from Nature by the Santal Female

Plate 1.2: Traditional Dress of Oraon Female

Plate 1. People of Different Ethnicity

Plate 1.3: An Old Oraon Male Sitting in his Yard

Plate 1.4: Worshiping Ritual of a Santal Male Under a Tree

3.1.3 Working and Dependent Member in Tribal Family

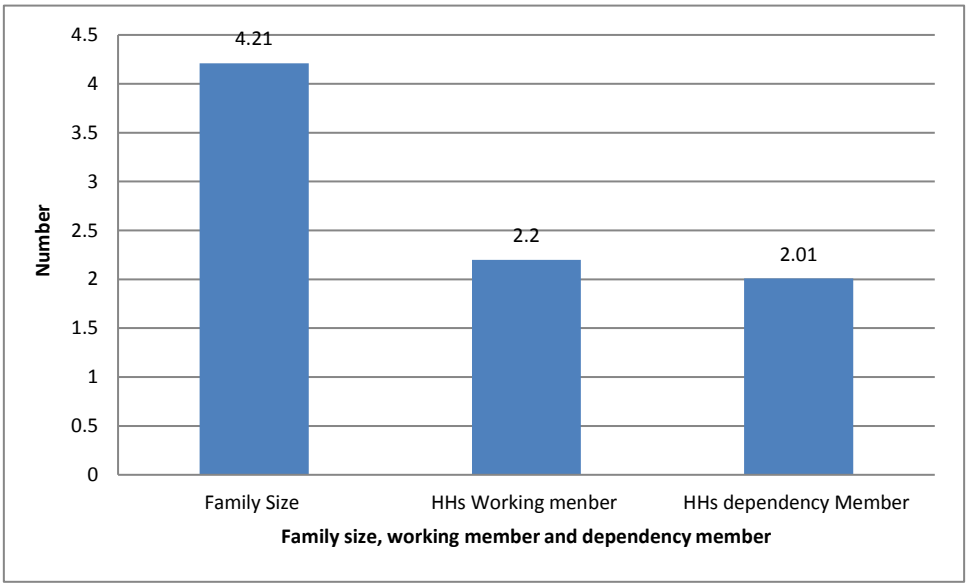

Figure 2. Status of HH Working Member and Dependence Member in Tribal Area.

(Source: Field Survey 2012-2015)

Through the above figure 2 found that family size per household was 4.21 and average working member and dependency in the tribal family was 2.2 and 2.01 respectively. In the tribal community in the study rural areas, family size, working members and dependent members were 4.21, 2.2 and 2.01. This indicates that the higher family size higher were the working members.

3.1.4 Dependency Ratio in Tribal Community

Table 5. Dependency Ratio among Tribal Community.

Age group ratio	HIES- 2010			Tribal
	National	Rural	Urban	
0-14	38	40.7	35.3	27.49
15-64	58.15	55.1	61.2	69.04
65+	3.85	4.2	3.5	3.47

(Source: HIES, 2010 and Author's Field Survey 2012-2015)

In the above table 5 shows that the highest percentage (69.04%) of tribal household members' belonged to 15-64 age group followed bellow 0-14 years' age group (27.49%), and 65+ age group (3.47%). It was found that age group and the number of family members were inversely related, in that higher the age group, lower was the number of family members. The dependency ratio in urban area was much faster than the rural area. Among tribal dependency ration is less the national level.

3.1.5 Occupational and Livelihood

In the study area basically there are three major ethnic groups. These are Santal, Oraon, Pahan, Munda, Barman, Rabidas and Mahali are living with their culture, customs, tradition and social values. Moreover, some tribes like Mahali, Rabidas has their traditional occupation.

In the study area there are diversified occupation among the tribal households were found. The main occupation of the respondents is agriculture, service, wage labor, business and driving.

Table 6. Occupational Status of the Tribal People.

Types of Occupation	**HHs no**	**% engaged**
Agriculture (Produce from own agriculture land)	85	22.14
Agricultural day labor	234	60.94
Service	23	5.99
Livestock rearing	9	2.34
Fishing	5	1.30
Small business	11	2.86
Traditional profession	17	4.43
Total	384	100.00

(Source: Author's field survey 2012-2015)

The above table 6 is shown the engagement of sample households in various activities. It is found that 60.94% households are involved in agricultural day labor activities. It is mentionable that in the study area most of the agriculture land are single cropped due to depending on rainy.

Around 22.14% household depend on their own cultivable land for production, 5.99% in various formal and no-formal service sectors (Offices support staff, Security guard and Garment factory), 2.34% of total sample HHs are involved in livestock rearing. At same time they also earn partially from daily agriculture sector, and 2.86% tribal households was found involved with small business activities (Petty shop, tea stole). Among the Mahali and Robidas tribal community have their own tradition occupation *e.g.* shoe making and repairing, bamboo material *etc*. Others those who are engaged in nonagricultural activities are working in construction site, daily wage labor *etc*. The figure mention bellow reflects that now nobody in the study villages fully depending on natural resources for their livelihoods.

The result is supported by Hossain (2013). He indicated in his research that the main occupation of tribal households is agricultural daily labor (64%), agricultural (12.5%). Some tribal are involved in small business (8.5%), service/professional (7.8%), fishing (4.8%) and tenant farmer (2.5%).

Samad (2006) in his research have shown that the entire Santal community is mainly dependent on agriculture labor. Only a small portion cultivate their own land others are involved in a non-farm activity such as, non-agricultural labor, small trade, service *etc*. He mentioned that the average daily wage of Santal agricultural laborer is Tk. 50.00 and 35.00 in peak season and lean seasons respectively. He also said that economic condition of the Santals is worsening day by day and they are now among the poorest groups of all indigenous communities.

Plate 2. Occupations of Different Tribal People

Plate 2.1: A Small Cottage Industries by the Mahali Tribal People

Plate 2.2: Tribal Men are Ploughing Land as a Day Labour

Plate 2. Occupations of Different Tribal People

Plate 2.3: Tribal Women Laboring in Paddy Field as a Day Labour.

Plate 2.4: Oraon Tribal Woman Working on their Homestead Vegetable Garden.

Plate 2. Occupations of Different Tribal People

Plate 2.5: Tribal People Harvesting Paddy as a Day Labor.

Plate 2.6: Tribal Woman Working as a Shopkeeper Near at her Home.

3.1.6 Household Monthly Income

In the study area, most of tribal people are depend for income on agriculture. Traditionally these tribal groups are very close to soil and agriculture. As mentioned in the table 6 shows that, 60.94 % tribal people are involved in agriculture daily labor. Therefore, major portion of income of tribal comes from agricultural laborers that are seasonal and depend on rain.

Table 7. Household Monthly Income Status of Tribal People in the Study Area.

Monthly Income of Household	**No of respondent household**	**% of Respondent**
Up to 2000	130	33.85
2001-4000	193	50.26
4000-6000	49	12.76
Above 6000	12	3.13

(Source: Field survey 2012-2015)

Through the above table 7 regarding average monthly income of the households, majority (50.26%) of the tribal household's income is up to 4,000.00 BDT per month. Only 3.13% reported that their income is more than 6,000.00 BDT.

Samad (2006) in his research have shown that the entire Santal community is mainly dependent on agriculture labor their average monthly income from agricultural day labor is Tk. 1,500.00 (daily 50.00 tk.) in the peak season of agriculture and 1,050.00 (daily 35 tk.) in lean season when the agricultural work was not available.

The research findings also backing by Pant *et al.* (2014) as he mentioned that the average annual income of tribal households was around US$ 350 (28,000.00 tk.) in 2007; this number grew significantly reaching over

US$ 570 (45600.00) in 2009. According to the Bangladesh Bureau of Statistics (2011) the estimated average income of US$ 1702 for a rural household in Bangladesh in 2010.

3.1.7 Community Wise Income Source of Tribal Community

Table 8. Comparison of Source of Income and Livelihoods Among Various Tribes.

Community	Total HHs	Agriculture	Agriculture day labor	Service	Livestock	Fishing	Small business	Traditional job
Santal	110	23.33	63.33	4.3	0.66	1.33	1.33	5.33
Oraon	120	28.49	53.36	7.77	2.59	0.51	1.55	5.69
Mahali	46	12.00	32	6	6	0	4	40
Pahan	88	22.98	54.02	3.44	5.74	9.19	4.59	0
Barman	20	15.00	70	5	5	0	5	0

(Source: Field survey 2012-2015)

The table 8 shows that the engagement of sample households in various activities. Among the Santal tribal community it is observed that 63.33% households are involved in agricultural day labor activities. On the other hand, it is 53.36% Oraon tribal people are engaged with agriculture daily labor. It is remarkable that among the Mahali tribal, 40% people are involved in their traditional occupation of bamboo making cottage industry.

This result also supported by Samad (2006) and Ali (1998). Both the research has shown that the majority Santal community in Bangladesh is mainly dependent on agriculture labor.

Bhowmick (1985) also mentions that the main profession of the Mahali is basket-making by bamboo which are sold mainly for agriculture product carrying and betel-leave packaging.

3.1.8 Status of Saving of Tribal people

Table 9. Household Savings and Loan Position.

District	Upazila	2013			2014		2015	
		HHs No	Savings	Loan	Savings	Loan	Savings	Loan
Chapai Nawabgonj	Gomostapur	98	232214	341244	280885	516476	319112	592198
Rajshahi	Godagari and Tanor	164	629039	528745	703072	638241	734549	625128
Naogaon	Potnitola	88	189721	269670	221587	327688	296229	359101
	Sapahar	34	17085	0	99170	101000	114736	321000
Total		384	2119033	2279318	2510258	3065810	2814516	3473854
Mean			5,518.32	5,935.72	6,537.13	7,983.88	7,329.47	9,046.49

(Source: Field survey 2012-2015

From the previous table 9 found that the savings and loan status of the sample households. Households kept money in cash and very little deposited in bank. In the study areas, it was found that no households took money as loan from bank, various NGOs, private money lender. The sample tribal household also deposit money to the NGOs accounts. The average loan of the sample household was 5,935.72 in 2013 that is increased up 9,046.49 BDT.

3.1.9 Land Holding Status in the Study Area

In the study area Naogaon, Chapai Nawabgonj and Rajshahi district, there were a total of all land holding 1504575. Among them, 42.26 % are non-farm land holding, 78.73 % are small farm land holding whose farm size is (0.05- 2.49 Acres), 18.83 % are medium farm land holding with 2.5 -7.49 acres' land, and 2.57% are large farm land those have abone7.5^{+} acres. On the other hand, in that are 37.76 % households are agricultural labor. It indicates that most of household are engaged with farming including agricultural daily labor (Appendix 3).

3.1.10 Land Holding of Tribal People

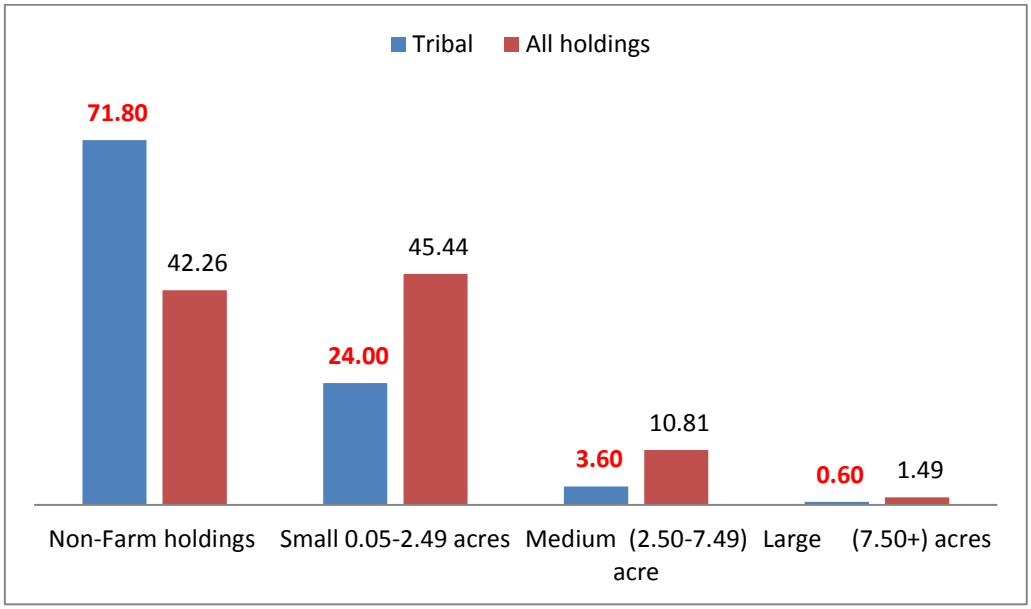

Figure 3. Farm and Non-Farm Land Holdings Size of Tribal People in the Study Area.

Source: Field Survey 2012-2015.

The above figure 3 shows that a total 71.80% HHs among tribal have no agricultural land that are treated as absolutely landless in Bangladesh that higher than total household in the study area. Other hand, 24.00 % of the tribal households have small farm holders, 3.60 % are medium farm holding, and 0.60% are large farm holding respectively.

Another study carried out by Raihan *et al.* (2009) shown that the trend of landlessness is increasing. Their study also shows that in 1970 the landlessness percentage was 19.8% that have reached 68.8% in 2001.

3.1.11 Comparison of Farm Land Between Tribal and Non-Tribal People

Table 10. Agriculture Farming Land Holding Size Among Tribal People in the Study Area.

Size classification holdings	As Agricultural Sample Survey of Bangladesh, 2014 and BBS				Among Surveyed Tribal HHs
	1960	1983-84	1996	2005	
Number of holdings owning no land or absolute landless	N/A	8.67	10.18	14.03	48.00
Number of marginal farmers (0.05-0.49 acres)	24.3	24.06	28.45	38.63	25.60
Number of small farm holdings (0.50-2.49 acres)	27.3	46.28	51.42	49.86	18.40
Number of medium farm holdings (2.50-7.49 acres)	37.68	24.72	17.61	10.34	7.80
Number of large farm holdings (7.50 acres - above)	10.69	4.94	2.52	1.17	0.20

(Source: BBS, 2014 and Field survey 2012-2015)

According to the above table 10 agriculture land ownership has a significant impact on the food security of rural household. In the study area 48.40% of the tribal households are agricultural landless. But in Bangladesh only 14.03% household have no agricultural land. It reveals that triple half of the tribal people are fully depend on agricultural daily or the profession. On the other hand, 48% tribal households are cultivable landless (less than 5 decimal), 25.60% are marginal farmers (5-49 decimal), 18.40 % are small farmer (50-149 decimal) and 8.00 % are medium farmer. The prevalence of food insecurity tended to be higher among landless or marginalize households who are more depends on riskier sources of income (*e.g.* Agricultural daily wage employment) than farm income. They are living on *khas* land (Government's land), 33.60% living on own land and 8% tribal households are living on neighbor's land.

3.1.12 Status of Livestock, Poultry and Domestic Animal in the Study Area

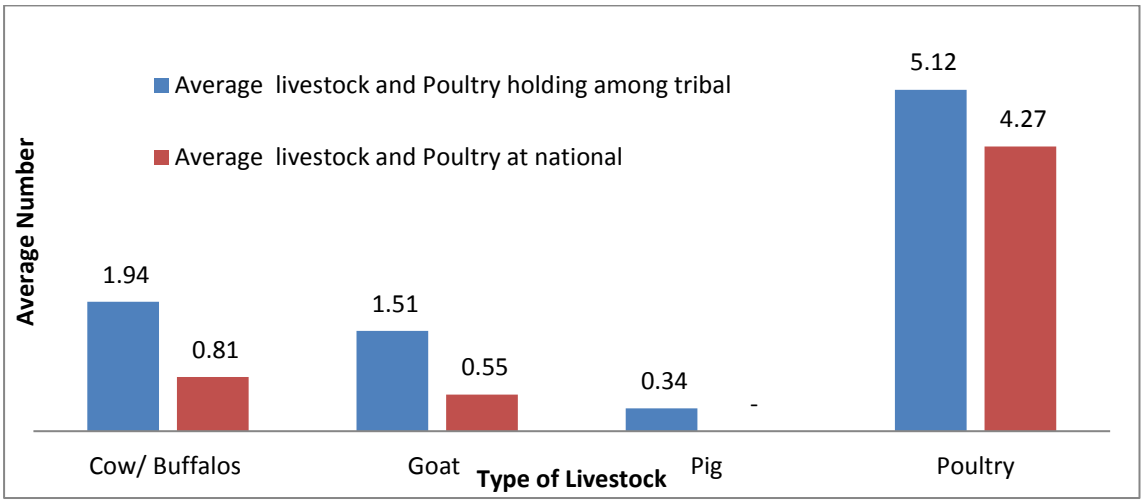

Figure 4. Livestock and Poultry Holdings by Tribal People.
Sources: Agriculture census 2008 and author's field survey 2012-2015.

The domestic animals (Cow, buffalo, pig, goat, and sheep) and poultry birds (duck, fowl, *etc*.) play an important role in the socio-economic life of tribal people. The outcome from the animal and poultry birds helps them with supplementary income so as to balance their economic burden. In the previous, most of the tribal was depend on bullocks and buffalos for ploughing land as most of other farmers in Bangladesh.

The above figure 4 shows that the average 1.94 number of cow, 1.51 number of goat, 0.34 number of pig and 5.12 number of poultry was found in the tribal family that is higher than national level. The main cause of the number having higher in the tribal people because majority tribal people live in the rural level.

Rahman (2003) found in his research that the average number of chicken and duck per family were 6.75 and 6.0 for landless, 5.75 and 2.0 for marginal, 9.15 and 2.84 for small, 9.38 and 2.19 medium, and 11.95 and 2.55 for large group respectively.

3.1.13 Status of Health and Sanitation of the Tribal People in the Study Area

Uses of sanitary latrine, drinking of tubewell water, use of electricity, buying ability, adoption of contraceptive measures, opportunity for medical facilities, schooling of children, and participation in cooperative society are indicator of living stander of a person or community. Higher user of these facilities indicate living standard of a person or family.

Table 11. Health and Sanitation Situation among Tribal People.

Livelihood standard indicator		**% respondent**
Using latrine	Pacca Latrine	5.80
	Pit Latrine	7.50
	Water seal Latrine	18.20
	Khacha/ Latrine without Seal	30.50
	Open Defecation	38.00
Source of Drinking Water	Tube well	39.40
	Deep tube well	19.00
	Pond	8.40
	Ring Wall	33.20

(Sources: Field survey 2012-2015.)

Table 11 shows that 5.80 % of the tribal household uses pacca latrine, 7.50 % uses pit latrine and 18.20 % uses water seal latrine. It is remarkable situation in the study area that most of the tribal people in the study area still 30.50% use unhygienic latrine and 38.00% use open field for excretion.

Zheng *et al.* (2013) reported that in Bangladesh between 1994 and 2009 sanitation using have significantly increased, the percentage of households openly defecating declined at a rate of about 1.8% per year from 30% in 1994 to 6.8% in 2009 in rural areas. On the other hand, access to individual improved sanitation facilities nearly doubled from about 30% in 2006 to 57% in 2009, with both rural and urban areas showing impressive progress.

In 2007, 20% of the poorest households still openly defecated, although more of them (38%) shared a latrine of any type.

Both the research finding it is revel that open defecation still remain 39.40 % among the tribal and poor rural people in Bangladesh.

Health Seeking Pattern among Tribal People

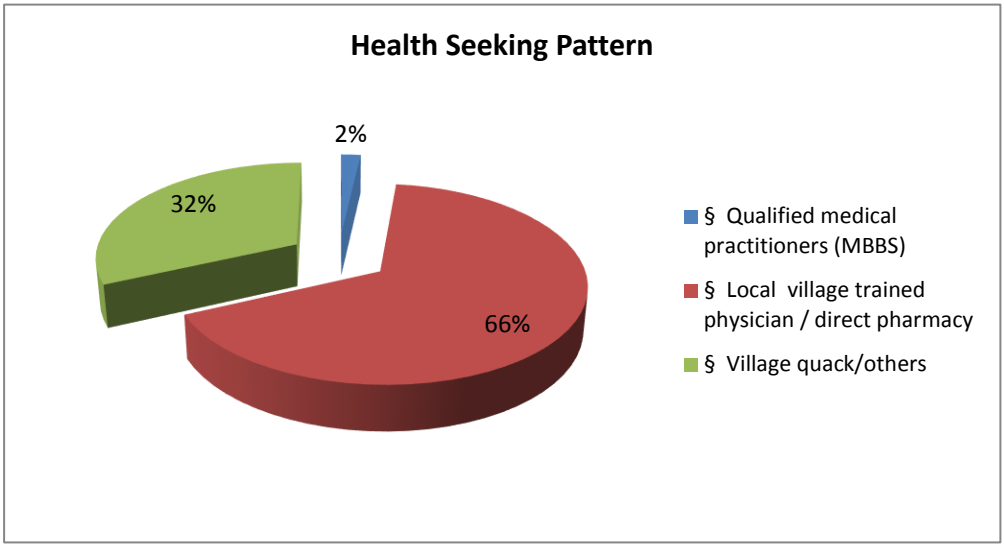

Figure 5. Health Seeking Pattern among of Tribal People.

(Source: Field Survey 2012-2015.)

The above figure 5 indicates that during the sickness, only 2% tribal people visited the doctor MBBS doctor, 73% visited local trained physician or pharmacy, and 35% tribal people visited local quake / their traditional *Junguru* / *Kabiraj (*Village quack / *Yurbadic physician)*. No kitchen attached to the bedroom at the tribal people home.

Rahman *et al.* (2012) mentioned that the village healer is still very popular among tribal people in Bangladesh that is support my result in this thesis. The both result indicate that the present systems of health care service delivery systems. More attention and priority should be given to the tribal people.

3.2 Environmental Change in the Study Area

3.2.1 Weather and Environmental Change in the Study Area.

3.2.1.1 Temperature of the Study Area

Table 12. Average Minimum and Maximum Temperature of the Study Area.

