IMPACT OF DEGRADATION OF WETLAND ECO-SYSTEM ON THE WETLAND DEPENDENT FISHING COMMUNITY: A CASE STUDY IN ERSTWHILE KAMRUP DISTRICT, ASSAM

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Abstract

The present study is the result of the research work on "Degradation of Wetland Eco-system in Assam and Its Impact on the Wetland Dependent Community: A Case study in Erstwhile Kamrup District " using both primary and secondary data. As per 2001 census report , 79.2 per cent fishermen of the total Scheduled Castes of Assam depends on wetlands as their livelihood . In Assam as well as in erstwhile Kamrup district fishing community comprises six groups , namely Kaibartas,Jal-Keots,Patnis,Jhalo-malos,Namasudras and Hiras. With the growth of population the increasing activities of human being on the wetlands degrade its ecosystem .Similarly the ecosystem of three sample wetlands of the erstwhile Kamrup district viz A. Kapla beel , B. Jalikhora and C. Deepor beel are being degraded day by day .As a result the productivity of the wetlands is declining and therefore , the different organism of the beels are being threatened. At the same time the people of the fishing community are suffering from economic crisis.

Keeping in view this background the study aims at an assessment of present status of the three sample wetlands under study at micro level and finding out the constraints associated with the wetlands. Moreover the study makes an attempt to examine the wetland ecosystem in terms of both physico-chemical and socio-economic parameters .Further with the help of the case study over a total of 300 sample households of twenty sample villages near the sample wetlands an effort is made to find out the present plight of the fishing community.

Key words : Wetland, dependent community, Eco-system, Assam , Kamrup district.

The article consists of four parts:

Part –I: Scope of Research and Design of the study
Part-II : Socio-economic Status of the Wetland Dependent Fishing Community
Part III: Physiochemical Parameters of the Sample Beels
Part -IV Role of Wetland ,Causes of Degradation of Wetland Ecosystem and Suggestions

Part –I:
Scope of Research and Design of the study

1.1 . Introduction

There is close relationship between the wetland and the wetland dependent community like fishing community and other aquatic and non- aquatic species. The fishing community in Assam is solely dependent on wetland as its livelihood. The other people are also dependent on wetland for fishing as fish is favorite food item of them. The community which depends on fisheries like wetlands is said to be fishing community

Wetlands which are said to be the backbone not only for the fishing community but also for the flora and fauna are commonly known a beels constitute vitally important fishery resource of Assam . Beel is either a geographical area with characteristics of both wet soil and bodies of water, or the transitional zone between aquatic and terrestrial eco-system where the surface of water called water table is usually at above or just below or near the land surface. According to Ramsar Convention, wetlands include a wide variety of habitats such as marshes peat lands floodplains, river and lakes, and coastal areas such as marshes, mangroves, coral reefs and other marine areas no deeper than six meters at low tide as well as human-made wetlands such as waste-water treatment, ponds and reservoirs.

In the Kamrup district, all fishing communities at one time used to fish and thereby earned their livelihood. Now a days out of the six fishing communities, only three communities exclusively depend on fisheries as their traditional occupation and the Hiras are partially dependent on the fisheries and completely on pottery as their livelihood.But the two communities viz. Patnis and Jal-Keots or Keots have completely given up the fishing trade and taken to cultivation and therefore, the Jal-Keots have identified themselves Halois or Haluwas or cultivators.

According to the Federal Magnuson-Stevens Fishery Conservation and Management Act, a fishing community is defined as a community that is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew and United States fish processors that are based in such community. Depending upon the types of fisheries (viz. large scale and small-scale fisheries) associated with them, the fishing communities are of two groups, namely small-scale fishing communities and large-scale fishing communities. Here importance is given on two concepts namely small-scale fisheries, small-scale fishing communities and fishermen. The first term

'small-scale fisheries' is used to mean artisanal fisheries for subsistence or local, small markets, generally using traditional fishing techniques and small boats. The second term 'small-scale fishing communities' is used to mean those fishing communities which depend on small-scale fisheries .