Year	Minimum temperature	Maximum temperature	Year	Minimum temperature	Maximum temperature
1979	21.1	31.8	**1997**	20.2	30.5
1980	20.2	31.2	**1998**	20.1	30.9
1981	20.5	30.5	**1999**	20.1	31.6
1982	20.3	31.7	**2000**	20.6	30.7
1983	20.0	30.9	**2001**	20.5	31.2
1984	20.2	30.9	**2002**	20.6	31.0
1985	20.3	31.3	**2003**	20.7	30.8
1986	20.1	31.0	**2004**	20.7	31.1
1987	20.5	31.5	**2005**	20.9	31.3
1988	20.4	31.4	**2006**	21.0	31.7
1989	19.4	31.4	**2007**	21.1	32.0
1990	19.6	30.9	**2008**	21.2	32.2
1991	19.8	31.3	**2009**	21.3	32.5
1992	19.7	31.6	**2010**	25.8	35.7
1993	20.1	31.1	**2011**	24.9	34.4
1994	20.4	31.1	**2012**	25.3	35.5
1995	20.6	31.2	**2013**	25.3	35.3
1996	20.5	31.5	**2014**	25.3	35.8

Source: Weather Station, Rajshahi.

Temperature, wind flow, humidity and rainfall are major element of the climate. It is very important factor to determine the weather. The temperature also influences and controls other elements of the weather, such as precipitation, humidity, clouds and atmospheric pressure. In the study area, average minimum and maximum temperature fluctuation every year. As a result, the people especially the poor and tribal suffer in various types' sickness.

Xu *et al.* (2012), Rahman and Kamaruzzaman (2015) said that hot and cold temperatures mainly affect cases of infectious diseases among children, including gastrointestinal diseases, malaria, hand, foot and mouse disease

and respiratory diseases. They also said that during heat waves, the incidences of renal disease, fever and electrolyte imbalance among children increase significantly.

Karim *et al.* (2012) demonstrated that increased incidence of dengue in Dhaka was associated with an increase in rainfall in the previous two months. However, an earlier study in Dhaka identified a significant positive association only at lag of two months.

Pearce *et al.* (1993) indicated that low and high temperature affect the growth of tomato fruit. Adams (2001) also gotten same result for the growth of tomato fruits.

3.2.1.2 Rainfall of the Study Area

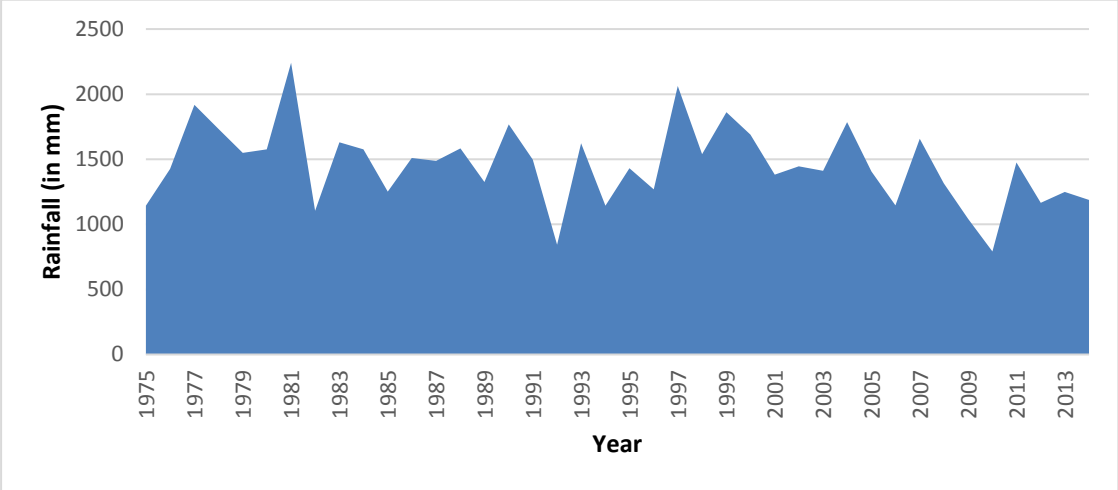

Figure 6. Trend of Rainfall in the Last 38 Years 1975 to 2014.
Source: Weather Station, Rajshahi.

The above figure 6 shows that the rainfall patters in the study area always being fluctuated. It varies year to year and place to place. In 1981 is the lowest rainfall year in the last 38 years. On the other hand, in 1980, 1997 the rainfall was higher since 175 to 2013. Due to changing rainfall pattern, meteorological drought happens in the study area and some sectors *i.e.* agriculture and fisheries faces problem that affect the production.

Habiba *et al.* (2012) mentioned that the farmer of the drought region in Bangladesh is facing this natural calamity, as a result agriculture product become low. Therefore, the farmer is adapting with the situation by adopting new technology *i.e.* cultivation of drought tolerant crop and short duration variety.

3.2.2 Natural Disaster in the Study Area

In the study area faces some types of natural disaster and calamities since 1976. Through the field survey from 2012 to 2014 it was found that these areas were suffered from Flood, River Erosion, Drought, *Kalboishakhy* (Tornado), Heavy rainfall and cold-wave.

Table 13. Natural Disaster in the Study Area.

Nature of Disaster	Period	Intensity of damages		Which Sector most effected	
		Too much	Medium	Too much	Medium
Flood	1987, 1988, 1992, 1998, 2003, 2004, 2013	1987, 1988, 1992, 1998, 2003, 2004	2013	Fisheries, Health, Infrastructure and communication	Livestock and Agriculture
River Erosion	1985,1988,1998, 1999, 2000, 2004, 2005, 2006, 2013	1985,1988, 1998, 2013	1999, 2000, 2004, 2005, 2006	Infrastructures, Road and High way	Agriculture, Fisheries, Domestic animals and Human resources
Drought	1976, 1979, 1989, 1992, 1996, 1999, 2004, 2005, 2007, 2010, 2011, 2012, 2014	1976, 1992, 1996, 1999, 2005, 2007, 2014	1979, 1989, 2004, 2010, 2011, 2012	Agriculture, Fisheries, Domestic animals and Human resources	Agriculture and Health services
Tornedo *(Kal Boishakhi Jhar*)	1988, 1992, 1995, 1997 2004, 2006, 2009, 2011, 2014	1988, 1992, 2004, 2006, 2014	1995, 1997, 2009, 2011	Fisheries, Livestock, Communication	Agriculture, Human Resources and Infrastructures
Heavy rainfall	1976, 1979, 1989, 1992, 1999, 2004,	1976, 1979, 1989, 2004	1992, 1999	Agriculture, Fisheries, domestic animal and Human resources	Domestic animal and Human resources
Cold-wave	2009, 2010, 2011, 2012, 2013	2009, 2010, 2011	2012, 2013	Agriculture, Fisheries, domestic animal and Human resources	Domestic animal and Human resources

Source: Field Survey 2012-2015.

The previous table 13 shows that the flood, river erosion, drought, tornedo, heavy rainfall and cold wave are the major disaster in the study area. Drought is the common disaster in the study area.

3.2.2.1 Drought in the Study Area.

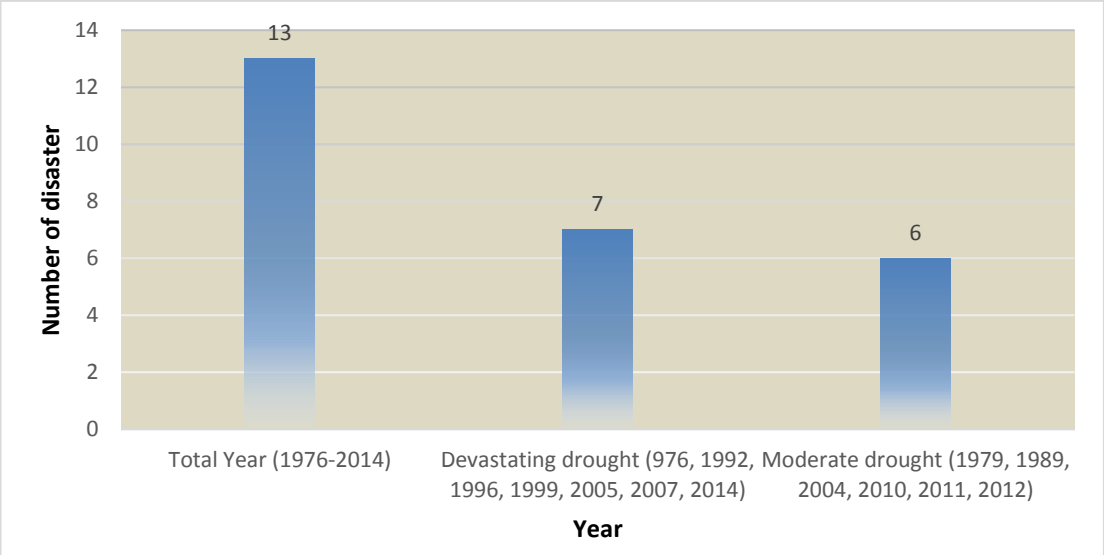

Figure 7. Drought in the Study Area.

Source: Field Survey 2012-2015.

Drought is common phenomena in the study area. Due to low rainfall, the meteorological drought is very common in the study area. The study reveals that since 1976 to 2014, a total of 7 times devastating drought was occurred. This study is also supported by Shahid and Behrawan (2008) and Shahid (2010).

From the field study, it is found that during the devastating drought Agriculture fisheries and livestock sector in the study area affected and this situation leads to decline major crop production even livestock sector also damages. Moreover, the waterbodies in the study area was dried due to drought, therefore, fish production failure.

This result is supported by the statement of Shahid (2008) and Shahid and Behrawan (2008) where they identified in the drought of 1994–1995 led to decrease in rice and wheat production of 3.5910×6 ton.

Moreover, Dey *et al.* (2011) marked 1994 as the driest year in the contemporary periods which lead to devastating impact on the northwestern part of Bangladesh. The drought events of 1997 support the declaration of Selvaraju *et al.* (2007) confirming that the drought of 1997 has led to short fall of one million tons of food grains of which 0.6 million tons were T. Aman. Along with this agricultural drought occur in some discrete pockets of the *Barind* region almost every year. Selvaraju *et al.* (2007) confirmed that around 2.32 million hectare of T. Aman rice crops damages due to agricultural drought every year.

3.2.2.2 Flood in the Study Area

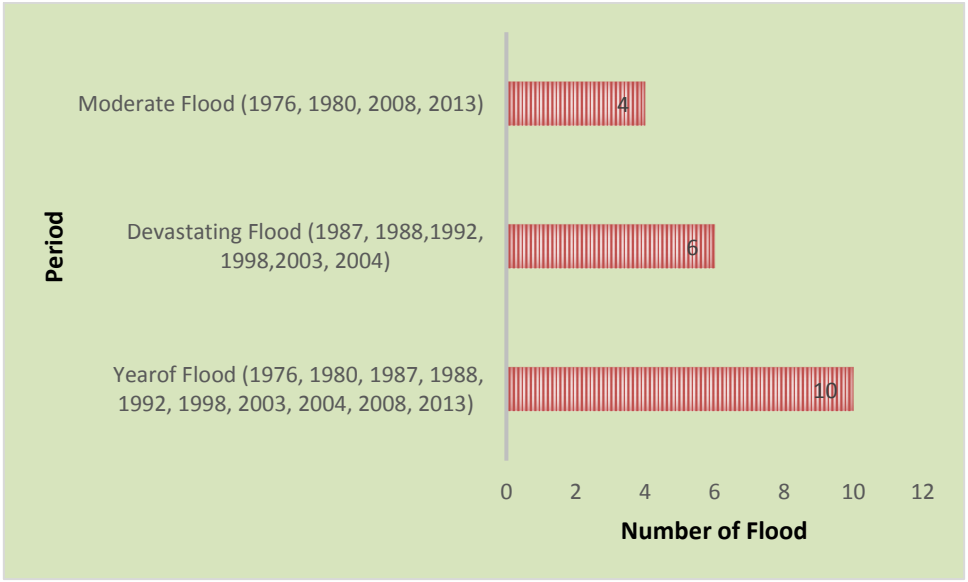

Figure 8. Flood Situations of Last 35 Years (1976 – 2013).

The above figure 8 shows that the study area was affected several times by flood. The most devastating flood occurred in the year 1987, 1988, 1992, 1998, 2003 and 2004. The respondent of FGD said that during those flood fishes, agriculture, infrastructure and human resources were damaged.

Brammer (1990) reported that the disastrous floods in Bangladesh in 1987 and 1988 that captured the world wide attention. The 1987 floods were predominantly rainwater floods caused by exceptional heavy monsoon rainfall and the 1988 floods were mainly river floods caused by heavy rainfall over a wider area of Ganges and Brahmaputra ricer catchment.

3.2.2.3 Other Natural Disaster in the Study Area

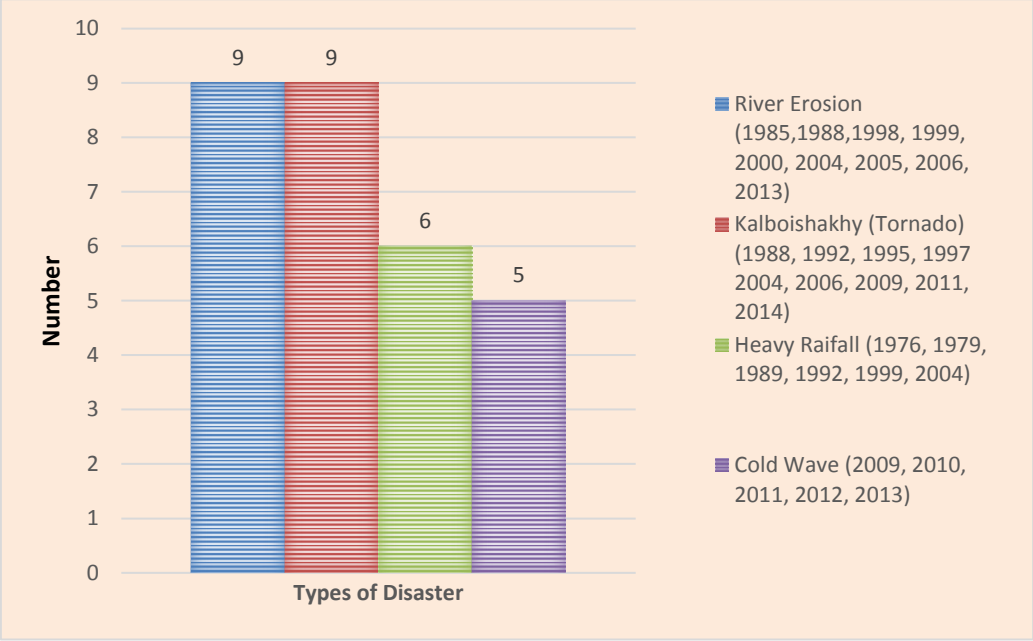

Figure 9. Some Common Natural Disaster in the Study Area.

In the study area, river erosion, *Kalboishakhi* (Tornado), Heavy rainfall and cold-wave happened in the different year.

3.2.3 Past and Present Environmental Scenario in the Study Area

The study area is under the *High Barind Tract* Agro-Ecological Zone it includes the southwestern part of the *Barind* Tract where the underlying Madhupur Clay had been uplifted and cut into by deep valleys. The three districts of Rajshahi, Naogaon, and Chapainawabgonj are belong to this agro-ecological zone. The river Atri, Mohananda, Padma and Punorvaba

have crossed this area. Climate of a specific area is a viable determinate factor. The flora and faunal diversity, Agriculture diversity even the culture of human society is determinate by climate of concern area. Generally, the climate of Bangladesh is very helpful for growth of flora and faunal. But the study area is exception. Here the climate is very warm and humid.

Rainfall is comparatively little in this region, the average being about 1,971 mm. It mainly occurs during the monsoon. Rainfall varies from place to place as well as year to year. For instance, the rainfall recorded in 1981 was about 1,738 mm, but in 1992 it was about 798 mm only. The temperature also fluctuates year to year. The average temperature ranges from 25° to 35°C in the hottest season and 9° to 15°C in the coolest season.

Plant is one of the most important components of environment. About 100 years back, this area was full of many types of plants like Sal, Bot (*Ficus benghalensis*), Chalta (*Dillenia indica*), Chatian (*Alstonia scholaris),* Gab *(Diospyros peregrine),* Tentul *(Tamarindus indica),* Kalo Kadam *(Andiana cordifolia),* Piralu *(Randia uliginosa) etc*. were available in the study area. But now most of the plants has disappeared from the area due to changing land pattern. According to the survey report of Bukanun- Hamilton (1807-16), Hunter Report (1876) and Carter's report (1928) witnessed that this area was very rich of plant and animal diversity.

Once the study area (Barind Tract) was the paradise of animal where variety types of organism was living. This area was the habitat of vermin, many types of wild animals. In the Barind tract area the earth warm was called "Mamcall". The farmer considered it as plough. As the report of Stephenson (1923) there were a total of 23 species of earthworm was available. But now only 8 species of earth warm are seen in the study area. In the study area, previously there were some types of though the study

area is facing a lot of environmental problems, but there are many types of tress, herbs, Shrubs, and Climbers are seen in the nearby brushes or small jungle. The quantity of these plants diversity is not more than previous. The Akashmoni (*Acacia auriculiformis),* Asamlota (*Mikania cordata),* Helecha (*Enhydra fluctuans,* Kalmishak (*Ipomea aquatic)* Eucalpter (*Eucalyptus camaldulensis,* Amm *(Mangifera indica) etc.* are seen in the study area.

3.2.4 Changing of Agriculture Practices

Agricultural practices are increasing day by day due to high demand of foods, resulting the area of jungle, bush, fellow land have been reducing at alarming rate. As agriculture is the dominant sector of the economy, land enjoys the highest importance as a resource. Another important aspect of land is that the rapid growth of population in a somewhat stagnant economy puts tremendous pressure on land, thereby adding scarcity value to a natural resource which is already in great demand. With the increase of population, use of land for non-farm and commercial activities as well as for housing and other purposes are increasing, thus gradually reducing the availability of cultivable land.

Small farms and landless households constitute about 80% of total rural households; the majority of whom depend on agriculture for their livelihood. It is obvious that total agricultural land over the periods in the past has not increased although population has increased significantly. It implies that in the near future, land available for cultivation decrease substantially which will have serious implication on agricultural production in Bangladesh.

Land use and land cover change due to increasing population and urbanization is one of the largest mechanisms of global change. In

northwest region of Bangladesh, growth of cities and rural settlement has been increased rapidly due to development of infrastructures. Consequently, land available for forest and agriculture has been reduced. It is expected that further development of infrastructures will reduce the area of land available for forest and agriculture by some 17 % over the next 25 years. This land use change will reduce groundwater recharge area leading to groundwater depletion.

Table 14. Changes in Land Use Pattern for Different Purposes During the Period of 2008- 2014 in the Study Area.

Year	Forest Land	Not Available for cultivable Land	Cultivable waste area	Current fallow area	Net cropped area
2008-2009	8	538	6	52	1520
2009-2010	8	539	5	49	1732
2010-2011	7	545	6	47	1728
2012-2012	7	546	5	40	1735
2012-2013	7	547	4	37	1738
2013-2014	7	556	3	16	1867

Source: Yearbook of Agricultural Statistics- 26th, 25th and 24th Series.

Table 14 presents changes in land utilization patterns during the period of 2008-2009 to 2013-2014. The table seen that in early 2008's land not available for cultivation was 538 thousand acres which had increased to 18 thousand acres at the end of 2014. On the other hand, net cropped land has increased by the end of 2014 of 347 thousand acres. This means, during the period fellow land becomes less and net cropped land increased for cultivation.

Photo 1. Dulali Hasdak.

Dulali Hasdak (66) widow of late Majhi Soren, is a Santal woman living the Uchadanga of Sadar union under Sapahar *upazila* of Naogaon district. It is a tribal populated village. A total of 97 tribal and Bengali families are living with social harmony. Most of them are belong to Oraon tribal community. The river *Punarvova* and Atrai is the main natural water resources. Other hand, a wetland (*beel*) is situated in the boarder side of this union.

When she was 10-15 years old, she shows that she mothers collected many types of edible vegetable from their homestead. She mentions some type vegetables like- Phutkuli *(Phyllochlamys taxoides Koorders),* Bhelwa *(Semecarpus anacardium* Linn.F.*),* Ban Ole *(Amorphophallus sp),* Pani aru *(Dioscorea oppsitifolia* Linn*),* Khapra sag *(Trianthema monogyna* Linn), Bhatua arak *(Chenopodium album* Linn*)* Kokro pump *(Celosia cristata* Linn.*),* Mushroom *(Centella asiatica* Linn*),* Mahua *(Madhuca indica* J.F. Gmel*) etc.* There were many big trees *e.g.* Bot, (Banyan tree), Paikor / Likor (A kind of Benian tree), Tentul (Tamarind) were available in the study area. There also some fruity plants like Mohua, Gab, Bon Kanthal (Wild Jackfruit), Domur, Telakucha (Ivory gourd) *etc*. in the area. They easily collect free of cost that was fulfilling their needs. The woman generally collected some short of fishes like Magur (Cat fish), Sing (Stinging catfish), Koi (Climbing perch), Jhinuk and Samuk (Snail), Kakra (Crab), Taki and Cheng (Spotted snakehead), *etc*. from the nearby Khandor (low land where water available during the rainy season) and, abandoned

ponds, and rivers. He also mentioned that during the period of October to December they collectively went the beel (Wetland) and rivers for collecting consumable wild food of animal and conserved it by drying.

There was a question to Dulali Hasdak, how you preserved these types of food item. She informed that most of the families collected the green young leaves of Pikor Ghach (Banyan tree) for food item and dried it for preservation. In the off season, they used it to cook for meal. Other types of food item like Mushroom they called it Beng Sag or Khukhri *(Centella asiatica* Linn*)* was one of the main sources of protein. That was also available in their area. But now it is not seen. They also preserved it by drying.

During interviewing her for case study, she gave me important information about their indigenous technology that was fully environment friendly. That time in that area there were many *Mathcom* -Mohua tree (*Madhuca indica* J.F. Gmel). From this tree they collected *mohua* fruit and made flour with rice and take it in their breakfast. The nut of the Mohua fruit they used for extracting oil using their traditional technology that they use as cooking oil. Moreover, they also used the fruit of Mohua for making Handi (Rice beer) a type of wine they use it in social occasion.

She also asked a question that why these types of indigenous food are not available in your area? She replied that in the last fifty years many water bodies have become dried because of not enough rain, wetland biodiversity destroyed by huge chemical fertilizer and the entire abandoned pond converted into modern fish culture where the owner of these land uses chemical fish feed for mono fish culture. Now in the ponds, there is not available tribal food like Ghongha/Rokoy (snail), Katcom (crabs), and Bumbi (Mud eel). So, now they have to depend on purchasing fish that is

not affordable as their need. On the other hand, the water level is very low in nearby river in summer season, therefore in the dry season agriculture is grow where huge chemical fertilizer use. As a result, the habitat is destroying day by day and reduces the indigenous fishes. She informed me that previous when the tribal food items were available in the nature they didn't anxiety for food. All foods they need collected from the nature any times. But now they face many difficulties for arranged food for their family.

There was another question to Mrs. Hasdak, how we can restore or preserve this indigenous and wild animal or edible plants or vegetable for food security. He replied that the government should take the initiatives to conserve some sanctuary for natural breeding, control the uses of chemical pesticide, and ensure the preserve forest.

Photo 2. Bagha Ekka.

Bagha Ekka (Born in 20-2-1928 as NID**)** is a tribal people of Oraon community. His father's name is late Rosua Ekka. He is living with his family in Kasroil village of Parbotipur union under Gomostapur *upazila* of Chapai Nawabgonj district. It is a tribal populated village. A total of 166 tribal and Bengali families are living with social harmony. Among the total families 148 families are tribal. Most of them are Oraon tribal community. As a tribal community they have own culture, traditions, customs and food habit.

The river *Punarvova* and *Mohananda* is the main natural water resources. Other hand, a wetland (*beel*) is situated in the boarder side of this union. Before liberation, most of the land was remaining fellow due to modern agriculture and irrigation. He has seen the liberation of Bangladesh. He also can remember the ruling of British. At the end of ruling period of the British, he was very young and could cultivate land and did household activities.

During the interviewing him for case study, he recalls his past life, the environmental situation of this area, what types of food they collect from the nature.

He said that when he was boyhood, the area was lack of modern agriculture. They fully depend on rainy in the rainy season. All cultivable land was under single crop. There was no tube-well, ring wall as the

sources of drinking water. The pond water was the only sources for drinking, bathing, agriculture and household purposes.

There were many big trees *e.g*. Bot, (Banyan tree), Paikor / Likor (A kind of Benian), Tentul (Tamarind) were available in the study area. There also some fruity plants like Mohua, Gab, Bon Kanthal (Wild Jackfruit), Domur, Telakucha (Ivory gourd) *etc*. in this area. Moreover, some short of animal like Sial (Jackal), Bejhi (Mongoose) Endur (Rat), Bon Biral (Wild Cat), Khorgosh (Hare), Bon Sukor (Wild Hog) *etc*. were found in this area. Moreover, they collected a lot of variety of fishes like Magur (Cat fish), Sing (Stinging catfish), Koi (Climbing perch), Jhinuk and Samuk (Snail), Kakra (Crab), Taki and Cheng (Spotted snakehead), Kacchaap (Tortoise) *etc*. from the nearby Khandor (low land where water available during the rainy season) and, abandoned ponds, and rivers. He also mentioned that during the period of October to December they collectively went the beel (Wetland) and rivers for collecting consumable wild food of animal and conserved it by drying.

When he was asked why these types of indigenous food in your area? His replied that in the last fifty years many water bodies have become dried because of not enough rain, wetland biodiversity destroyed by huge chemical fertilizer, and the entire abandoned pond converted into modern fish culture where the owner of these land uses chemical fish feed for mono fish culture. Now in the ponds, there is not available tribal food like snail, crabs, and Kuchia (Mud eel). So, now they have to depend on purchasing fish that is affordable as their need. On the other hand, the water level is very low in nearby river in summer season, therefore in the dry season agriculture is grow where huge chemical fertilizer use. As a result, the habitat is destroying day by day and reduces the indigenous fishes.

Plate 3. Natural Scenario of the Study Area

Plate 3.1: Natural Forest Converted to Agricultural Land in the Study Area.

Plate 3.2: Partial View of Dry Season in the Study Area due to Drought.

Plate 3. Natural Scenario of the Study Area

Plate 3.3: Bush Area Convert to Mango Orchard in the Study Area.

Plate 3.4: Natural Tribal Village turned in to Crop Land.

Plate 3. Natural Scenario of the Study Area

Plate 3.5: Natural Shiva River has Turned into Canal by Anthropogenic Activity.

Plate 3.6: Natural Forest Turned into Exotic Plant Garden due to Wrong Decision in the Study Area.

3.2.5 Present Status of Wetland in the Study Area

The study areas are situated in five *Upazilas*- Potnitola, Sapahar, under Naogaon district, Gomostapur under Chapai Nawabgonj district and, Godagari, Tanor under Rajshahi district.

Table 15. Wetland Degradation in the Study Area.

Sl. No	Name of *Upazila*	No's of *Beel*	Area (Hec.)
1	Potnitola	3	82.5
2	Sapahar	1	431.17
3	Gomostapur	3	545.88
4	Godagari	16	167
5	Tanor	1	157

Source: Upazila Department of Fisheries of Study Upazila 2015, and Field Survey 2012-2015.

The above table 15 shows that the trend of pond excavation has increased.

The study areas were once full of many types of indigenous fishes, wild animal, birds and plants. From where the people especially the poor and tribal people were collected food and fodder from the nature. The study showed that the tribal community people were mostly depends on natural resource.

Loss and degradation of wetland ecology and the environment around the *beel* area have had serious adverse impact on the fauna and flora resources. Some of the species, as the study found, have been already extinct while many of them are threatened and reduce significantly.

Shopan *et al.* (2013) carried out a research on declining wetland in Bangladesh. It is found that, total wetland area in the Northwest region of Bangladesh during the dry period in 1989, 2000 and 2010 were 1208.72, 903.54 and 867.18 sq. km respectively. This indicates a decrease of 25.25%

wetland areas from 1989 to 2000 and a decrease of 4.02% wetland areas from 2000 to 2010. The changes of wetland areas during the dry periods of different years in the selected districts and *upazilas* of the Northwest Bangladesh are also estimated.

3.2.6 Present Status of Pond Water Bodies in the Study Area

Table 16. Upazilla wise Distribution of Total Wetland (Ponds).

Upazila	Number of ponds			% of increase in 1990 to 2015
	1990	2000	2015	
Potnitola	4460	5059	7207	61.88
Sapahar	2673	3386	3442	77.66
Gomostapur	1287	1515	2117	60.79
Godagari	2985	3278	5038	59.25
Tanor	4260	4410	6077	70.10
Total	17655	19648	25896	68.18

Source: *Upazila* Department of Fisheries Office (2015) of Potnitola, Sapahar, Gomostapur, Godagari and Tanor *Upazila* and field visit 2012-2015.

The table 16 shows that the numbers of ponds in the study area have increased 68.17% since 1990. The result is supported by Hassan and Moniruzzaman (2010). Hasan said that the overall wetlands (pond) have increased by about 50% over 55 years (Hassan and Moniruzzaman, 2010). The cause for increasing pond due to increase commercial fish culture for meet the requirement.

Photo 3. Changing Land Pattern of Tanor beel by Exavating artificial pond.

Photography by author

The plate 3 shows how artificial ponds are increasing by human activities. That's why the number of ponds is rising in the study area.

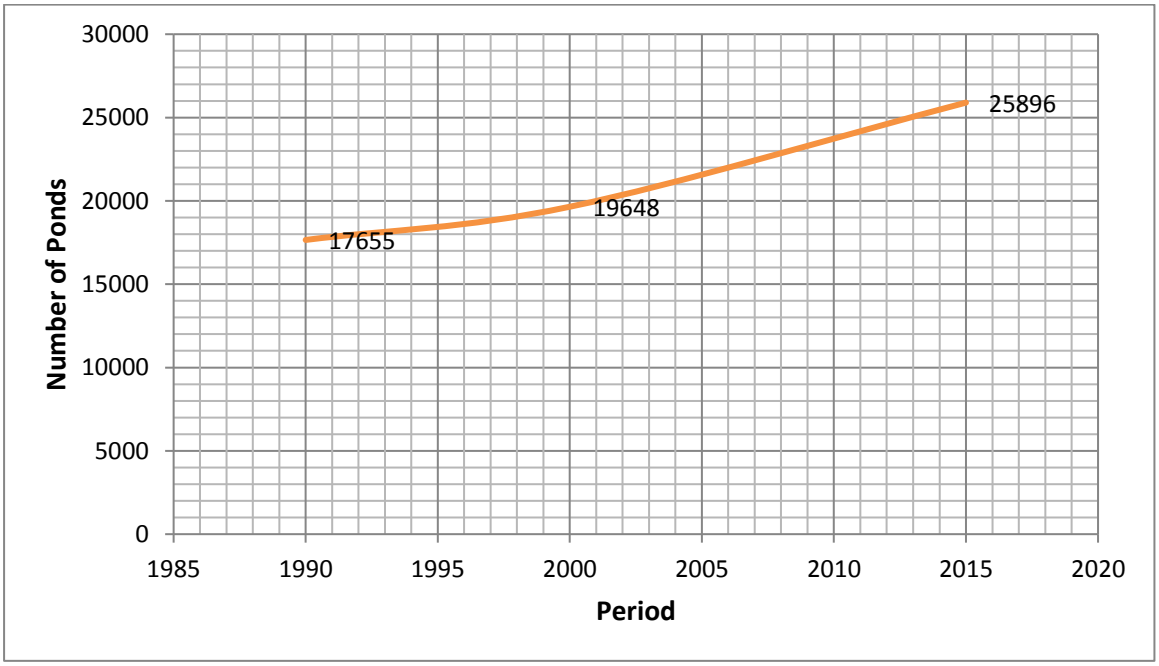

Figure 10. Number of Artificial Ponds Increased in 1985-2015.

The above figure 10 also shows that the number of pond water-bodies have increased in the last 25 years. The study revel that due to fish culture and meet up the demand of fish, the people are excavated pond.

Zaman *et al.* (2006) found that 65.5% ponds were used for fish culture, whereas 28.5 and 6% ponds were cultivable and derelict, respectively.

3.2.7 Human Intervention on Wetland Environment

Human activities can have some positive and negative impact upon the wetlands. Human interference can enhance or reduce the abilities of the wetland to provide the essential goods and services. The physical, chemical, and biological component of the wetland is altered due to human interference. Increasing population has resulted in encroachment upon the wetland for the purpose of settlement and agriculture. The lands in around the *beel* are normally used for agriculture. But during summer, agricultural

activities are disrupted due to flood and the areas are covered by water bodies. Fishing is then widely practiced by the local people and fishermen. Regarding the land use of these Beel, People practice agriculture at the side of wetland when the water of the wetland recedes.

These natural water bodies are changing by some types of anthropogenic activities. In the study areas, huge number of artificial water bodied like ponds and cannel are being made for fish culture.

3.2.8 A Case from the Tanor Beel (Wetland) that is Destroying by the Human

Tanore Upazila area 295.39 sq. km, located in between 24°29' and 24°43' north latitudes and in between 88°24' and 88°38' east longitudes. It is bounded by Nachole and Niamatpur *upazilas* on the north, Paba and Godagari *upazilas* on the south, Mohanpur and Manda *upazilas* on the east, Nachole, Nawabganj sadar and Godagari *upazilas* on the west. There is seven unions in this upazila. There are also five number of open wetland in this *upazila* that's area is 157 hectares' land. Most of land of Chanduria union is under wetland. There is a small river named *Siba* that is not running like before. I have collected data on land pattern changing by anthropogenic activities. This point is also known as Selimpur or Chanduria *Chawkir Ghat* that is only 18 km from Rajshahi district head quarter. This area is wetland and the lands are remains under water in the maximum time. Therefore, the wetland ecosystem was very rich previous.

Md. Abdul Samad (75) said that when he was 10-12 years old, this area was full of wetland natural resources. There were various types of plants, fishes, animals, birds and wild animal. There were some big trees like Bot (banyan), Tetul (Tamarind), Bansh Jhar (Bamboo-clump), brushes where the Beji (*Herpestes edwardsi*), Khorgosh (*Lepus nigricollis*), Sial (Jackal),

Bonbiral (Felis chus), Katbiral (Squirrel), Bagh Dasha (*Prionailurus viverrinus*), Udhbiral civet (*Viverra zibetha*) were found in this area. In the wetland area there were many types of fishes were found from where the people collected freely. Some types of indigenous fish sepsis that was available in this are Rui / Ruhit (*Lebeo rohita*), Catla (*Catla catla*), Chela (*Chela cachius*), Mirka (*Cirrhinus mrigala*), Bata (*Labeo bata*), Darkina (*Parluciosoma daniconius*), Punti (*Puntius sophore*), Chanda (*Pseudambassis ranga*), Baila (*Glossogobius giuris*), Koi (*Anabas testudineus*), Khalisha (*Colisa fasciatus*), Moa (*Rohtee cotio*), Gojar (*Channa marulius*), Taki (*Channa punctatus*), Sole (*Channa striatus*), Ouiya (*Lepiodocephalus guntea*), Tengra (*Mystus vittatus*), Batasi (*Pseudotropius atherin*oides), Sing (*Heteropneustes fossilis*), Magur (*Clarias batrachus*), Boal (*Wallago attu*), Chitol (*Netopterus chitola*), Bai (*Mastacembelus armatus*), Kalbaus (*Labeo callbasu*), Tara Baim (*Macroganthus aculeatus*), Fuli (*Notopterus notopterus*), Bagha Air (*Bagarius bagarius*), Gang Ghaura, Bheda (*Nandus nandus*), Bashpata (*Ailia coila*), Icha (*Macrobrachium lamrrei*), various types of Kakra (crab), Boro kakra samuk (*snail),* Jhinuk (*Lamellidens Marginalis*) *etc.* There are also various types of birds like Dhan salik (*Acridotheres tirstis*), Ghugu (*Streptopelia tranquebarica*), Dahuk (*Amaurornis phoenicurus*), Kani bock (*Ardeola grayii*), Nolbock (*Ardea cinerea*), Pangkori (*Phalacrocorax niger*), Bali has (*Nettapus coromandelianus*), Fepi, Samu Kol (*Anastomus oscitpus*), Sona Bang (*Rana tigrina*), Guisap (*Varaus bengalensis*), Kheksial (*Vulpes bengalensis*), Badur (*Pteropus giganteus*),

Indur (*Mus musculus*) *etc*. were found in the study area. But now most fish species, animal and plants are not available in the study area. The causes for not available these fisheries, plants and wild resources are- degradation of wetland, development intervention on wetland, over use of chemical fertilizer, loss of natural habitat *etc*.

Islam and Chowdhury (2014) found 38 zooplankton genera and 26 physio-chemical variables were recorded in Trimohini *Beel*. He also mentioned that a large number of inland fresh water non-cultivable fishes and other aquatic biota of the Trimohini *Beel* may be eliminated in future due to mixing of continuous chemicals from agriculture fields. It is necessary to conserve the ecosystem of Trimohini *Beel* for the fresh water non-cultivable fishes and another aquatic biota.

Plate 4. Wetland Degradation in the Study Area

Plate 4.1: Natural Wetland in 2011

Plate 4.2: Degradation of Wetland by Anthropogenic Activities in 2014

Plate 4. Wetland Degradation in the Study Area

Plate 4.3: Degradation of Natural Waterbodies due to Human Intervention.

Plate 4.4: Degradation of Wetland through Rice Mill Waste.

Plate 4. Wetland Degradation in the Study Area

Plate 4.5: Degradation of Wetland by Non Degradable Wastage.

Plate 4.6: Brick Field in the Wetland.

3.3 Biodiversity (Flora and Fauna) Degradation in the Study Area

3.3.1 Flora Resources in the Study Area

The flora resources at the study area were studies as the fisheries and wildlife resources. The fisheries resources included the fishes, fresh water crustaceans, crabs and shellfishes. The wildlife resources comprising of birds, amphibians, reptiles and mammals were observed at the study area. Details are discussed below:

The fisheries resources were studied to find out the existing and previous state of all species as commonly available (CA), Moderately available (MA), Rarely available (RA), Critically Rare (CR), Endangered (EN), Vulnerable (UV), Not threatened (NO), Data deficient (DD), Exotic (EX) in the study area and developed an inventory as per response of local resource user.

3.3.1.1 Trees Resources in the Study Area

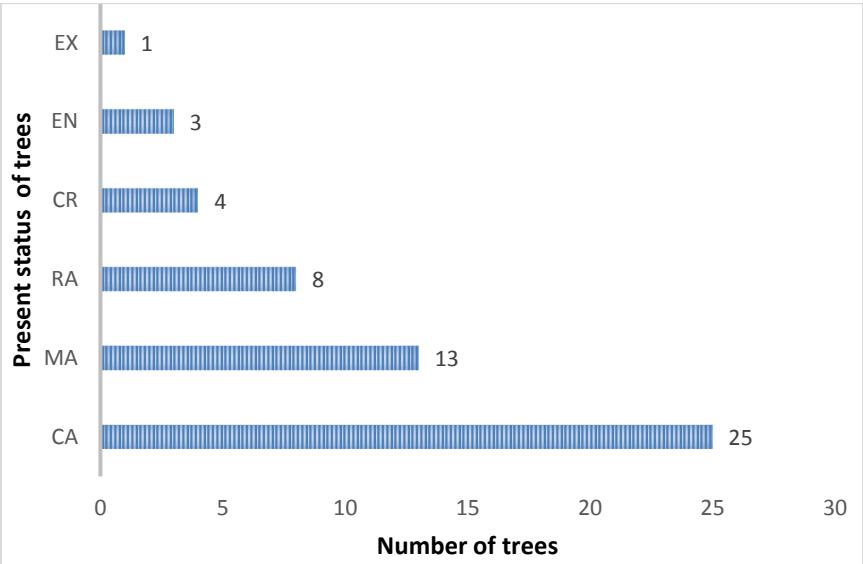

Figure 11. Status of Plants Resources.

Source: Field Survey Data 2012-2015.

As mentioned by the local resource user of the study area, the above figure 11, were a total of 54 tree species observed by them since long back. Out

of which 25 are commonly available, 13 are moderately available, 8 are rarely available and 4 are critical endanger. (Appendix 9.a)

Flowra *et al.* (2013) found that 14 numbers of plants those were used as medicinal are critically endanger.

3.3.1.2 Shrubs Resources Status

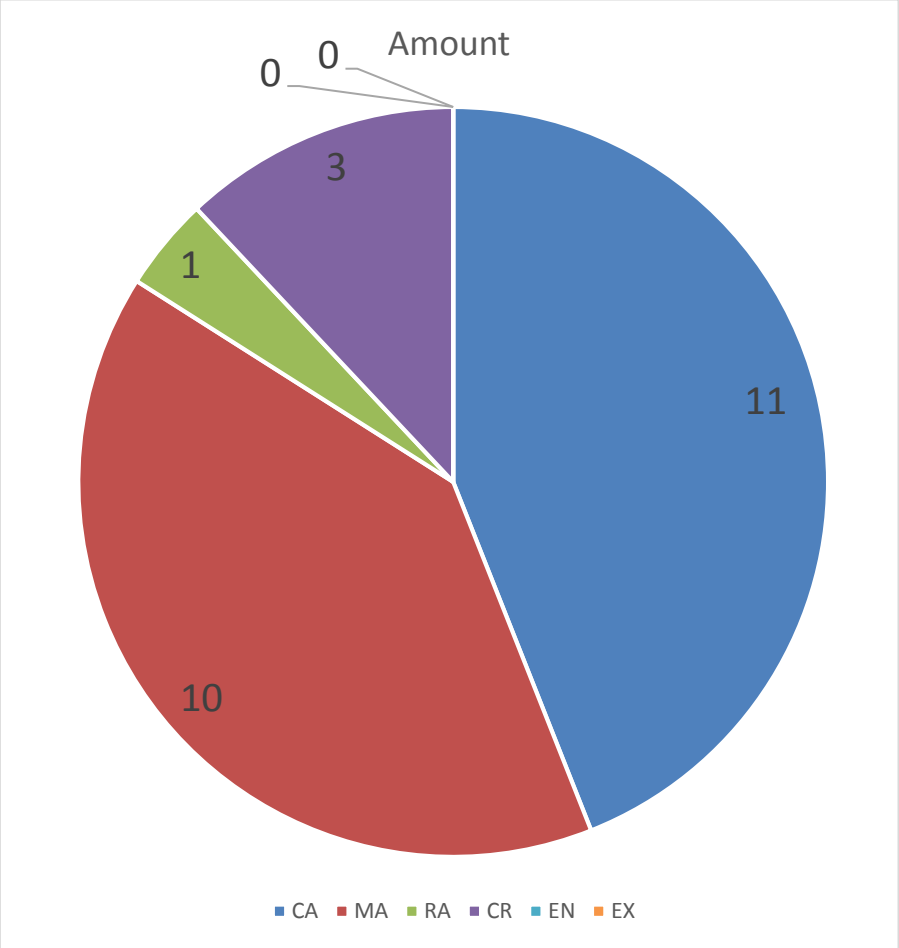

Figure 12. Present Status of Shrubs in the Study Area.

Source: Field Survey 2012-2015.

CA= Commonly available, MA= Moderately available, RA= Rarely available, CR= Critically endanger, EN= Endangered, VU = Vulnerable, NO= Not threatened, DD=Data deficient, EX= Exotic

The figure 12 shows that 25 types of shrub were identified in the study area. Among them 11 types are commonly available, 10 is moderately available, 1 is rarely available and other 3 also critically endangered. (Appendix 9.b)

3.3.1.3 Herbs and Climber Plant in the Study Area

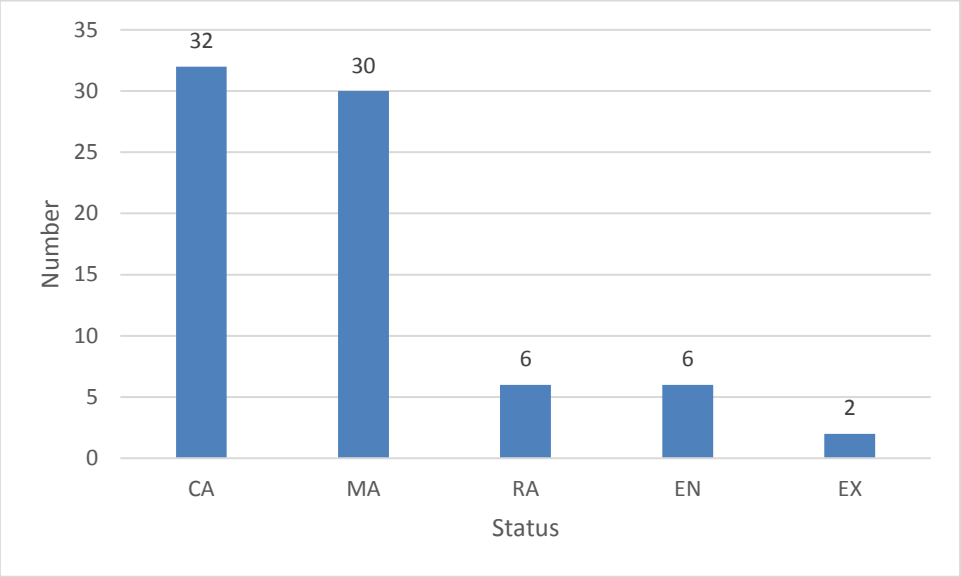

Figure 13. Present Status of Herbs and Climber Plants in the Study Area.

Source: Field survey 2012-2015.

The above figure 13 shows that in the study area a total of 76 types herbs were identified. Among them 35 numbers of herbs are commonly available, 31 numbers of herbs are moderately available, 6 is rarely available and 4 is critical endanger in the study area. (Appendix 9.c)

From the above three figure regarding plants, shrubs and herbs diversity, we can see that a total of 157 types of plant, shrub and herbs biodiversity were found. The tribal people are use these some types of trees, shrubs and hers as food and medicine.

3.3.2 Faunal Biodiversity in the Study Area

In the study area there are some *Beel* (Wetland), and river. Therefore, some types of fish species are available. The Samuk (*Pila globosa*), Jhinuk (*Lamellidens marginalis),* Roi (*Labeo rohita),* Catla (*Catla catla),* Chanda (*Pseudambassis ranga),* Moa (*Rohtee cotio) etc.* also available in the study area. In the beel area of there also some types of turtle *i.e.* Kali Khaitha

(*Hardella thurji*), Gono Khaitha (*Geuns kachuga*), Kori kaitha (*Kachua tecta*) was the major. But now it is very uncommon even during the study period no one shows these types of turtle.

Among the amphibians, Kuno Bang (*Bufo melanostictus),* Sona Bang (*Rana tigrina)* are very common in the study area.

There are some types of birds are still available in the study area. The Kabutor (*Columba liviab),* Ghugu (*Streptopelia tranquebarica),* Pati kak (*Corvus splendens),* Babui (*Ploceus philippinus),* Chowrui (*Passer domesticus) etc*. are common bird in the study area.

The declination of different fish species has possibly been attributed due to both manmade and natural causes. Climate change effects (drought, flood, siltation *etc*.), water pollution due to excessive use of fertilizer and pesticides, over fishing (both young and broods) are found as major declination causes of fish diversity of the study area. According to Flowra *et al.* (2013) combined effect of natural hazard like floods, drought, and siltation destroys the nursery, feeding and breeding ground of fishes and finally causes depletion and or extinction of the existing fish species. They reported same declination causes in Baral and Choto Jamuna river. Galib *et al.* (2013) observed similar decline causes of fish diversity of inland water bodies of Bangladesh and recommended to solve them for the existence of fish population.

3.3.2.1 Fisheries of the Study Area

Table 17. Fish Resources in the Study Area.

Categories	Total Number	%
CA	16	28.57
MA	19	33.93
RA	13	23.21
CR	4	7.14
EN	4	7.14
EX	0	-

Source: Field survey 2012-2015.

CA= commonly available, MA= moderately available, RA= rarely available, CR= critically endanger, EN= Endangered, VU = Vulnerable, NO= Not threatened, DD=Data deficient, EX= Exotic

The result reveals that in the study area a total of 56 number of fish species were found. Among them 28.57 % (16) fish species were found commonly available, 33.93% (19) were moderately available, 23.93 (13) fish species were found rarely available in the study area. On the other hand, 7.14% (4) fish species were critically endanger and 1.14% (4) fish species are endanger. (Appendix 10.a)

The result of the study is supported by Akhtaruzzaman and Alam (2014). They identified 62 fish species under 10 orders of which 35.48% was identified as Cypriniformes, 25.81% as Siluriformes, 20.97% as Perciformes, 6.45% as Channiformes, 3.23% as Osteoglossiformes; and the rest the five orders *viz.* Anguilliformes, Cyprinodontiformes, Synbranchiformes, Beloniformes and Tetraodontiformes as 1.61% of the total catch. The availability status was remarked in four categories and obtained as available (46.77%), seasonal (8.06%), rare (6.45%) and extremely rare. They found 24 species were found inclined too extinct in near future that recorded as extremely rare in the study area. (38.71%).

Another researcher (Galib *et al.*, 2013) recorded 81 fish species including 72 indigenous and 9 exotic species in the challan *beel* area under 12 fish orders, 27 families and 59 genera. Availability of maximum 46% fish species were ranked as low followed by common (23%), abundant (17%), rare (9%) and very rare (5%). This result also supports of this study.

3.3.2.2 Prawn, Crabs and Mollusks Resources in the Study Area

Table 18. Prawn, Crabs and Molluscan Diversity in the Study Area.

Status of	Total Number	%
CA	5	50.00
MA	2	20.00
RA	1	10.00
CR	0	-
EN	2	20.00
EX	0	-
Total	10	100.00

Source: Field Survey 2012-2015.

A= commonly available, MA= moderately available, RA= rarely available, CR= critically endanger, EN= Endangered, VU = Vulnerable, NO= Not threatened, DD=Data deficient, EX= Exotic

The table 18 shows that in the study area a total of 10 Shrimp and Prawn, Crabs and Mollusks Resources were found. Among the 50% (5) are commonly available, 20% (2) are modernly available, 10 (1) is rarely available in the study area. (Appendix 10.b)

Deb (1998) indicated that the societal value of the coastal environment that supports life and livelihood of millions of coastal communities of Bangladesh is not recognized, aquaculture industry might give rise to severe ecological, economic and social problems and conflicts.

3.3.2.3 Amphibian of the Study Area

Table 19. Amphibian Diversity in the Study Area.

Category of Amphibian	**Total Number Amphibian**	**% of Amphibian**
CA	2	25.00
MA	3	37.50
RA	2	25.00
CR	0	-
EN	1	12.50
EX	0	-

Source: Field Survey 2012-2015.

The above table 19 shows that there was 8 number of amphibians in the study area. Among them only 25 % (2) amphibians are commonly available, 37.50 (3) are moderately available in the study area. Moreover 12.50% (1) amphibian nor found in the study area. (Appendix 10.c)

3.3.2.4 Reptiles of the Study Area

Table 20. Reptiles Diversity in the Study Area.

Status of Reptile	Total Number of reptile	% of Reptile
CA	7	46.67
MA	3	20.00
RA	3	20.00
CR	0	-
EN	2	13.33
EX	0	-

Source: Field Survey 2012-2015.

From the table 20 we see that a total of 15 reptiles was identified from the field survey. Among them 46.67 % (7) is available in the study area (Appendix 10.d).

3.3.2.5 Mammals in the Study Areas

Table 21. Mammal Diversity in the Study Area.

Status of Mammals	Total Number of Mammals	% of Mammal
CA	3	27.27
MA	3	27.27
RA	2	18.18
CR	0	-
EN	3	27.27
EX	0	-
Total	11	100.00

Source: Field Survey 2012-2015.

CA= commonly available, MA= moderately available, RA= rarely available, CR= critically endanger, EN= Endangered, VU = Vulnerable, NO= Not threatened, DD=Data deficient, EX= Exotic

The table 21 shows that 11 numbers of mammals in the study area. Among them 3 (27.27%) is commonly available, 2 (18.18%) is rarely available 3 (27.27%) are rarely available in the study area (Appendix 10.e).

Rahman (2012) conducted a survey on ecology and status of herpeto-mammalian fauna from November 1995 to October 1996 in the Padma river and its adjacent areas, Rajshahi. In their study, a total of 50 species of herpeto-mammalian fauna was recorded. Among these, 5 (10%) were amphibians, 20 (40%) reptiles and 25 (50%) mammals. In the amphibians, 3 species were common, rest one species was fairly common and one few. In the reptiles, 5 species were very common, 4 common, 7 fairly common, 3 few and only one species was occasionally found. Of the mammals, 2 species were very common, 5 common, 10 fairly common, 6 few and 2 species were occasional. Among the total species, 3 species of amphibians were vulnerable nationally, 4 species of reptiles were critically endangered, 4 endangered and 4 vulnerable and one species of mammals were critically endangered (*Lutra lutra*), 6 endangered and 4 species were vulnerable

nationally. Group discussion with the local people indicated that species diversity of herpeto mammalian fauna has been decreased day by day in the study area. This might be due to the results of highly disturbance by human. Meanwhile, increase of human population, destruction of habitat, expansion of agricultural activities, illegal hunting and trade are the main causes for declining herpeto-mammalian fauna in the study area.

Rahman *et al.* (2014) conducted a detail study on ecology and the wildlife diversity in the Eco-park of Jamuna bridge and its adjacent area of Sirajgonj district. He recorded a total of 89 species of wild animals, of which, 6 (6.74%) species were amphibians, 11 (12.36%) reptiles, 56 (62.93%) birds and 16 (17.94%) mammals. Regarding relative abundance, 18 (20.22%) species of wildlife were very common, 35 (39.33%) common, 28 (31.46%) fairly common, 7 (7.87%) few and only one (1.12%) was occasionally found. He of 25 species of wildlife were identified as threatened category. In amphibians, 3 species were vulnerable nationally. In reptiles, 4 species were vulnerable and one endangered. In birds, 4 species were vulnerable, 6 endangered and one critically endangered (*Gallicrex cinerea*). In mammals, 3 vulnerable and 3 endangered nationally. Among the amphibians, skipper frog (*Euplyctis cyanophlyctis*) and toad (*Bufo melanostictus*) frequently occurred. Among the reptiles, common garden lizard (*Calotis versicolor*), common skink (*Mabuya carinata*) and cheekered keel back water snake (*Xenochorphis piscator*) were frequently occurred.

3.3.2.6 Terrestrial Birds

Table 22. Terrestrial Bird's Diversity in the Study Area.

Status of Terrestrial Birds	**Total Number of Terrestrial Bird**	**% of Terrestrial Birds**
CA	8	23.53
MA	6	17.65
RA	13	38.24
CR	4	11.76
EN	3	8.82
EX	0	-

Source: Field Survey 2012-2015.

CA= commonly available, MA= moderately available, RA= rarely available, CR= critically endanger, EN= Endangered, VU = Vulnerable, NO= Not threatened, DD=Data deficient, EX= Exotic

There are some types of birds are available in the study area. The above table 22 shown that a total of 34 types terrestrial birds was shown in the study area. Among them 23.53 % (8) is commonly available, 17.65 % (6) is moderately available and majority terrestrial birds 28.24 % (13) is rarely available in the study area (Appendix 11.a).

3.3.2.7 Migratory Birds of the Study Area

Table 23. Migratory Bird Diversity in the Study Area.

Status of migratory Birds	**Number of Migratory Birds**	**% of Migratory Birds**
CA	5	35.71
MA	1	7.14
RA	5	35.71
CR	3	21.43
EN	0	-
EX	0	-
Total	14	100.00

Source: Field Survey 2012-2015.

CA= commonly available, MA= moderately available, RA= rarely available, CR= critically endanger, EN= Endangered, VU = Vulnerable, NO= Not threatened, DD=Data deficient, EX= Exotic

Because of food availability for the bird in wetland of the study area, there are many migratory birds were coming. But due to destroyed habitats, now it has decline. The above table 23 shows that only 5 (35.71%) migratory birds are common in the study area. Other hand, 3 nos. (21.43%) of migratory birds are critically endanger in the study area (Appendix 11.b).

Karmakar *et al.* (2011) has studied on the diversity, habitat, distribution and residential status of avifauna of Joypurhat District under Rajshahi Division. He recorded 57 species, belonging to 8 orders, 28 families and 48 genera, were recorded. Among 57 species, 89.43% were resident and 11.57% migratory. He also recorded that14.04% for fairly common to 45.61% for rare species.

The study revealed that most of the species used more than one habitat and the highest number of species, 52 (91.23%), was observed on the trees, whereas the lowest number of species, 3 (5.26%), was found around the

ponds. He mentioned that a number of environmental and man-made factors appeared to be responsible for declining population and species diversity of the birds in the study area.

Rahman *et al.* (2014) recorded the birds, common myna (*Acrodotheres tristis*), pied myna (*A. fuscus*), black drongo (*Dicrurus macrocercus*) and house crow (*Corvus splendens*) occurred frequently. Among the mammals, shrew (*Suncus murinus*), flying fox (*Pteropus giganteus*) and black rat (*Rattus rattus*) frequently occurred. Illegal exploitation of trees, overgrazing of domestic animals, shooting and collection of young animals are the mentionable causes for declining wild animals.

3.3.3 Declining Forest and Forest Resource in the Study Area

Forests are both environmentally and economically important natural resources in the terrestrial ecosystem. The total land under forest in Bangladesh is about 2.56 million ha, which includes officially classified and unclassified state lands, and forestlands accounted for by village forests and tea or rubber gardens. Although a significant part of the existing forest area is designated as State Forest, most of this land is actually barren of tree vegetation. In Bangladesh natural forest areas constitute almost 31 per cent, and forest plantation 13% of forest areas. Only 5% of existing forestlands are designated as protected areas. In terms of per capita forestland, Bangladesh ranks amongst the lowest in the world, with about 0.02 ha per person. The forests of Bangladesh have been disappearing at an accelerating rate. The good to medium density forest of the Chittagong Forest Division had shrunk from approximately 30,000 ha in 1985 to 20,000 ha in 1992. In Cox's Bazar, natural forest cover dropped from 31,300 ha in 1985, to about 24,300 ha in 1992. In Sylhet only about 6,000 ha, *i.e.*, 15% of the actual forest area had remained in its original state in 1987. In Sundarbans, 78% of the forest had canopy closure of 75% or more

in 1961, which was reduced to 65 per cent in 1984. As of 1989 only about 17 per cent of the total legitimate Sal forest area remained across central and northwest Bangladesh.

From the 10 case studies of the study area, it would be said that there is some forest and jungle area were existed where many types wild animals, plant, herbs and shrubs were available in the study area.

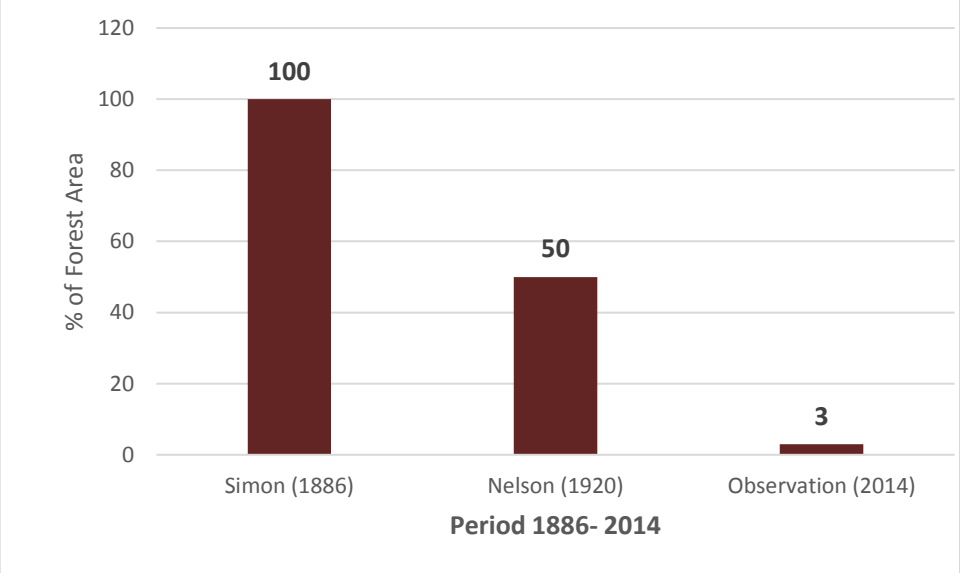

Figure 14. Status of Forest in the Study Area.

These observation is supported Rahman (2009). According to the report of Simon (1886) the *Barind* Tract was out of crop cultivation due to drought and full of thorn brushes. There were big trees *e.g.* Bot, Pakur, Tetul, Jum, Khejur, Tal, Babla, Bansh, Boroi *etc*. There were also land of vast pasture land and thorn brush. At that times the *Jaminder* (Land Lord) and government staffs visiting the area for hunting. Another survey report of Nelson (1920) mention in the same book that huge area of this region was converted into cultivable land by cutting the natural forest trees and brush land. The pastureland also demolished for making cultivable land.

Another settlement report by Carter (1928), it was found that the land of this part of the Bengal was high land, opened, and *Tares* (*Bondhur*) with

some cannel. Source: (*Borendra Anchaler Etihas*, page-62 and Agriculture year book 2013 25th Series, BBS). The above figure 14 shows the trend of declining forest in the study area. This figure is more or less the data of perception of declining forest land and biodiversity of tribal people in the investigation area.

Photo 4. Mr. Agustin Murmu.

Agustin Murmu (10-10-1957) S/o Borka Murmur and Dhoni Soren, (85), village Daempur, Union Parbotipur belong to Santal tribal community. In this village, there are three types of tribal community living with harmony. The Santals are major in numbers, other are Oraon and Mali. Mr. Murmu said that when he was 8- 10 years old, with his friends, every day they went out with Dhanuk (Bow) and Batul (a types of local made tools for hunting) for hunting Gudu (Rat), birds, and wild animal that was available in that area. Sometimes they went out far from his house for hunting Hare, Sojaro, Tortoise *etc.* for one or two week. They went out for hunting wild animal and dried it's and preserved. But now the wild animal is not available because of lack of jungle.

In this life he has seen many changes in the environment. Previous heavy rainfall occurred in the rainy season, but now not enough. There was some big tress like Banyan, tamarind but all big tree was cut down. He mentioned that various types of birds were seen but now many birds are not seen

because of lacks enough food for birds. The main cause is the disappeared of tree Bot (Banyan), Dumur, *etc*.

He was asked how we can restore these natural resources in the area. He suggested that many *khas* pond, forest land, wetland and river should be reserved for growing local plant variety, wetland resource.

Photo 5. Dashomoni Tirkey.

Dashomoni Tirkey (02-12-1952) w/o Horipoda Ekka, is a Oraon woman living the village Kasroil of Parbotipur union under Gomostapur *upazila* of Chapai Nawabgonj district. It is a tribal populated village. A total of 166 tribal and Bengali families are living with social harmony. The river *Punarvova* and *Mohananda* is the main natural water resources. Other hand, a wetland (*beel*) is situated in the boarder side of this union. During the interviewing her for case study, he recalls his past life, the environmental situation of this area, what types of food they collect from the nature and how they met their nutrition.

There were many types of plants, herbs, shrubs. But now these are not available in the nature. She mention some type vegetable like- Phutkuli *(Phyllochlamys taxoides* Koorders*),* Bhelwa *(Semecarpus anacardium* Linn.F.*),* Ban Ole *(Amorphophallus sp),* Pani aru *(Dioscorea oppsitifolia* Linn*),* Khapra sag *(Trianthema monogyna* Linn), Bhatua arak *(Chenopodium album* Linn*),* Kokro pump *(Celosia cristata Linn.),*

Mushroom *(Centella asiatica* Linn*),* Mahua *(Madhuca indica* J.F.Gmel*) etc.* There were many big trees e.g. Bot, (Banyan tree), Paikor / Likor (A kind of Benian), Tentul (Tamarind) were available in the study area. There also some fruity plants like Mohua, Gab, Bon Kanthal (Wild Jackfruit), Domur, Telakucha (Ivory gourd) *etc*. in the area. They easily collect free of cost that was fulfilling their needs. The woman generally collected some short of fishes like Magur (Cat fish), Sing (Stinging catfish), Koi (Climbing perch), Jhinuk and Samuk (Snail), Kakra (Crab), Taki and Cheng (Spotted snakehead), *etc*. from the nearby *Khandor* (low land where water available during the rainy season) and, abandoned ponds, and rivers. He also mentioned that during the period of October to December they collectively went the *beel* (Wetland) and rivers for collecting consumable wild food of animal and conserved it by drying.

There was a question to Dashomoni Tirkey, how you preserved these types of food item. She informed that most of the families collected the green young leaves of Pikor Ghach (Banyan tree) for food item and dried it for preservation. In the off season, they used it to cook for meal. Other types of food item like Mushroom they called it Beng Sag or Khukhri *(Centella asiatica* Linn*)* was one of the main sources of protein. That was also available in their area. But now it is not seen. They also preserved it by drying.

During interviewing her for case study, she gave me important information about their indigenous technology that was fully environment friendly. That time in that area there were many Mohua tree (*Madhuca indica* J.F. Gmel*).* From this tree they collected *mohua* fruit and made flour with rice and take it in their breakfast. The nut of the mohua fruit they used for extracting oil using their traditional technology that they use as cooking

oil. Moreover, they also used the fruit of Mohua for making *Haria* (Rice beer) a type of wine they use it in social occasion.

3.3.4 Perception of Availability Forest Food Degradation in the Last 35 Years

Jogen Pahan (62) S/O late Baddynath Pahan is a Pahan tribal living in the village of Chaklahar of Sironty Union under Sapahar *Upazila* in Naogaon district. His family is living in this village from 1956.

Photo 6. Jogen Pahan.

He was the only educated tribal person who passed matriculation examination in 1971 and jointed as primary teacher in 1973.

He is eyewitness of independent of Bangladesh.

This village is very near to *Jobbai Beel (*Wetland*)*. Punorvova River is much closer to their village.

When I was taking interview him, he said that before liberation of Bangladesh this area was scattered with low habitat. There was no road like present. We have to Naogaon by walk. Most of the land remained uncultivated. But, there was many big tree e.g. *Bot Gach* (Banyan tree), Tamarind tree and Mango trees and is also full of jungle. The people cultivate only *Aman* in rainy season and Aush in very small scale. The people don't cultivate vegetable like this time.

The tribal people of *Pahan* (They also called Munda) community people was collected various types of edible leaves and herbs from the jungle and

fallow land. Plenty types of tubers also the collected from the jungle. Some types of leaves of trees (Pikor- A kind of Banyan) the collected and preserved it by drying. In the lean period, they used it for carry.

There were many types of indigenous fish in the *Beel* and nearby river. *Ruhi, Katla, Kalbouse* (Carp), Tengra, Bain, Soil, Shati, Cheng, Magur, Sing was available in the beel. During the dry season, the tribal people collected much fishes from the beel and dried it for preservation. When the fish was not available the used their dried fish. At the same times, they also collected snail from the *beel* and preserved it in mud whole.

When they have no work, much tribal man went out for two or three week for hunting. They collected mongoose, hare, tortoise, *etc*. from the nature. They conserved the meat of hunted animals applying their traditional technology.

He said that *Mohua* fruit was the very popular in the tribal society. They used the flash of fruits with rice floor for making bread and *Handi* (rice beer) in special occasion. They also use the nut for making oil for cooking.

He was asked about environmental changing in the area. He informed me that climatic parameter has changed. Earlier, in the rainy season, heavy rainfall was happening. He informed me that after liberation, the government social forestry activities were started. At that time many big trees were cut down. During the last 30 years many exotic plants have taken place in the government forest land area where no indigenous plants, herbs are grown even the birds and wild animals are not seen in that forest. Therefore, the tribal people lost their sources of natural food.

Now, they have to depend on cultivated vegetable these are nor affordable for the tribal people due to low income. Many tribal people in his village are taking vegetable once in a week. Some tribal household who have

cultivable land grows vegetable for consumption. But most of the tribal HHs has no cultivable land. Therefore, they are suffering in malnutrition. Furthermore, he said that source of tribal food is being degradation due to use of chemical fertilizer, destroying natural habitat of flora and fauna, from the tribal collected sufficient food for live.

3.3.5 Perception of Causes of Environmental Degradation

Table 24. Perception of Tribal People about Environmental Degradation.

Causes for environmental degradation	**% of respondent**	
Sample 163	Yes	No
High Settlement	85	15
Cutting of big trees	96	4
Over use of fertilizer in Agriculture field	78	22
Drought	100	0
Irregular precipitation	98	2
Filling the Natural water bodies	69	31
Land conversion into Agriculture	89	11
Over population	95	5
Brick field	18	82

Source: FGD 2012-2015.

The major causes of environmental changes in the study area are deforestation, rapid changing land use pattern, and high population pressure on existing area, both for settlement and shifting cultivation. Other causes include drought irregular precipitation, brick field *etc.*

Ali (1997) pointed out that the flood control and drainage (FCD), and flood control drainage and irrigation (FCDI) projects became threat to the fish resources during the last 20 years. The same fate has been observed in the study area.

3.3.6 Tribal Perception on Environmental Change

Table 25. Perception of Tribal People on Environment Changes.

Name of area	Participant			Nos of respondents	
	Male	Female	Total	Yes	No
Potnitola	25	35	60	58	2
Potnitola	8	12	20	17	3
Sapahar	11	10	21	20	1
Sapahar	3	9	12	10	2
Gomostapur	5	5	10	7	3
Godagari	8	2	10	9	1
Total	60	73	133	121	12
% of respondents				90.98	9.02

To find out the perception on environmental changes in the study area, 6 no's of Focus Group Discussion (FGD) were conducted. In those FGDs a total of 133 tribal people whose age was between 40 to 60^{+} years. Among them, 90.98% participants said that the environment is changing. Very few percentage participants (9.02%) answered negative.

3.4.7 Lose of Wetland Resources

Wetlands are valuable resource for agriculture-based economy of Bangladesh. Wetlands support huge production potential for fisheries sector. With the loss of wetlands, the open water fisheries production is declining gin Bangladesh. Besides the fisheries, wetlands function as retention area that controls floods, recharges the ground water, work as irrigation water source *etc*.

Table 26. Fish Production from Different Water Bodies of Greater Rajshahi District (1990-2000).

Name of the water bodies	**Area (ha)**	**Fish Production**				
		1990		**2000**		**Variation in production MT/ha**
		Total (MT)	**MT/ha**	**Total (MT)**	**MT/ha**	
Rivers and Canals	18991	2563	0.13	2316	0.12	(0.01)
Beels	19889	8055	0.40	6518	0.33	(0.08)
Floodplains	185043	19799	0.11	15728	0.08	(0.02)
Pond	15369	22518	1.47	35302	2.30	0.83

Source: Mortuza and Hossain, 2006).

The greater Rajshahi District has vast fisheries resources, covering 2,39,292 ha, nearly one-third of the total land mass. There are 18,991 ha of rivers and canals, 19,889 ha of beels and 185,043 ha of floodplains. It has also 56,954 ponds covering an area of 15,369 ha. The total fish production of the area was estimated at 59864 metric tons (MT), of which open water contributed 24,562 MT (41.03%) and culture fishery produced 35,302 MT (58.97%) for the year 2000. The fish production from rivers and canals, beels, floodplains, and ponds were estimated at 2,316, 6,518, 15,728 and 35,302 MT, receptively.

3.4.4 Loss of some selected fish items of tribal people from wetland sources

Table 27. Some Wild Fisheries Items Consumed by Tribal People.

Name	Pre 1970	1985	2000	2005	2015
Snail	CA	CA	MA	MA	NA
Oyster	CA	CA	MA	MA	NA
Crab	CA	CA	MA	MA	NA
Tortoise	CA	CA	RA	NA	NA
Mud eel	CA	CA	MA	NA	NA

Source: FGD 2012-2015.

Trend of declining some selected wild aquatic animal and fishes consumed by tribal people.

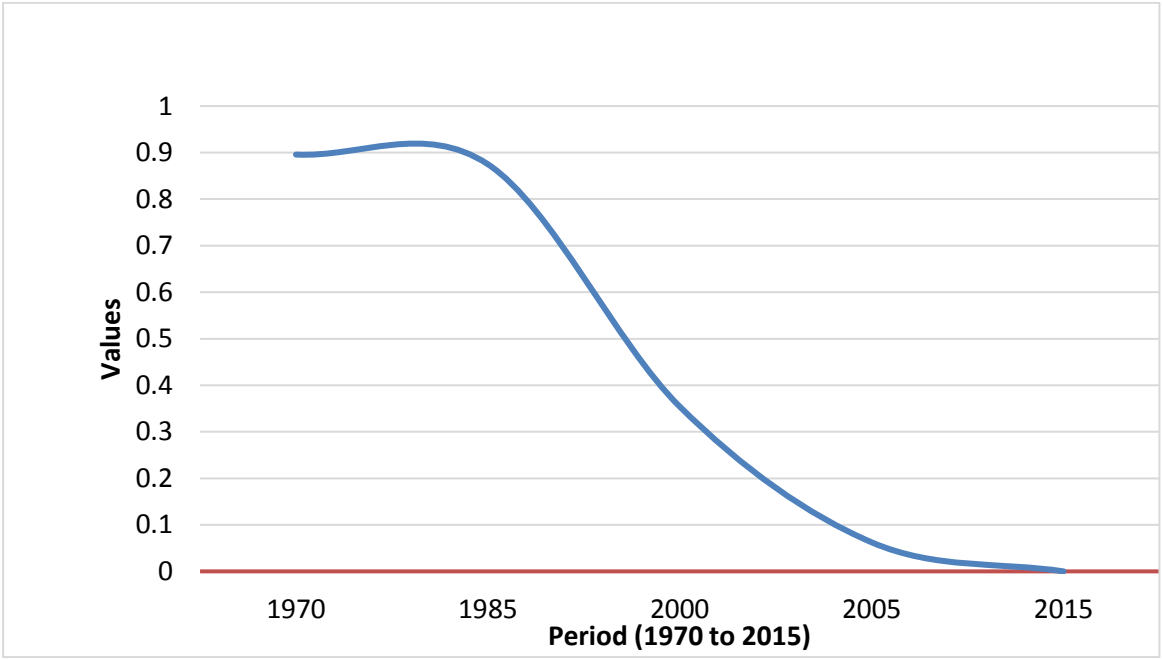

Figure 15. Some Selected Food Items Decline Last 35 Years.

The above table 27 and figure 15 shows that the trend of some selected wild aquatic animal and fisheries is declining.

The result is very much supported by Sinha and Lakra (2005). From their study, it was found that most of the tribal people are small and marginalized holdings. They lead their livelihood by agriculture daily labor. Their diet comprises variety of non-conventional foods viz., edible forms of flowers, fruits, shrubs, herbs, leaves, stems, seeds, wild mushrooms, wild animal and natural fisheries. Their study also identified that 50 types of leaves, 41 types of fruits, 15 types of flowers, 14 types of tubers, 11 types of seeds and 5 types of gums form part of tribal diet.

Freshwater molluscs play a vital role in the economy and tradition of West Bengal in India serving as a food of 80.81 % families belonging to more than 30 numbers of castes of general schedule and tribal people. Traditional foods and traditional means of obtaining and preparing them are part of a culture heritage, thus traditional food is holistically entwined with culture and personal identity, as well as with physical health' (Coleman, 1996).

Freshwater molluscs play a vital role in the economy and tradition of West Bengal in India serving as a food of 80.81 % families belonging to more than 30 nos. of castes of general schedule and tribal people. Fresh water molluscs serve as the protein source of 37 groups of tribal communities in Bangladesh (Flowra *et al.,* 2013).

3.4 The Impact of Environmental Degradation on "Tribal Traditional Food System"

In my thesis I have used the term "Tribal traditional food system". It refers to identify all food within a particular culture available from local natural resources and culturally accepted. It also includes the sociocultural meanings, acquisition and processing techniques, use, composition, and nutritional consequences for the people using the food. Depletion of natural resources by environmental degradation has a significant effect on the traditional tribal food systems.

Destruction of wetlands has a negative impact on poor people especially the tribal people in the study area. The tribal people capture indigenous fisheries items (snail, crabs, *etc*.) is the main source of protein for the poor tribal. Again loss or depletion of animal and plant species limits the productive opportunities of rural. The country's food deficit is being met out with using chemical fertilizers and pesticides extensively. The World Health Organization (WHO) estimates that, 37 million people in the developing world suffered acute or chronic poisoning due to exposure to toxic pesticides (Khan, 1991). Most of the tribal people are involve with agriculture daily labor therefore these group are usually at greater risk of sickness due to pesticide poisoning.

The combined effect of fishing, overcapacity, by-catch management as well as environmental degradation have made 60-70% of the major world fisheries resources are in urgent need of management action to restrict the increase in fishing capacity and to rehabilitate damaged resources (FAO, 1991). The survey reports from the Department of Fisheries (DoF, 1986) showed that 1,24,216 acres of open water area in the greater Rajshahi District including rivers, numerous *beels* and floodplains, is gradually declining because of flood control, drainage and irrigation project as well

as Farakkan impact. The rapid population growth in Bangladesh and the faster rate of expansion of agricultural, domestic, irrigation and industrial activities for which water is essential, frequently shifting priorities from inland fisheries development to other uses.

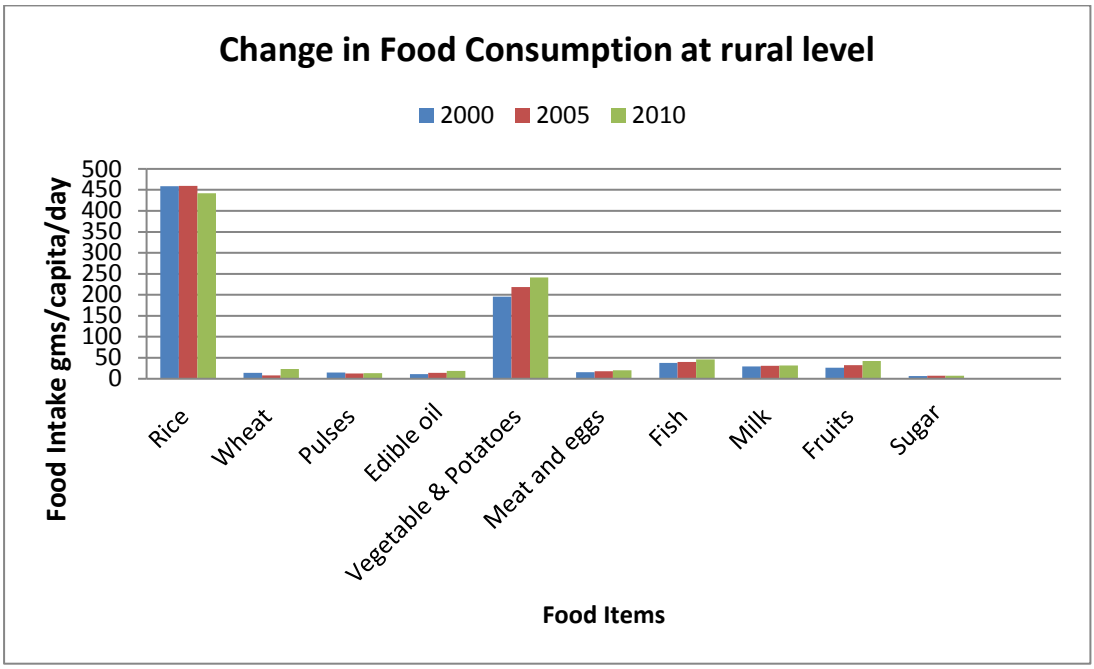

Figure 16. Changes in Consumption (Gms/Capita/Day of Major Food Items in Bangladesh, 2000, 2005 to 2010.

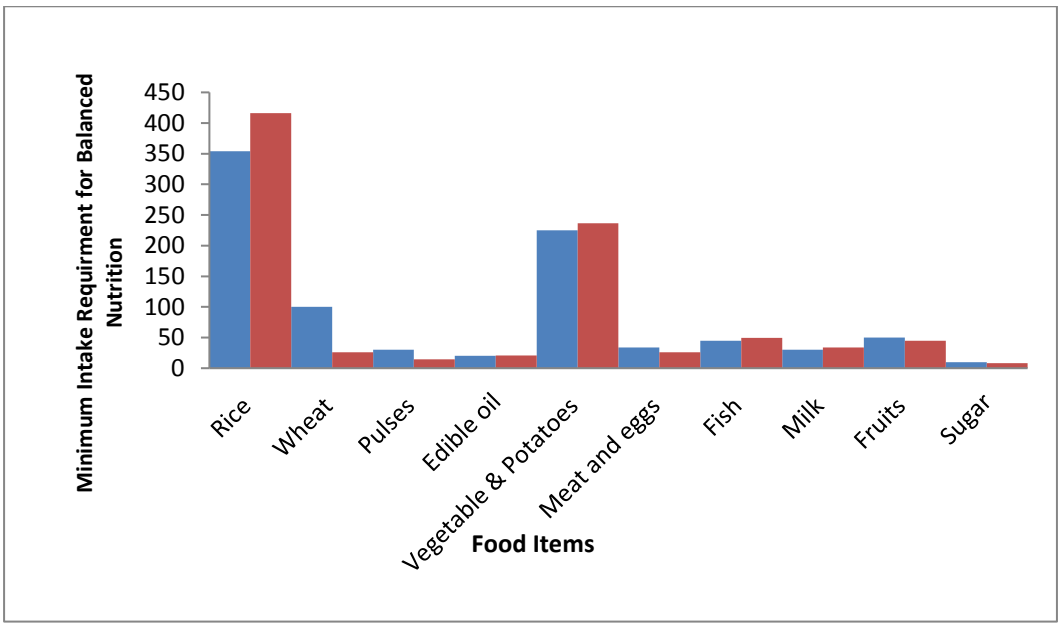

Figure 17. Changes in Consumption (Gms/Capita/Day) of Major Food Items in Bangladesh, 2010.

Today, though people are not dying, they are going hungry and becoming underdeveloped with reduced mental and physical capacity. The hungry population of over 60 million people is larger than most other global cases- the third largest poor population in any country after China and India (UNDP, 2005). Nearly half of Bangladesh's children are underweight, making it one of the most severe cases of malnutrition in the world. While Bangladesh has definitely got more food than it had thirty years back, yet almost nearly half of Bangladesh is still far from being food secure.

The World Bank and GoB-UN in their respective reports on MDGs put the target of 34% children being underweight as non-attainable at present rates of progress. Much will need to be done to achieve the 2015 MDG target of halving the proportion of people who suffer from hunger and malnutrition. Demographic changes in upcoming years are likely to affect poverty and hunger in adverse ways.

While poverty is an overall denominator of this food insecurity in the country, the additional intensifiers are disability (gender, age, and physical challenge) and location (disaster proneness, access to the market, *etc*.) as well as other aspects related to utilization (education, awareness, cultural practices, *etc*.). Issues of governance and accountability further prevent attempts at providing targeted safety nets and price stabilization.

3.4.1 Environmental Changes and Impact on Food Security

The terrestrial and aquatic areas of the country support a large number of diverse biological population, both plant and animal. The biodiversity depends on the type and quality of habitat, and level of interference of the human population and development activities. Notwithstanding insufficient baseline information on biological resources, it is believed that development practices have caused a significant depletion of terrestrial and

aquatic species diversity. Over- exploitation of some very common species in an unwise manner has led to them being reduced to a vulnerable status; for example, the Freshwater Crocodile is now threatened. Mangrove forests form a unique environment of floral-faunal assemblages. Leaf litter undergoing decomposition provides particulate and dissolved organic matter to the estuarine ecosystem, and this complex detritus-based food web supports a number of marine and brackish water organisms. The Sundarbans support a very rich and diverse fish fauna of 400 species, 270 species of birds, and over 300 species of plants. It is an important staging and wintering area for migratory shore birds, gulls, and terns. They comprise the largest remaining tract of habitat for the Royal Bengal Tiger (*Panthera tigris*). St. Martin's Island is an important nesting area for marine turtles, and a wintering ground for migratory shore birds.

Bangladesh is gifted with a number of natural forest ecosystems including inland forest, Land and wetland. It also has littoral mangrove ecosystems. Bangladesh Climate Change Country Study has made an attempt to qualitatively analyze the impact of climate change on forest resources of Bangladesh

It is found that increased rainfall during the monsoon would cause increased runoff in forest floor instead of infiltration into the soil. As a result, there would be enhanced soil erosion from the forest floor. The erosion problem would be more pronounced in poorly dense hill forest areas. Prolonged floods would severely affect growth of many timber species, while it would cause high incidence of mortality for Artocarpus species. In contrast, enhanced evapotranspiration in winter would cause increased moisture stress, especially in the Barind and Madhupur Tract areas, affecting the Sal forest ecosystem. The tea plantations in the north-east would also suffer due to moisture stress. It was found that the

Sundarbans mangrove forest would be the worst victim of climate change. Due to a combination of high evapotranspiration and low-flow in winter, the salinity of the soil would increase. As a result, the growth of freshwater loving species would be severely affected. Eventually the species offering dense canopy cover would be replaced by non-woody shrubs and bushes, while the overall forest productivity would decline significantly. The degradation of forest quality might cause a gradual depletion of rich diversity of the forest flora and fauna of the Sundarbans ecosystem (Ali and Ahmed, 2001)

"Nowa Dharte ima mouje jomatea perach tahakana, nonde khon ala geyela bonchole tahekana, Niteo jotagelea barech chaba kedalea."

-Elezabeth Hembrom, a Santal woman

Meaning- This planet was full of variety types of food for the man. From these resources all animal and human being lead their life" - said Elejabeth Hembrom (85), a Santal woman of Raipur village of Sironty union under Sapahar upazila of Naogaon district. She doesn't tell accurate year of the birth but she can recall little bit the British ruling period. During liberation of Bangladesh she had 2 sons and 1daughter. So it is indicating that she is enough aged to explain the environmental situation, natural resources and food system of Santal tribal people.

Photo 7. Elejabeth Hembrom.

As daily labor family she has to go collect wild vegetable like Hencha ara (Dhekisag), Kalmi sak, Kochu (arum), Mushrum was available in field and jungle area. As she brings to mind, damru and sang (Wild potato), saluki (Water lily) were available in the derelict they collected and preserve by own technology.

Previous, the village Raipur was called Kanta bon means full of jungle where any single person afraid for goes inside this area. Because of many wild animals were available. This area was also full of wild fruit like Mander Gom (Ata), wool apple, jungle jackfruit, Gab, *etc*. Many varieties of vegetable and wild fruit she doesn't recall because of not available

She said that many Matcom (Mohua) trees were there. They collected fruit and nut of the mohua. They prepared special bread mixed with rice flour in special day. They also prepared *Handi* (Rice beer) using *mohua* fruit. It is very popular drinks in the Santal society. The palm tree was also available in this area. Ripen palm used as food and the juice they used as Tari.

She was asked how the resources are being destroyed. She replied that the jungle land is already became agricultural land and the beel is remain dried out maximum times. Moreover, the exotic plants are taken place in land of natural forest. Therefore, forest animal and plants are not available in this area. She also mentioned that natural resources dependent tribal community is suffering food insecurity.

Consumption Pattern and Food Preferences

Table 28. Consumption Pattern of Sample Tribal Household Members in the Study Area.

Variable	Daily with 3 meals	Daily with at least 1 meal	Weekly	Monthly	Occasionally/ Time of festival
Rice	79.17	20.83	0	0	0
Bread	0	0	0	0	0
Potato	29.17	58.33	12.70	0	0
Fish	0	0	66.66	20.84	12.5
Pulse/*Dal*	0	0	62.50	8.33	29.17
Vegetable	0	29.16	70.83	0	0
Egg	0	0	12.5	45.83	41.67
Chicken	0	0	8.33	37.5	54.17
Red meat	0	0	0	20.83	79.17
Milk	0	0	0	0	16.67
Butter	0	0	0	0	0
Fruits	0	0	20.82	0	79.18

Source: Field Survey 2012-2015

Rice is main food of all types of tribal in the study area. Some households use bread for breakfast. 79.17% tribal families have three meals in a day and 20.83% HHs have at least one meal in daily. 66.66 % tribal families take fish in a one week and at the same time 62.50% families use pulse (Dul) in a week. For animal protein 37.5% HHs take chicken at least one time in a month and 54.17% HHs take chicken occasionally or time of festival.

Red meat like pig, mutton and beef are taken by 20.83% tribal HHs in month and 79.17% tribal family take at occasionally.

The tribal people were taken 48 types of non-conventional leaves, herbs, shrubs and tuber from the nature. Among them 8 types of tubers were taken by the tribal people in the time of food shortage. They got this type of tuber from the forest, Jungle and fellow areas. But now they do not get this food from the forest and Jungle because this land is converted into cultivable

land. More over about 50% of edible weeds are not seen in the nature which was taken by tribal people as vegetable.

Table 29. Average per Capita Daily Food Intake by the Tribal People.

Food item	**Amount intake (g/capita/day) by tribal people**	**Non-tribal people**
Rice	580	439.6
Pulses	10	14.2
Fresh fish	25	42.1
Meat	14.84	15.6
Milk	3.84	32.4
Egg (No.)	0.1	5.2
Leafy vegetables	76.84	43.4
Other vegetables	85	113.6
Potato	60.41	63.3
Fruits	0	32.5
Edible oil (ml)	9.14	16.5
Sugar/molasses	2.94	8.1
Spices	31.15	35
Tari (Toddy)	8.18	0

Source: Field Survey 2012-2015.

Both tribal and non-tribal households had the same consumption items. Conventional item like rice, pulses, fresh fish, dry fish, meat, milk, egg, leafy vegetables, other vegetables (brinjal, bitter gourd, sweet gourd, white gourd, bottle gourd, country bean, cauliflower, cabbage, yard long bean, okra, plantain stem, radish and arum) potato, tomato, fruits (banana, apple, bitter plum, guava, grapes, orange and papaya), tea, cigarette and tobacco were the intake of the hilly people. Table 30 shows that tribal people ate rice of an amount of 580 g/capita/day which was little higher than the national average. The tribal of the study area ate very low quantity of meat Average 14.84g/capita/day, fresh fish 25 g/capita/day. Their consumption basket contained very little quantity of pulses 10 g/capita/day), milk 3.84

ml/capita/day, egg 0.11 no./capita/day, sugar/molasses 2.94 g/capita/day *etc*. Especially they consumed pulses, fish, milk, egg, oil, and sugar/molasses far below the non-tribal.

A comparative analysis of the tribal families and non tribal family's reveals that the Tribal adult people consume much rice than non-tribal. The reason might be their higher involvement in physical activities as well as agricultural production. Some necessary protein and vitamin contains items *e.g.* fish, leafy vegetables, potato, tomato, fruits, spices and condiments, and sugar less consume by the tribal people. The reason was that the tribal household who have cultivable land for paddy, vegetable production.

In contrary, the farm land holding households consumed pulses, fresh fish, meat, milk, egg, other vegetables, edible oil than the other landless tribal households due to better production and purchasing power. Besides, the tribal also drink their traditional home-made rice beer. They called it *Hundi* in Santal, *Haria* in oraon.

Table 30. Perception of Tribal People on Environmental Changing.

Types Natural Resource	Before 1970	1985	2000	2005	2015
Agriculture (%)	31	71.33	78	81.00	94.00
Forest (%)	2	1.50	0	0	0.17
Fallow Land (%)	24	8.33	5	5.00	1.67
Jungle (%)	19	9.17	0	0.83	0.50
River	4	4	4	4	4*
Canal	-	1	2	2	2
Pond	8	12	0	11	13
Beel	1	1	1	1	1
Government. Pond	13	8.83	0	2.83	3.67
Public pond	0	4	8	12	15

Rivers*- Atri, Punorvova, Mahananda and Padma.

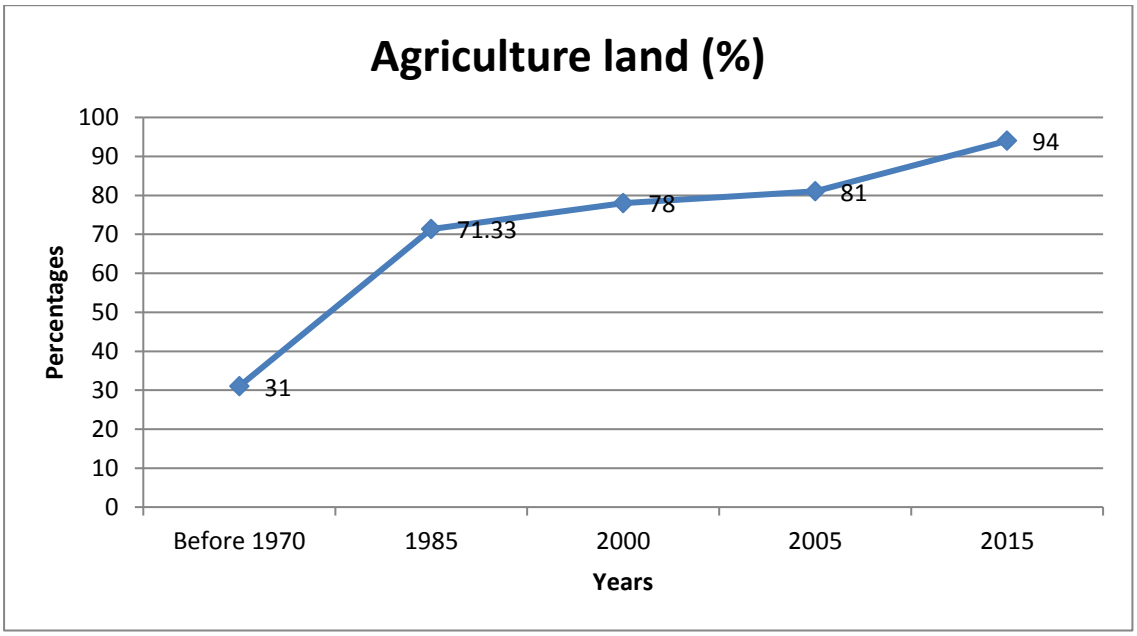

Figure 18. Tribal People's Perception About Changing Agriculture Land.

The figure 18 shows the trend of changing land pattern in the study area. The respondent said that before independent near about 31% land used for agriculture that was tripled in 2000. They also reported almost 94% cultivable land is under any types of agriculture cultivation in 2015.

3.4.2 Natural Resource, Occupation and Food Security

Access to productive resources is a crucial factor in the eradication of food insecurity and rural poverty. The landless tribal people is often the best predictor of poverty and hunger. The poorest are usually landless or land poor. Inadequate rights of access to land, and insecure tenure of those rights, often result in entrenched poverty and are significant impediments to rural development and the assurance of food security. Improved access to land allows a family to increase household food consumption, thereby helping to ensure household food security. Improved access to land may enable the family to increase household income by producing a surplus for sale in the market and may improve the ability of a household to access credit. Secure access to natural resources often provides a valuable safety net as a source of shelter, food and income in times of hardship, and a family's land may be the last available resort in the case of disaster.

Natural assets associated with land include water, forests and natural pastures. Moreover, land rights often include collective rights held by social groups and rights of access to common property resources. Besides agricultural land, forests, rangelands, wetlands and wildlife resources are important sources of livelihood and food security.

Occupation is the main source of income. The occupation of tribal people is not secured. The study reveals that 60.94 % tribal people's income come from agricultural daily labor. The monthly income from the daily labor is very low. In the study area, 50.26 % tribal household's income is 2000 to 4000. That is very low for maintenance their family requirement.

Plate 5. Food Items of Tribal People

Plate 5.1: BAYANG (Wild Potato).

Plate 5.2: Snail as Traditional Food.

Plate 5.3: Wild Spinach.

Plate 5.4: Medicine for Traditional Rice Bear.

Plate 5.5: Traditional Spinach for Tribal People.

Plate 5.6: Rodent as a Food Items.

3.4.2.1 Availability of Wild Fruit in the Study Area

Table 31. Perception of Availability of Wild Fruits Taken by Tribal.

Period	Status of wild fruits consumed by tribal people				
Before 1070	Commonly Available (CA)	Moderately Available (MA)	Rarely available	Not available	Total
1970	9	1	0	0	10
1985	3	5	2	0	10
2000	3	1	4	2	10
2005	3	1	2	4	10
2015	3	1	1	5	10

Source: Author's FGD 2012-2015.

CA= Commonly Available, MA= Moderately Available, RA=Rarely Available and NA= Not Available

From the field survey by using FGD, the respondent identified that a total of 9 (90%) fruits plants out of 10 were available in the study area. From them the tribal people were collected fruit for them. But in 2015, 8 numbers (80%) indigenous fruit plants have disappeared. As a result, the tribal people are getting fruit as their needs.

Agrahar-Murugkar and Subbulakshmi (2005) identified 14 types wild edible berries, fruits, roots, and nuts consumed by the Khasi tribe those content macronutrients, minerals, and vitamins. He also said that the wild edibles eaten by the Khasi are a good source of nutrients, and considering their low cost and easy availability.

3.4.2.2 Availability of Wild Tuber Food Consumed by Tribal People of the Study Area

Table 32. Present Status of Wild Tuber Food Items Consumed by Tribal People.

Period	**Status of availability of wild tuber food items**				
Before 1070	Commonly Available	Moderately Available	Rarely available	Not available	Total
1970	11	0	0	0	11
1985	6	5	0	0	11
2000	3	6	2	0	11
2005	1	2	8	0	11
2015	1	2	1	7	11

Source: Author's FGD 2012-2015.

3.4.3 Edible Weeds Consumed by Tribal People in the Study Area

The non-conventional plant items that are consumed by the tribal people may have considerable nutritive value as they have been consumed for a longer period of time. At the same time, the tribal knowledge of wild plants, gained over centuries of living amidst natural conditions, will help in greater documentation of edible plants that have survived in the forests but may have disappeared from the regions where forests have been lost due to human habitat.

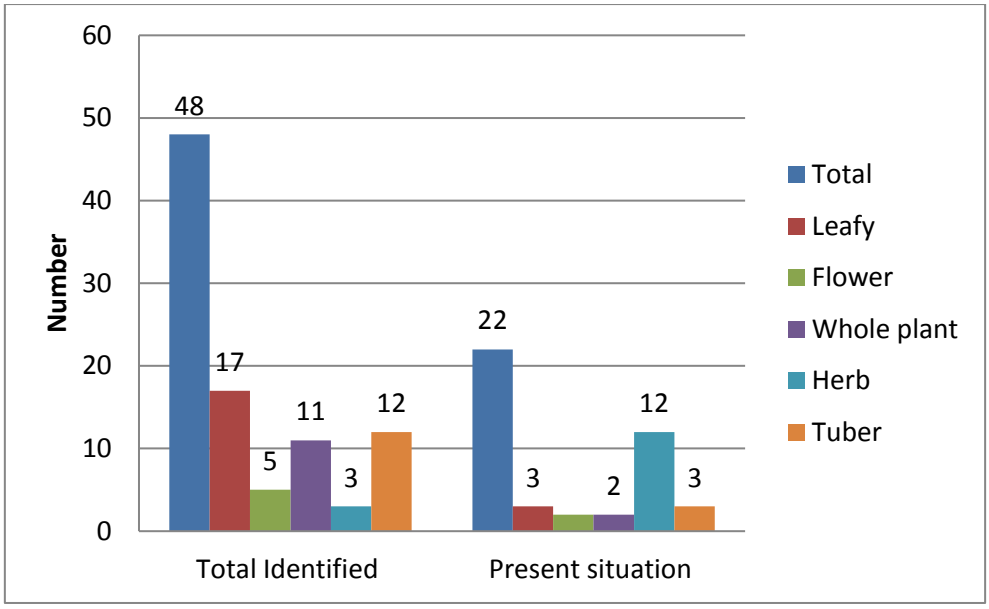

Figure 19. Present Status of Edible Weeds Taken by Tribal People.

The figure 19 shows that the tribal people identified a total of 48 numbers edible weeds in the study area. Among them the tribal consumed as 17 numbers are leafy variety, 3 number are flower variety, 5 numbers of whole plant, 3 types of herbs, and 12 types of tuber food they got from nature. But due to changing environment now they get only 22 types of those edible weeds food items. (Appendix 6)

The result supported by Sinha and Lakra (2005). They also identified 50 types of leaves, 46 types of fruits, 15 types of flower 14 types of tubers, 11 types of seeds and 5 types of gums form part of tribal diet.

Stokoe and Sillitoe (2000) conducted a study in two rural villages, Ujankhalshi (Rajshahi District) and Agcharan (Tangail District), Bangladesh, the paper examines the livelihoods of women in the homestead environment, paying particular attention to local woman's indigenous knowledge. He stated his study that the wild vegetable for the daily survival of the landless poor became increasingly apparent. The study collected preliminary data on the seasonality, where about and usage of a

variety of wild plant foods. Issues discussed are: the collection of wild vegetables; knowledge of wild vegetables; decline in the incidence of wild vegetables; and the domestication of wild vegetables.

3.4.4 Status of Food Security Among Tribal People in the Study Area

The measure the food security situation of the tribal people, an in order to measure food security, a household food security index was constructed by defining a minimum level of nutrition necessary to maintain a healthy living. Any household above this line was classified as food-secure. The food security line used in this study was measured using average recommended level of calorie intake of 2400 kcal as the desirable and cut off point (FAO, 2002).

Table 33. Food Security Index.

Food Security Status	**% of Households**	**% of food insecure tribal HHs**	**Calorie intake**
Food Secure (K0)	144	37.5%	K0≥1 (2582.36)
Food Insecure	240	62.5%	K0≤0 (2153)
	384		

Source: Field Survey 2012-2015.

Based on calorie intake, most of the sample households (62.5%) were found food insecurity since their per capita per day calorie intake ≥2153. It was high among the tribal who have farm land, service holder and engaged in rather than agriculture daily labor is more food secure since their per capita calorie intake ≤2582.36 Kcal.

3.4.5 Summary of Impacts of Environmental Change

Table 34. Summary of Impacts of Environmental Change on Tribal Food Items Sources and Food Systems.

Environmental Parameter	**Present Situation**	**Potential Impacts in Tribal Food Security**	
		Positive	**Negative**
Cultivated land	Increased	Higher production	Wild edible weeds and leafy plants decrease, lose of biodiversity
Natural wetland	Decrease	Rice production increased	Lose of wetland ecosystem, Loss of indigenous fishes, loss of tribal food item's habitat, tribal food items not available, Food insecurity of Tribal
Manmade waterbodies (artificial pond)	Increased	More water for irrigation and fish farming	Limit the access to tribal people
Natural forest and vegetation	Decreased		Negative environmental impact, lose of wild animal and birds use as food items of tribal people
Social forest	Increased	Economical gain	Natural forest decreased
Forest and jungle	Decreased		Not available of wild potato like-Ban Aru, Bayang (*Dioscorea sp*.), loss of biodiversity
Fish diversity Indigenous Fish species	Decreased		Deplation of local fish species
Cultivation of exotic fish	Increased	Increase Fish production	Threaten of indigenous fish species
Wild animal	Decreased		Loss of food items of tribal Loss of Biodiversity
Birds	Decreased		Shortage of tribal food people's food items
Edible plant and weeds	Decreased		Hamper of indigenous people food security
Perennial water bodies vs ponds	Increased	Increase surface water reserver	Decreased Natural water reservior
Plant diversity (Fruits and Timber)	Decreased	–	Loss of indigenous food Loss of local fruits items

To be continue.

Environmental Parameter	Present Situation	Potential Impacts in Tribal Food Security	
		Positive	**Negative**
Indigenous plant diversity	Decreased	–	Negative impacts on biodiversity
Exotic plants	Increased	Economic Gain	Impacts on indigenous biodiversity
Open water fishery	Decreased	–	Indigenous fish diversity decreased
Indigenous Fish diversity	Decreased	–	Negative impacts on health of local low income peoples
Exotic fish diversity	Increased	Higher Production	Negative impacts on ecosystem of indigenous fish diversity
Natural water resources	Declined	–	Crisis of surface water
Wildlife species diversity	Decreased	–	Negative impacts on food chain and food pyramid
Habitat destruction	Wide spread	–	Environmental degradation
Medicinal plants	Decreased	–	Negative impacts on local community people's health
Fish Farming	Increased	Economic gain	Fish diversity decrease
Rain	Irregular		Loss of Agriculture production

From the above table, it is found that the environmental component is threatening by the human intervention. The natural water bodies are decreasing due to destruction by artificial pond excavation. As a result, the indigenous fish are vanishing from the nature. Moreover, extic fish and plants have replaced in the natural habitat. Therefore, the tribal people are not getting food from the nature. This situation not only changing the food baskets of the tribal peole but also changing their food habit.

Conclusion

The tribal people faced several risk factors and constraints in improving their livelihood. These factors were lack of modern technology, lack of education, high price of daily commodities, lack of agricultural land, reduction of land productivity due to drought and natural calamities like flood, drought, and low rainfall. They identified some other problems in their livelihood. These were: loss of biodiversity, loss of wetland resource and forest resources.

The biodiversity in the study area is declining day by day. According to the research result, it is found that in the previous when the wetlands, rivers and canal when no anthropogenic activities (Artificial ponds, Chemical use, Modern agriculture *etc*.) were not initiated a total of 56 number of fish species were found. But now only 28.57 % fish species were found commonly available. It is remarkable situation that 7.14 fish species were critically endanger and 1.14 fish species are endangering.

The biodiversity in the study area is declining day by day. According to the research result, it is found that in the previous when the wetlands, rivers and canals when no anthropogenic activities *e.g*. artificial ponds, Chemical use, Modern agriculture *etc*.) were not initiated a total of 56 number of fish species were found. But now only 28.57 % fish species were found commonly available. It is remarkable situation that 7.14 fish species were critically endanger and 1.14 fish species are endangering.

The meat of some wild animal *e.g.* rabbits, hare, wild cat, mongoose, was very popular to the tribal people. But now it is not available in the study area. The tribal people claim that human intervention on the wetland resource, forest and land use changing are the cause for depleting the

habitat of indigenous fishes, wild animal and plants in the study area. The biodiversity in the study area is declining day by day.

Through the study it was found that 90.98% respondent said that the environment of the study area has changed due to High Settlement, cutting big trees, over use of fertilizer in Agriculture field, destroying wetland by digging artificial ponds for commercial purposes, natural calamities *etc*.

In the absence of adequate assistance, tribal households in the study area met the stress situation in their own way. Sample households sold their labor advance during various kinds of stresses situation followed by use of previous savings, borrowed money, selling the livestock, poultry. They had little options to face the emergency situation with little savings in their hands.

Recommendations

Based on the findings of the study, the following recommendations have been suggested to improve their livelihood and food security, natural resources based food systems of tribal people, food consumption level and copping strategies of indigenous households in various stress situations.

1. Governments should consider seriously taking steps to conserve the reserve forest and wetland resource by strong monitoring.
2. The indigenous foods especially edible plants, vegetable species should be popularized through a massive education program in the study area, so that the majority people don't destroy these variety.
3. Government should take initiatives to make availability of tribal food items snail, *Jhinuk (oyster),* tortoise and other non-conventional fisheries through conserving protecting area.
4. This is necessary to create an enabling environment to improve access to and availability of micronutrient rich tribal foods. Develop long-term strategies that ensure nutritious foods are available locally by restoring natural ecosystems.
5. Tribal should be given priority to lease the government pond in the tribal village.

Chapter Four

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Chapter Five

Appendices

Appendix 5.1. Number of living species.

Groups	Identified species	Estimated Total
Bacteria and viruses	5800	10,000
Protozoa and algae	100,000	250,000
Fungi	80,000	1,500,000
Invertebrates	1,500,000	7 to 50 million
Amphibians and reptiles	12,000	13,000
Fish	20,000	23,000
Birds	9100	9200
Mammals	4200	4300
Vascular plants	250,000	300,000
Nonvascular plants	1500,000	200,000
Total	2,125,300	9 to 52 million

Source: Cunningham and Saigo, 2001.

Appendix 5.2. Number and Percentages of Some Species to be Threatened with Extinction in the World

Taxons		Number of threatened species	Approximate total species (In the world)	Percentage threatened
Animals	Molluscs	354	10^5	0.4
	Crustaceans	126	$4.0X10^3$	3
	Insects	873	$1.2X10^6$	0.07
	Fishes	452	$2.4X10^4$	2
	Amphibians	59	$3.0X10^3$	2
	Reptiles	167	$6.0X10^3$	3
	Birds	1029	$9.5X10^3$	11
	Mammals	505	$4.5X10^3$	11
	Total	3565	$1.35X10^6$	.03
Plants	Gymnosperms	242	758	32
	Monocotyledons	4421	$5.2X10^4$	9
	Monocotyledons: palms	925	2820	33
	Dicotyledons	17474	$1.9X10^5$	9
	Total	22137	$2.4X10^5$	9

Source: Smith, 1993.

Appendix 5.3. Land Status of Study area.

			Number of farm holdings				Number of holdings			Agriculture labor house holds
Districts	All holdings	Non-Farm holdings	Total	Small (0.05-2.49 Acres)	Medium (2.5-7.49) acres	Large (7.5+ acres)	Owner	Owner-cum-tenant	Tenant	
Naogaon	611822	221301	390521	295534	81877	13110	364604	195075	52143	264031
Chapai Nawabganj	320388	163487	156901	116936	35327	4638	220570	67171	32647	95942
Rajshahi	572365	250984	321381	271263	45513	4605	370734	137950	63681	208189
Total	1504575	635772	868803	683733	162717	22353	955908	400196	148471	568162
%		42.26	57.74	78.70	18.73	2.57	63.53	26.60	9.87	37.76

Appendix 5.4. Floral and Faunal Resources in Bangladesh.

Categories	Total Number of Species
Flora	
Angiosperms	5000
Gymnosperms	5
Algae/Seaweed	168
Fauna	
Sponges	3
Corals	66
(Marine +fresh water) molluscs	(336+26)362
Insect	2493
Mites	19
Shrimp/prawns	56
Molluses	437
(Marine +fresh water) crabs	(11+4)15
Lobsters	3
Echinoderms	4
(Marine +fresh water) Fish	(442+266)708
Amphibians	22
(Marine +inland) Reptiles	(17+109)126
Birds	628
(Marine +inland) Mammals	(3+110)113

Source: Khan, 1991: Ahmed and Ali, 1996; Alam, 1967; Jahan, 1993, IUCN, 2000, Saddiqui, 2007.

Appendix 5.5. Ethnic Household and Population of Bangladesh in 2011.

Sl. No	Name of Zila	General Household	Population	% of Tribal	
				General HHs	Population
1	**Bangladesh**	**353727**	**1586141**	**100**	**100**
1	Barisal Division	745	2757	0.21	0.17
1	Barguna Zila	325	1143	0	0.07
2	Barisal Zila	15	76	0	0
3	Bhola Zila	11	57	0	0
4	Jhalokati Zila	6	29	0	0
5	Patuakhali Zila	376	1399	11	0.09
6	Pirojpur Zila	12	53	0	0
2	**Chittagong Division**	**194138**	**897871**	**54.88**	**0**
7	Bandarban Zila	36283	172401	10.26	56.61
8	Brahmanbaria Zila	25	118	0.01	10.87
9	Chadpur Zila	282	1292	0.08	0.01
10	Chittagong Zila	6834	32165	1.93	0.08
11	Comilla Zila	604	2974	0.17	2.03
12	Cox's Bazar Zila	2885	14551	0.82	0.19
13	Feni Zila	117	639	0.03	0.92
14	Khagrachhari Zila	70175	316987	19.84	0.04
15	Lakshamipur Zila	56	244	0.02	19.98
16	Noakhali Zila	51	347	0.01	0.02
17	Rangamati Zila	76821	356153	21.72	0.02
3	**Dhaka Division**	**35177**	**149007**	**9.94**	**22.45**
18	Dhaka Zila	4515	20123	1.3	9.39
19	Faridpur Zila	6651	3233	0.18	1.27
20	Gazipur Zila	3525	15368	1	0.2
21	Gopalgonj Zila	348	2066	0.1	0.97
22	Jamalpur Zila	376	1569	0.11	0.13
23	Kishorgonj Zila	94	433	0.03	0.1
24	Madaripur Zila	17	76	0	0.03
25	Manikganj Zila	115	582	0.03	0
26	Munshiganj Zila	24	103	0.01	0.04
27	Mymensing Zila	8632	35907	2.44	0.01
28	Narayangan Zila	165	899	0.05	2.26
29	Narasingdi Zila	40	208	0.01	0.06
30	Netrokona Zila	6021	25247	1.7	0.01
31	Rajbari Zila	293	1285	0.08	1.59
32	Shariatpur Zila	10	93	0	0.08
33	Sherpur Zila	4180	16231	1.18	0.02

To be continued.

Sl. No	Name of Zila	General Household	Population	% of Tribal	
				General HHs	Population
34	Tangail Zila	6071	25584	1.72	1.61
4	**Khulna Division**	**8905**	**4053**	**2.52**	**2.56**
35	Bagerhat Zila	698	3327	0.2	0.21
36	Chuadanga Zila	329	1268	0.09	0.08
37	Jessor Zila	3790	17432	1.07	1.1
38	Jhenaidaha Zila	698	3108	0.2	0.2
39	Khulna Zila	476	2054	0.13	0.13
40	Kustia Zila	373	1666	0.11	0.11
41	Magura Zila	1760	8099	0.5	0.51
42	Meherpur Zila	4	18	0	0
43	Narail Zila	208	943	0.06	0.06
44	Satkhira Zila	569	2615	0.16	0.16
5	**Rajshahi Division**	**58465**	**245015**	**16.53**	**15.45**
45	Bogra Zila	2008	7981	0.57	0.5
46	Joypurhat Zila	5705	23139	1.61	1.46
47	Naogaon Zila	28374	116736	8.02	7.36
48	Natore Zila	2853	11912	0.81	0.75
49	Chapi Nawabganj Zila	3216	14190	0.91	0.89
50	Pabna Zila	501	1973	0.14	0.12
51	Rajshahi Zila	11132	49312	3.15	3.11
52	Sirajganj Zila	4676	19772	1.32	1.25
6	**Rangpur Division**	**24618**	**102001**	**6.96**	**6.43**
53	Dinajpur Zila	15999	66861	4.52	4.22
54	Gaibandha Zila	1123	4312	0.32	0.27
55	Kurigram Zila	115	486	0.03	0.03
56	Lalmonirhat Zila	23	126	0.01	0.01
57	Nilphamari Zila	109	495	0.03	0.03
58	Panchagarh Zila	383	1528	0.11	0.1
59	Rangpur Zila	4727	18561	1.34	1.17
60	Thakurgaon Zila	2139	9632	0.6	0.61
7	**Sylhet Division**	**31679**	**148960**	**8.96**	**9.39**
61	Habiganj Zila	14534	65802	4.11	4.15
62	Maulvibazer Zila	13217	63466	3.74	4
63	Sunamganj Zila	1444	6911	0.41	0.44
64	Sylhet Zila	2484	12781	0.7	0.81

Appendix 5.6. Edible Weeds, Plants and Tubers Use as Food by Tribal People of North-Western Region in Bangladesh.

Sl. No	Local name	Scientific name	Parts consume	Consumed by tribes
1	Lopung	*Aerua lanata* Juss	Leaf /Seed	Santal
2	Jangli chaurai	Amaranthas viridis Linn.	Leaf and young shoot	All tribes
3	Jangli lahsun	*Asphodelus tenuifolius* Cavan	Leaf	Oraon
4	Koil Khara	*Asteracantha longifolia* Nees.	Leaf	All tribes
5	Ochoic arak	*Boerhaavia diffusa* Linn.	Leaf	Santal
6	Garudi arak	*Alternanthera* sessilis Br.	Young plant	Santal and Oraon
7	Janum arak	*Amaranthus spinosus* Linn	Leaf and tender shoot	All tribes
8	Kokro pump	*Celosia cristata* Linn.	Leaf	Oraon
9	Beng Sag, Chatum arak	*Centella asiatica* Linn	Whole plant	Oraon, Munda and Santal
10	Bhatua arak	*Chenopodium album* Linn	Leaf	Santal, Oraon
11	Hurhura	*Cleome vlscosa* Linn	Young plant	Santal, Oraon
12	Kenna Sag	*Commelina benghalensis* Linn	Leaf	All tribes
13	Pat sag	*Corchorus olitorius*	Leaf	Oraon, Santal
14	Tena arkha	*Cyanotis axillaris* Roem. And Sch.	Leaf	Oraon
15	Kantha arak	*Euphorbia granulate* Forsk	Young plant	Santal
16	Seta kata arak	*Gynandropsis gynandra* (Linn.) Briq.	Young plant	Santal
17	Pitta sag	*Leucas cephalotes* spreng.	Leaf	All tribes
18	Muchari	*Limnophila conferta* Benth	Leaf	All tribes
19	Chottor arkha	*Limnophila gratioloides* R. Br.	Tender plant	Oraon
20	Sunsunia/ Chatong arak	*Marsilea minuta* Linn.	Leaf	All tribes
21	Netho sag	*Oxalis corniculata* Linn	Leaf	Santal and Oraon
22	Gima arak/ Gima sag	*Polycarpon loeflingiae* Benth.	Leaf	Santal
23	Sauri arak	*Polygonum glabrum* Willd	Tender young plant	Santal
24	Kawoa sag	*Rungia parviflora* Nees.	Young Plant	Oraon

To be continued-

Sl. No	**Local name**	**Scientific name**	**Parts consume**	**Consumed by tribes**
25	Khapra sag	*Trianthema monogyna* Linn	Young plant	Oraon
26	Origara	*Vicia hirsute* Koch	Young plant	Oraon and Santal
27	Ban Kunduri	*Melothria heterophylla* (Lour*)*	Herb and Fruit	Oraon / Santal
33	Ban Kasrla	*Momordica dicoica* Robox	Herb	Oraon /Santal
34	Kujri	*Celastrus paniculatus* Willd	Herb	Oraon
35	Mahua	*Madhuca indica* J.F.Gmel	Flower	Oraon/ Santal
36	Sal	*Shorea robusta* Gaertn .F.	Flower	Santal / Oraon
37	Phutkuli	*Phyllochlamys taxoides* Koorders	Flower	Oraon
38	Sahar Baha	*Dillenia pentagyna* Roxb.	Flower	Santal
39	Sahada baha	*Streblus asper* Lour	Flower	Santal
40	Bhelwa	*Semecarpus anacardium* Linn.F.	Tuber	Oraon
41	Ban Ole	*Amorphophallus* sp.	Tuber	Oraon
42	Chun aru	*Dioscorea* sp.	Tuber	
43	Churka	*Dioscorea* sp.	Tuber	
44	Kanta aru / Baiyang	*Dioscorea* sp.	Tuber	Santal
45	Karundi aru	*Dioscorea bellophylla* Linn	Tuber	Santal
46	Pani aru	*Dioscorea oppsitifolia* Linn.	Tuber	Oraon / Santal
47	Ranja aru	*Dioscorea* sp.	Tuber	Oraon
48	Tunga aru	*Dioscorea wallichii* Hook F.	Tuber	Oraon

Appendix 5.7. Status of Wild Fruits Consumed by Tribal People in the Study Area.

English Name	Scientific Name	Before 1970	1985	2000	2005	2015
Mango	*Mangifera indica* L	MA	MA	CA	CA	CA
Berry	*Syzygium cumini* L	CA	MA	RA	RA	NA
Jack fruit	*Artocarpus heterophylla*	CA	MA	MA	MA	MA
Palm	*Borassus flabellifer*	CA	CA	CA	CA	CA
Guava	*Sidium guajava*	MA	CA	CA	CA	CA
Wild Jack fruit	*Artocarpus heterophylla*	CA	RA	RA	RA	RA
Mohua	*Madhuca indica*	CA	MA	RA	NA	NA
Desi Gab	*Diospyros perigrina*	CA	RA	NA	NA	NA
Wood apple	*Aegle marmelos*	CA	MA	NA	NA	NA
Dumur	*Ficus hispida*	CA	CA	RA	NA	NA

Source: Author's FGD 2012-2015.

CA= Commonly available, MA= Moderately available, RA=Rarely Available and NA= Not available

Appendix 5.8. Status of Wild Tuber Consumed by Tribal People in the Study Area.

English Name	Scientific name	Before 1970	1985	2000	2005	2015
Lotus	*Nelumbo nucifera*	CA	CA	MA	RA	NA
Tuber of water lily	*Nymphaea nouchali*	CA	CA	MA	RA	NA
Water caltrop	*Trapa natans*	CA	CA	MA	RA	NA
Flower of Water lily	*Nymphaea nouchali*	CA	CA	MA	RA	NA
Fruit of water lily	*Nymphaea nouchali*	CA	CA	MA	RA	NA
Fruit of Lotus	*Nelumbo nucifera*	CA	CA	MA	RA	NA
Wild potato	*Patata selvatica*	CA	MA	RA	RA	NA
Elephant Foot Aroid	*Amorphophallus campanulatas*	CA	MA	MA	MA	MA
Taro stem	*Colocasia esculenta*	CA	MA	CA	MA	MA
Wild potato	*Patata selvatica*	CA	MA	RA	RA	NA
Drumstick	*Moringa oleifera*	CA	MA	CA	CA	CA

Source: Author's FGD 2012-2015.

CA= Commonly available, MA= Moderately Available, RA=Rarely Available and NA= Not available

Appendix 5.9. Floral Diversity in the Study Area.

Appendix 5.9.a: List of plant biodiversity

Sl. No	Local Name	Scientific Name	Present Status
1	Akanda	*Calotropis procera*	MA
2	Akasmoni	*Acacia auriculiformis*	CA
3	Amm	*Mangifera indica*	CA
4	Amloki	*Phyllanthus embelica*	RA
5	Amra	*Spondias pinnata*	MA
6	Arjun	*Terminalia arjuna*	CA
7	Assath	*Ficus reliosa*	RA
8	Babla	*Acacia arabica*	MA
9	Bahera	*Terminalia belerica*	MA
10	Bakul	*Mimosops elengi*	MA
11	Bel	*Aegle marmelos*	CA
12	Boro Jam	*Syzygium cumini*	RA
13	Bot	*Ficus benghalensis*	RA
14	Chalta	*Dillenia indica*	CA
15	Chambol	*Artocarpus chaplish*	CA
16	Chatian	*Alstonia scholaris*	RA
17	Chitki	*Phyllanthus reticularis*	CA
18	Chondon	*Santallum album*	EN
19	Debdaru	*Polyalthia longifolia*	CA
20	Dumur	*Ficus hispodia*	CA
21	Ralpter	*Ealyptus camaldulensis*	EX
22	Gab	*Diospyros peregrine*	EN
23	Haritoki	*Terminalia chebula*	RA
24	Hijal	*Barringtonia acutangula*	RA
25	Jilapi	*Elacocarpus floribundus*	EN
26	Jam	*Syzygium cumini*	MA
27	Jambora	*Citrus grandis*	MA
			To be continued.

Sl. No	Local Name	Scientific Name	Present Status
28	Jamrul	*Syzygium cumini*	RA
29	Jarul	*Lagerstroemia speciosa*	RA
30	Kadam	*Anthocephalus cadamba*	CA
31	Kajubadam	*Anacradium occidentalis*	CR
32	KaloJam	*Syzygium cumini*	CA
33	Kanchon	*Bauhinia malabarica*	CR
34	Kanthal	*Artocarpus heterophylla*	CA
35	Khaibabla	*Pithecellobium dulce*	CR
36	Khejur	*Phoenix sylvestris*	CA
37	Kothbell	*Feronia limnonia*	CA
38	Krishnachura	*Delonix regia*	CA
39	Latim	*Trewia polycarpa*	CR
40	Meheguni	*Swietenia mahogania*	CA
41	Narikel	*Cocos nifera*	CA
42	Neem	*Azadirachta indica*	CA
43	Pakur	*Ficus comosa*	MA
44	Palas	*Butea monosperma*	RA
45	Rainti Korai	*Samanea saman*	CA
46	Sofeda	*Achras sapota*	RA
47	Sajna	*Moringa oleifera*	CA
48	ShilKorai	*Albizia procesa*	RA
49	Simul	*Bombax ceiba*	RA
50	Sishu	*Dalbergia sisso*	CA
51	Tal	*Borassus flabellifer*	CA
52	Tomal	*Diospyros cordifolia*	CR
53	Tejpata	*Cinnamomum obtusifolium*	CR
54	Tetul	*Tamarandus indica*	CA

CA= commonly available, MA= moderately available, RA= rarely available, CR= critically endanger, EN= Endangered, VU = Vulnerable, NO= Not threatened, DD=Data deficient, EX= Exotic

Appendix 5.9.b. List of Shrubs diversity

Sl. No	Local Name	Scientific Name	Status
1	Banganbilash	*Bouganvillea spectabilis*	CA
2	Bans	*Bambusa arundinaceae*	CA
3	Batol	*Sapium indica*	RA
4	Bedana	*Punica granatum*	RA
5	Beli	*Jasminum sambac*	CA
6	Bichuti	*Tragia involvrata*	MA
7	Boroi	*Zizyphus mauritiana*	CA
8	Carpus Tula	*Gossypium herbaceum*	MA
9	Dadmordan	*Cassia alata*	RA
10	Dalim	*Punica granatum*	MA
11	Doincha	*Sesbania sesban*	CA
12	Golap	*Rosea centifolia*	CA
13	Ishormul	*Aristolochia indica*	RA
14	Jaba	*Hibiscus-rosa sinensis*	MA
15	Jogdumur	*Ficus racemosa*	MA
16	Kamini	*Murraya pabykata*	MA
17	Kamranga	*Averrhoa carabola*	CA
18	Karabi	*Thevetia peruviana*	CA
19	Koromcha	*Pongamia pinnata*	MA
20	Lalverenda	*Racinus sp.*	MA
21	Payara	*Psidium guajava*	CA
22	Pape	*Carica papaya*	CA
23	Shet Verenda	*Racinus communis*	CA
24	Sonalu	*Cassia fistula*	MA
25	Ulatkambal	*Abroma augusta*	MA

CA= Commonly available, MA= moderately available, RA= rarely available, CR= critically endanger, EN= Endangered, VU = Vulnerable, NO= Not threatened, DD=Data deficient, EX= Exotic

Appendix 5.9.c: Herbs Diversity in the Study Area.

Sl. No	Local Name	Scientific Name	Status
1	Shet Nayantara	*Vinca sp.*	MA
2	Alkoshi	*Dolichos pruries*	MA
3	Amlakochi	*Coleus amboinicus*	CR
4	Apang	*Achyranthes aspera*	EN
5	Basak	*Adhatoda vasica*	CA
6	Bhoiamla	*Phyllanthes niruri*	CA
7	Bimraj	*Wedelia chinensis*	CR
8	Bishkathali	*Polygonum hydropiper*	CA
9	Bishkuchu	*Steudnera virosa*	MA
10	Bissolla korola	*Polygonum recumbens*	CR
11	Botamphul	*Gomphrena globosa*	EN
12	Brammisak	*Bacopa monniera*	CR
13	Choto kalkasundi	*Cassia sophera*	CA
14	Dadmari	*Ammania baccifera*	CR
15	Dania	*Coriandrum sativum*	CA
16	Datura	*Datura metel*	CA
17	Dolonchapa	*Hedychium coronarium*	MA
18	Dopati	*Impatiens balsamina*	MA
19	Dudhilata	*Finlaysonia obovata*	MA
20	Durbaghash	*Cynodon dactylon*	CA
21	Gadaful	*Tagetes erecta*	CA
22	Gandharaj	*Gardenia jasminoides*	CA
23	Gaja	*Cannabis indica*	EN
24	Ghagra	*Xanthium indicum*	CA
25	Ghechu	*Aponogeton appendiculatus*	MA
26	Gritokumary	*Aloe indica*	MA
27	Hasnahena	*Cestrum nocturnum*	MA
28	Hatisur	*Helietropium indica*	CA

To be continued

Sl. No	Local Name	Scientific Name	Status
29	Kachu	*Calocasia esculenta*	CA
30	Kuchripana	*Eichhornia crassipes*	CA
31	Kalokeshi	*Eclipta alba*	CA
32	Kalomeg	*Andrographis paniculata*	CA
33	Kash	*Saceharum spontaneum*	CA
34	Kolaboti	*Canna indica*	MA
35	Patharkuchi	*Kalanchoe sp.*	MA
36	Lajjaboti	*Mimosus pudica*	EN
37	Lemongas	*Cymbopogon citratus*	MA
38	Makna	*Euryle ferox*	CA
39	Mankuchu	*Alocasia indica*	CA
40	Mistridana	*Scoparia dulcis*	MA
41	Mohabingoraj	*Wedelia calendulacea*	EN
42	Moroghful	*Celosia cristata*	MA
43	Niloparazita	*Ecbolium sp.*	MA
44	Olkachu	*Amorphophallus panulatus*	CA
45	Padda	*Nelumbo nucifera*	EX
46	Pataseola	*Vallisneria spiralis*	CA
47	Podina	*Mentha viridis*	CA
48	Premkata	*Chrysopogon aciculatus*	CA
49	Rambegun	*Solanum ferox*	UC
50	Ramtulsi	*Ocimum gratissimum*	CA
51	Roktodron	*Leonurus sibiricus*	CA
52	Sada Datura	*Datura alba*	MA
53	Shaluk	*Nymphae nouchali*	MA
54	Shet akanda	*Calotropis procera*	MA
55	Sialmutra	*Argemone mexicana*	MA
56	Singara	*Trapa bispinosa*	MA
57	Sola	*Aeschynomene aspera*	MA
58	Susni	*Marselia quadrifolia*	CA

To be continued

Sl. No	Local Name	Scientific Name	Status
59	Thankuni	*Centella asiatica*	CA
60	Titbegun	*Solanum indicum*	MA
61	Tokma	*Hyptis suaveolens*	MA
62	Akondilota	*Stephania hernandifolia*	CR
63	Anantalota	*Withinia somnifera*	MA
64	Asamlota	*Mikania cordata*	CA
65	Bet	*Calamus rotang*	EN
66	Dodilota	*Euphorbia aromatica*	MA
67	Dudkalmi	*Operculina turpethum*	MA
68	Harjora	*Vitis quadragularis*	MA
69	Helecha	*Enhydra fluctuans*	CA
70	Kalmishak	*Ipomea aquatica*	CA
71	Kumarilota	*Smilax roxburghiana*	CA
72	Pipul	*Piper longum*	MA
73	Poisak	*Basella alba*	CA
74	Satamuli	*Marselia quadrifolia*	MA
75	Swarnalota	*Cuscuta reflexa*	MA
76	Telakucha	*Coccinea cordifolia*	CA

Appendix 5.9.d. Medicinal Plant Diversity in the Study Area.

Sl. No	Local Name	Scientific Name	Biodiversity Status
1	Akondilota	*Stephania hernandifolia*	RA
2	Anantalota	*Withinia somnifera*	MA
3	Asamlota	*Mikania cordata*	CA
4	Bet	*Calamus rotang*	EN
5	Dodilota	*Euphorbia aromatica*	MA
6	Dudkalmi	*Operculina turpethum*	MA
7	Harjora	*Vitis quadragularis*	MA
8	Helecha	*Enhydra flatuans*	CA
9	Kalmishak	*Ipomea aquatica*	CA
10	Kumarilota	*Smilax roxburghiana*	CA
11	Pipul	*Piper longum*	MA
12	Poisak	*Basella alba*	CA
13	Satamuli	*Asparagus racemosus*	MA
14	Swarnalota	*Cuscuta reflexa*	MA
15	Telakha	*Coccinea cordifolia*	C A

CA= Commonly available, MA= Moderately available, RA= Rarely available, CR= Critically endanger, EN= Endangered, VU = Vulnerable, NO= Not threatened, DD=Data deficient, EX= Exotic

Appendix 5.10. Faunal Resources of the Study Areas.

Appendix 5.10.a. Fish Diversity in the Study Area.

Sl. No	**Local Name**	**English Name**	**Scientific Name**	**Biodiversity Status**
1	Roi	Rohu	*Labeo rohita*	CA
2	Catla	Catla	*Catla catla*	CA
3	Chitol	Chitol	*Notopterus chitala*	RA
4	Mirga	Mrigel	*Chela cachius*	CA
5	Bata	Bata	*Labeo bata*	CA
6	Darkina	Blackline Rasbora	*Parluciosoma daniconius*	MA
7	Titputi	Spotfin Swamp Barb	*Puntius ticto*	CA
8	Raik	Reba carp	*Cirrhinus reba*	MA
9	Kakila	Fresh water Garfish	*Xenentodon cabcila*	MA
10	Chanda	Indian Glassy Fish	*Pseudambassis ranga*	CA
11	Lamba Chanda	Long Chanda	*Chanda nama*	MA
12	Poa	Poa	*Pama pama*	MA
13	Bele	Tank Goby	*Glossogobius giuris*	MA
14	Koi	Climbing perch	*Anabas testudineus*	CA
15	Khoilsa	Stripled Gourami	*Colisa fasciatus*	MA
16	Moa	Moa	*Rohtee cotio*	CA
17	Gojar	Giant Snakehead	*Channa marulius*	RA
18	Shol	Banded Snakehead	*Channa striatus*	CA
19	Taki	Spotted Snakehead	*Channa punctatus*	CA
20	Puia	Guntea Loach	*Lepiodocephalus guntea*	MA
21	Ghuci Baim	Striped Spinyeel	*Macrognathus pancalus*	CA
22	Air	Long-Whiskered Catfish	*Aorichthys aor*	MA
23	Guja	Tengra / Seenghari	*Aorichthys seenghala*	RA

To be continued

Sl. No	**Local Name**	**English Name**	**Scientific Name**	**Biodiversity Status**
24	Tengra	Striped Dwarf Catfish	*Balasio tengana*	RA
25	Batachi	Indian Potasi	*Pseudeutropius atherinoides*	RA
26	Sing	Stinging Catfish	*Heteropneustes fossilis*	CA
27	Magur	Magur Catfish	*Clarias batrachus*	CA
28	Bacha	Bacha	*Eutropiichthys vacha*	RA
29	Boal	Freshwater Shark	*Wallago attua*	CA
30	Deshi Sorpothi	Olive Barb	*Puntius sarana*	MA
31	Chitol	Knife Fish	*Notopterus chitola*	MA
32	Boro baim	Eel Fish	*Mastacembelus armatus*	MA
33	Kalibaus	Black Rohu	*Labeo callbasu*	MA
34	Tara baim	One-stripe spiny Eel	*Macrognathus aculeatus*	MA
35	Foli	Gray Feather Back	*Notopterus notopterus*	RA
36	Baghar air	Spotted Ctfish	*Bagarius bagarius*	MA
37	Khorsholla	Mullet	*Ralinomugil corsula*	MA
38	Rang Chanda	Rang Chanda	*Chanda ranga*	MA
39	Batashi	Indian Potasi	*Pseudeutropius atherinoides*	MA
40	Pabda	Indian Butter-catfish	*Ompok bimaculatus*	MA
41	Gang Ghaira	Garua bachcha	*Clupisoma garua*	RA
42	Bheda	Mottled Nandus	*Nandus nandus*	EN
43	Gulsa	Kabasi Tengra	*Mystus cavasius*	RA
44	Madhu pabda	Pabo catfish	*Ompok pabda*	RA
45	Kuchia	Eel fish	*Ophichthys boro*	CA
46	Ghaura	Ghaira	*Clupisoma gaura*	CA
47	Baspata	Gangetic Ailia	*Ailia coila*	RA
48	Chela	Chela	*Oxygester pholo*	RA

To be continued

Sl. No	**Local Name**	**English Name**	**Scientific Name**	**Biodiversity Status**
49	Rita	Large Gray Catfish	*Rita rita*	RA
50	Chapila	Indian River Shad	*Gudusis chapra*	CR
51	Ilish	Hilsa Fish	*Tenualosa ilisha*	EN
52	Rani	Necktie Loach	*Botia dario*	EN
53	Gangina	Box fish	*Chaca chaca*	CR
54	Phasa	Anchovy	*Setipinna phasa*	CR
55	Potka	Ocellated Puffer fish	*Tetraodon cutcutia*	EN
56	Gainna	Kuria Labeo	*Labeo gonius*	CR

Appendix 5.10.b. Shrimp, Prawn, Crabs and Mollusks Resources in the Study Area.

Sl. No	Local Name	English Name	Scientific Name	Status
1	Icha	Prawn	*Macrobrachium lamrrei*	CA
2	Golda chingri	Prawn	*Macrobrachium rosenbergii*	EN
3	Matite Kakra	Crab	*Liocarcinus vernalis*	CA
4	Choto kakra	Crab	*Liocarcinus vernalis*	EN
5	Majari kakra	Crab	*Liocarcinus vernalis*	MA
6	Sada kakra	Crab	*Liocarcinus vernalis*	RA
7	Boro Samuk	Apple Snail	*Pila globossa*	CA
8	Guli Samuk	Bonded Snail	*Vivipara bengalensis*	CA
9	Choto Samuk	Horn Shell	*Cerithedia cingulata*	CA
10	Jhinuk	Freshwater mussels	*Lamellidens marginalis*	MA

CA= Commonly available, MA= Moderately available, RA= Rarely available, CR= Critically endanger, EN= Endangered, VU = Vulnerable, NO= Not threatened, DD=Data deficient, EX= Exotic

Appendix 5.10.c. Amphibians Diversity in the Study Area.

Sl. No	Local Name	English name	Scientific Name	Status
1	Kuno Bang	Common Toad	*Bufo melanostictus*	CA
2	Sona Bang	Bul Frog	*Rana tigrina*	CA
3	Choto Bang	Small frog	*Microhyla ornata*	MA
4	Pani Bang	Boulenger's Frog	*Rana alticola*	MA
5	Katkoti Bang	Skipper Frog	*Rana cyanophlyticus*	MA
6	Gecho Bang	Tree Frog	*Rana temporalis*	RA
7	Lal Chena Bang	Red Microhylid	*Microhyla ruba*	RA
8	Charchiri Bang	Cricket Frog	*Rana limnocharis*	EN

CA= Commonly available, MA= Moderately available, RA= Rarely available, CR= Critically endanger, EN= Endangered, VU = Vulnerable, NO= Not threatened, DD=Data deficient, EX= Exotic

Appendix 5.10.d. Reptiles Diversity in the Study Area.

Sl. No	Local Name	English name	Scientific Name	Biodiversity Status
1	Guishap	Monitor Lizard	*Varaus bengalensis*	CA
2	Dhorashap	Water snake	*Xenochrophis piscator*	CA
3	Choto Bang	Small frog	*Microhyla ornata*	CA
4	Ghokhra Shap	Binocellate Cobra	*Naja naja*	CA
5	Tiktiki	Spotted lizard	*Hemidactylus flaviviridis*	CA
6	Girgiti	Lizard	*Gekko gecko*	CA
7	Raktochosa	Common Garden lizard	*Calotes versiocolor*	CA
8	Sankani	Banded Krai	*Bungarus fasciatus*	MA
9	Daras Shap	Rat Snake	*Ptys mosus*	MA
10	Jat Shap	Bengal Cobra	*Naja kaouthia*	MA
11	Ajogor	Rock Python	*Python molurus*	EN
12	Kumir	Crocodile	*Crocodylus porosus*	EN
13	Bora Shap	Russels Viper	*Vipera russellii*	EN
14	Dheki Bora Shap	Chain viper,	*Daboia russelii*	EN
15	Dudhraj Shap	Copper Head Trinket Snak	*Elaphe radiata*	EN

CA= Commonly available, MA= Moderately available, RA= Rarely available, CR= Critically endanger, EN= Endangered, VU = Vulnerable, NO= Not threatened, DD=Data deficient, EX= Exotic

Appendix 5.10.e. Mammals diversity in the study area.

Sl. No	Local Name	English name	Scientific Name	Biodiversity Status
1	Kheck Sial	Bengal Fox	*Vulpes bengalensis*	CA
2	Gaowra / Bonbiral	Jungle cat	*Felis chus*	MA
3	Beji	Common Mongoose	*Herpestes edwardsi*	MA
4	Kathbirali	Irrawadedy Squirrel	*Callosciurus pygeregthrus*	MA
5	Badur	Flying Fos	*Pteropus giganteus*	CA
6	Indure	House Mouse	*Mus musculus*	CA
7	Banor	Rhesus Macaque	*Macaca mulata*	EN
8	Udh Biral	Smooth Indian Otter	*Lutra perspicillata*	RA
9	Susuk	Ganges River Dolphin	*Platanista gangetica*	E
10	Khorgosh	Block-naped Hare	*Lepus nigricollis*	RA
11	Mechobagh	Fishing Cat	*Prionailurus viverrinus*	EN

CA= Commonly available, MA= Moderately available, RA= Rarely available, CR= Critically endanger, EN= Endangered, VU = Vulnerable, NO= Not threatened, DD=Data deficient, EX= Exotic

Appendix 5.11. Birds Diversity in the Study Area.

Appendix 5.11.a. Terrestrial Birds in the Study Area.

Sl. No	Local Name	English name	Scientific Name	Biodiversity Status
1	Pati kak	House crow	*Corvus splendens*	CA
2	Dhan Shalic	Common Myna	*Acridotheres tristis*	CA
3	Babui	Baya Weaver	*Ploceus philippinus*	MA
4	Chowrui	House Sparrow	*Passer domesticus*	CA
5	Ghugu	Red Turtle Dove	*Streptopelia tranquebarica*	RA
6	Kabutor	Pigeon	*Columba livia*	CA
7	Kanakua	Greater Coal	*Centropus sinensis*	RA
8	Chil	Black kite	*Milvus migrans*	MA
9	Bulbuli	Redvented Bulbul	*Pycnonotus cafer*	MA
10	Kokil	Koel	*Endynamys scolopacea*	RA
11	Kanakuka	Lesser Coal	*Centropus bengalensis*	RA
12	Hottiti	Red-wattled Lapwing	*Vanellus indicus*	RA
13	Holday Pakhi	Black-headed Oriole	*Oriolus xanthornus*	RA
14	Madhukha	Purple Sunbird	*Nectarinia asiatic*	CR
15	Satvaira	Jungle Babbler	*Turdoides striatus*	CR
16	Darkak	Jungle Crow	*Corvus macrorynchos*	CR
17	Dhanuk	White-breasted waterhen	*Amaurornis phoenicurus*	CR
18	Doel	Magpie Robin	*Copsychus saularis*	CA
19	Tia	Para Keet	*Psittacula krameri*	RA
20	Tuntuni	Tailor bird	*Orthotomus sutorius*	MA
21	Shama	Shama	*Copoychus malabaricus*	MA
22	Kath Thokra	Folder-backed wood pecker	*Dinopium javanense*	RA
23	Gang Chill	River Tern	*Sterna aurautia*	RA
24	Kora / Dahuk	Water cook	*Gallicrex cinerea*	RA
25	Lakhipecha	Bran owl	*Tyto alba*	CA
26	Hutum Pecha	Spotted owlet	*Athena brama*	CA
27	Sokun	Vulture	*Gyps bengalensis*	RA
28	Catok pakhi	Plaintive cakoo	*Cacomantis merulinus*	RA
29	Nolkak*			RA
30	Saros	White stork	*Ciconia ciconia*	MA

To be continued

Sl. No	Local Name	English name	Scientific Name	Biodiversity Status
31	Ratchora	Large-tailed Nightjar	*Caprimulgus macrurus*	MA
32	Moyna	Pied Mayna	*Strurnus contra*	CA
33	Kutum pakhi	Rufous Trcepie	*Dendrocitta vagabunda*	RA
34	Baj pakhi	Kestred Eagle	*Falco tinnunculus*	RA

CA= Commonly available, MA= Moderately available, RA= Rarely available, CR= Critically endanger, EN= Endangered, VU = Vulnerable, NO= Not threatened, DD=Data deficient, EX= Exotic

Appendix 5.11.b. Migratory Birds Diversity in the Study Area.

Sl. No	Local Name	English name	Scientific Name	Biodiversity Status
1	Kani bock	Pond Heron	*Ardeola grayii*	CA
2	Nolbock	Grey Heron	*Ardea cinerea*	CA
3	Choto Bock	Little Egret	*Egretta garzetta*	RA
4	Machranga	Common Kingfisher	*Alcedo atthis*	CA
5	Pankuri	Little Cormorant	*Phalacrocorax niger*	RA
6	Patihas	Spot-billed duck	*Anas poecilorhyncha*	CA
7	Bale Has	Cotton Pygmy Goose	*Nettapus coromandelianus*	RA
8	Cegha	Fantail Snipe	*Gallinago gallinago*	RA
9	Go- bock	Cattle Egret	*Bubulcus ibis*	CA
10	Kajla Bock	Common Pochard	*Aythyaferina*	MA
11	Manik Jor	Woolly-nacked stork	*Ciconia episcopus*	CR
12	Kada Khoncha	Snipe	*Gallinago stenura*	CR
13	Shamuk Kol	Openbill stork	*Anastomus oscitpus*	CR
14	Hargila	Lesser Adjutent	*Leptoptilos javanicus*	RA

CA= Commonly available, MA= Moderately available, RA= Rarely available, CR= Critically endanger, EN= Endangered, VU = Vulnerable, NO= Not threatened, DD=Data deficient, EX= Exotic
(N.B. The birds Nolkak is local name and their scientific name is not identified)

Appendix 5.12. List of Edible Tribal Food Items Taken from Floral Resources by Oraon Tribal People of the Study Areas by Tribal Community.

Sl. No	Local name	Scientific name	Parts consume
1	Vatua Sak	*Chenopodium album* Linn	Leaf
2	Lopung	*Aerua lanata* Juss	Leaf
3	Jangli chaurai	*Amaranthas viridis* Linn.	Leaf & young shoot
4	Jangli lahsun	*Asphodelus tenuifolius* Cavan	Leaf
6	Koil Khara	*Asteracantha longifolia* Nees.	Leaf
7	Ochoic Sag	*Boerhaavia diffusa* Linn.	Leaf
8	Kokro pump	*Celosia cristata* Linn.	Leaf
9	Kenna Sag	*Commelina benghalensis* Linn	Leaf
10	Pat sag	*Corchorus olitorius*	Leaf
11	Tena arkha	*Cyanotis axillaris* Roem. And Sch.	Leaf
12	Pitta sag	*Leas cephalotes* spreng.	Leaf
13	Ahari Sag	*Limnophila conferta* Benth	Leaf
14	Sunsunia/ Chatong arak	*Marsilea minuta* Linn.	Leaf
15	Netho sag	*Oxalis corniculata* Linn	Leaf
16	Gima sag	*Polycarpon loeflingiae* Benth.	Leaf
17	Kujri Sag	*Celastrus paniculatus* Willd	Herb

CA= Commonly available, MA= Moderately available, RA= Rarely available, CR= Critically endanger, EN= Endangered, VU = Vulnerable, NO= Not threatened, DD=Data deficient, EX= Exotic

Appendix 5.13. List of Food Item Taken from Floral Resources of the Study Areas by the Tribal Community.

Sl. No	Local name	Scientific name	Parts consume	Consumed by tribes
1	Bhatua arak	*Chenopodium album* Linn	Leaf	Santal, Oraon
2	Lopung	*Aerua lanata* Juss	Leaf	Santal
3	Jangli chaurai	*Amaranthas viridis* Linn.	Leaf & young shoot	All tribes
4	Jangli lahsun	*Asphodelus tenuifolius* Cavan	Leaf	Oraon
6	Koil Khara	*Asteracantha longifolia* Nees.	Leaf	All tribes
7	Ochoic arak	*Boerhaavia diffusa* Linn.	Leaf	Santal
8	Kokro pump	*Celosia cristata* Linn.	Leaf	Oraon
9	Kenna Sag	*Commelina benghalensis* Linn	Leaf	All tribes
10	Pat sag	*Corchorus olitorius*	Leaf	Oraon, Santal
11	Tena arkha	*Cyanotis axillaris* Roem. And Sch.	Leaf	Oraon
12	Pitta sag	*Leucas cephalotes* spreng.	Leaf	All tribes
13	Muchari	*Limnophila conferta* Benth	Leaf	All tribes
14	Sunsunia/ Chatong arak	*Marsilea minuta* Linn.	Leaf	All tribes
15	Netho sag	*Oxalis corniculata* Linn	Leaf	Santal and Oraon
16	Gima arak/ Gima sag	*Polycarpon loeflingiae* Benth.	Leaf	Santal
17	Kujri	*Celastrus paniculatus* Willd	Herb	Oraon
18	Mahua	*Madhuca indica* J.F. Gmel	Flower	Oraon/ Santal
19	Sal	*Shorea robusta* Gaertn. F.	Flower	Santal / Oraon
20	Phutkuli	*Phyllochlamys taxoides* Koorders	Flower	Oraon
21	Sahar Baha	*Dillenia pentagyna* Roxb.	Flower	Santal
22	Sahada baha	*Streblus asper* Lour	Flower	Santal
23	Kanta aru / Baiyang	*Dioscorea sp.*	Tuber	Santal
24	Beng Sag, Chatum arak	*Centella asiatica* Linn	Whole plant	Oraon, Munda & Santal
25	Garudi arak	*Alternanthera sessilis* Br.	Young plant	Santal and Oraon
26	Chottor arkha	*Limnophila gratioloides* R. Br.	Tender plant	Oraon

To be continued

Sl. No	Local name	Scientific name	Parts consume	Consumed by tribes
27	Janum arak	*Amaranthus spinosus* Linn	Leaf and tender shoot	All tribes
28	Hurhura	*Cleome vlscosa* Linn	Young plant	Santal, Oraon
29	Kantha arak	*Euphorbia granulate* Forsk	Young plant	Santal
30	Seta kata arak	*Gynandropsis gynandra* (Linn.) Briq.	Young plant	Santal
31	Sauri arak	*Polygonum glabrum* Willd	Tender young plant	Santal
32	Kawoa sag	*Rungia parviflora* Nees.	Young Plant	Oraon
33	Khapra sag	*Trianthema monogyna* Linn	Young plant	Oraon
34	Origara	*Vicia hirsute* Koch	Young plant	Oraon and Santal
35	Ban Kunduri	*Melothria heterophylla (*Lour*)*	Herb and Fruit	Oraon / Santal
36	Ban Kasrla	*Momordica Dicoica* Robox	Herb	Oraon /Santal
37	Ban Ole	*Amorphophallus sp.*	Tuber	Oraon
38	Bayang	*Dioscorea bulbifera* L.	Tuber	Santal
39	Chun aru	*Dioscorea sp.*	Tuber	Santal
40	Churka	*Dioscorea sp.*	Tuber	Santal
41	Bhelwa	*Semecarpus anacardium* Linn.F.	Tuber	Oraon
42	Damru (Pisko)		Tuber	Santal
43	Karundi aru	*Dioscorea bellophylla* Linn	Tuber	Santal
44	Pani aru	*Dioscorea oppsitifolia* Linn.	Tuber	Oraon / Santal
45	Ranja aru	*Dioscorea sp.*	Tuber	Oraon
46	Tunga aru	*Dioscorea wallichii* Hook F.	Tuber	Oraon
47	Ultho*		Tuber	Santal
48	Kanta aru / Baiyang	*Dioscorea sp.*	Tuber	Santal

**Ultho'* a kind of wild potato. The turm is come from Santal. The spelling is not available in the Bangla and English

Appendix 5.14. Questionnaire (in English)

Institute of Environmental Science (IES)

University of Rajshahi

(Impact of Environmental Changes on Natural Resources-based Food System of Tribal Community of North-Western Region in Bangladesh)

(Use only for Research)

(This Questionnaire has translated and edited from Original Bangla Questionnaire)

General Information

Village	
Post	
Union	
Sub-district	
District	
Name of Family Head	
Name of Respondent	

Section 1. Family Information

1.1 Respondent Male ------- Female

1.2 Ethnicity ……

1.3 Information of Family Members

Sl. No	Name	Male or Female	Age	Marital status	Educational qualification	Main occupation	2nd occupation	Mean Monthly income

Section 2. Economical Information

2.1 Have own land? Yes ---------- No ----------

2.2 If yes, please fill up the following table-

Nature	Amount (Decimal)
Homestead	
Agriculture land	
Garden	
Pond	
Fellow land	
Other	
Total	

2.3 Income from the land (Past year)

Particular	Annual income (Tk.)
Own farm land	
Vegetable production	
Share cropper	
Leas	
Mortgage of own land	
Government land (Temporary leasing)	
Other	
Total	

2.4 Income from non-agriculture source

Particular	Annual income (Tk.)
Daily labor wages	
Small Business	
Fishing	
Van / Rickshaw puller	
Livestock	
Poultry	
Other	
Total	

2.5 Number of Domestic animal / poultry bird in the family

Particular	Number	Market price (Tentative)
Cow/ Buffalo		
Goat / Sheep/ Ram		
Hen / Duck		
Pigeon		
Total		

2.6 Annual expenditure in the family

Head of Expense	**Amount of expenses (Tk.)**
Food	
Dress	
Treatment	
Education	
Fuel / Oil / Electricity	
Festival / Special day / occasion	
Expenses for non-essential / traditional food items (Betel leave, tobacco, cigarette, rice bear *etc*.)	
Housing repairing	
Gift to relatives or other	
Washing material (Soap, washing powder *etc*.)	
Entertainment	
Cosmetics and ornament	
Paid loan installment	
Travelling cost	
Cost for livestock and poultry bird rearing	
Others	
Total	

Section 3. Health related information

3.1 Health seeking pattern

Health service provider / person	Please tick
Sub-district Health complex	
Union Health Complex	
Chamber of MMBS doctor	
Pharmacy / trained village doctor	
Traditional Healer	
Others	
Total	

3.2 Drinking Water

Source of water	Please tick
Tube well	
Pond	
River / Canals	
Wing well	
Water purification	
Supply by government agency	

3.3 Sanitation / Latrine

Type of latrine	Please tick
Sanitary (Pacca)	
Pit Latrine	
Open defecation	

Section 4. Health related information

4.1 Access to the natural resource

Types of Natural Resource	**Have you access or not (Yes / Not)**	**Name of biodiversity you collect from Nature**
River		
Government land		
Forest		
Wetland		
Pastureland		
Total		

Section 5. Food Menu

5.1 What type of food you have taken in the last week

Food Items	Time of intake (Daily)					Source
	Daily	¾ times/ week	2 times / week	1 times / week	Not in a week	Source of food (Market, nature, Neighbor

5.2 What type of food you have taken nature

Name of food Items (Local name)	Which part you have taken	How to cook

5.3 What type of food item collect from natural wetland/ ricer/ canal *etc.*

Name of food Items (Local name)	Which part you have taken	How to cook	How to preserve

Section 6. Perception of Environment Change
6.1 Do you think that the environment changing --- Yes ---------- No
6.2 Status of Environment in the biodiversity (Please identifies the species names)

Plant		Wild Animal		Birds		Fisheries	
Pre 1970	2015	Pre 1970	2015	Pre 1970	2015	Pre 1970	2015

6.3 Cause of declining the above biodiversity in the area
1.
2.
3.
4.

6.4 What is natural disaster occurred in this area last 30 years?

Thanks for cordial assistance for above information

Information data collector
Name---
Signature----
Date: ------