Fishing communities are an important part of Assamese heritage and economy and its wetland ecosystems. Fishing communities in Assam are not homogenous , as they belong to different six communities like Kaibartas, Jal-Keots, Patnis, Jhalo-Malos,Namasudras and Hiras. These communities have their distinct social , cultural governance structures and traditional practices ,depending upon the geographical location where they inhabit. In Assam as well in Kamrup district most of the fishermen depend on the small-scale fisheries as their livelihood. But a days they have not maintained their families through the profession of fishing due to shortage of fish production arising out of degradation of wetland ecosystem which takes place because of many man-made and natural factors. Further the local people are left aside in the conservation process, they become indifferent to the status of wetlands and are unaware about the ecological importance and economic potentiality of the wetland fisheries.

In Assam there are six fishing communities, viz Kaibartas, Jal-keots ,Patnis , Jhalo-malos , Namasudras and Hiras . Besides these communities there are some tribal communities like Boros and other general people who occasionally depend on wetland for fish , grasses for cattle , Kuhila trees for making idols . Apart from these , the potters collect Hira mati i.e a special type of clay from the wetlands for making different types of pots . Thus the beels have the immense socio-economic and biological values to the local people and the fishermen , apart from the geomorphologic importance as storage basin during floods as the wetlands provide the habitat for a wide variety of aquatic fishes, plants, migratory birds, large animals, and threatened or endangered species offering feeding, breading and nursery ground to others.

Despites these significance the wetland and its different species of flora and fauna have been seriously threatened by the growing human activities like encroachment of shallow inundated areas by cultivators, felling of trees, cutting and burning of vegetation, overgrazing, siltation, deforestation, heavy deposit of aquatic weeds in the beels, multi-use of wetland water for drinking, industry, agriculture and recreation.

Keeping in view the sustainable development and management of the beel fisheries a large number of stakeholders are directly or indirectly associated with the wetland eco-system as beel fisheries. These include i. state government, ii. NGOs ,iii. villagers or fishers and iv. lessees or Mahaldar. Each of them works at different level of management. Still then the people of the fishing community are suffering from economic crisis due to insufficient income earned from the avocation of fishing .

Keeping these backgrounds in view, we intend to make a detailed survey over three compact areas of wetlands of erstwhile Kamrup district of Assam covering sample villages with 20 per cent of the households belonging to wetland dependent community with special reference to the fishing community. Realising the importance of sustainable development and the need for conservation of wetland ecosystem here an attempt is made to highlight the status of wetland ecosystem and causes of degradation of wetland ecosystem and its impact on the fishing community and on the different organisms living in the wetland .

1.2 Objectives : The sole objectives of the paper are as follows

i. To assess the present ecological status of the sample beels under study at micro level ,
ii. To find out the constraints or factors responsible for degradation of wetland ecosystem ,
iii. To examine the wetland ecosystem in terms of both psychocio-chemical and socio-economic parameters and
iv. To highlight the present socio-economic plight of the fishing community of 300 sample households .

1.3 . Research Design

The study is a combination of three research designs viz. A :Exploratory , B : Descriptive and C. Experimental

A. Exploratory design: The study is exploratory in nature. There are three methods for exploratory research. i.e. i. review of literature, ii. experienced persons and iii. case study

i. **Review of Literature and Researches :** Various source materials have been collected from different publications, selected books, articles, papers by eminent economists, sociologists, environmentalists, ecologist and others as appended in the bibliography and have been reviewed for classification of the basic concepts as related to the problem under study.

ii. **Survey of experienced persons:** Some experienced persons from the concerned areas have been consulted for collecting source materials such as leading fishermen, fish traders, village headmen, social workers, mahaldars etc.

iii. **Case study:** Here, case means unit of study and it mainly consists of the wetland dependent community like fishing community and the status of the study area. In this case, both inductive and deductive methods have been used.

B. Descriptive Research Design : The descriptive research design involves the following steps

1. **Universe of the study :** The universe of the study consists of the status of three wetlands of erstwhile Kamrup district namely Kapla , Lalikhora and Deepar and the wetland dependent fishing community.

2. **Sampling frame**

2.1Sample district: Erstwhile Kamrup district and sample beels

For the purpose of intensive study, the researcher has selected the erstwhile Kamrup. on two grounds: First , all the fishing communities viz. Kaibarta, Jal-Keots, Namasudra, Patni, Jhalo-Malo and Hira are found in district. Secondly, the district possesses three important beels namely Deepar Beel, the lone Ramsar Site of the State, Jalikhora and Kapla beel. These beels are said to be the backbone of the fishing community as these are their main source of livelihood.

2.2 Sample Wetlands

In Assam out of 3513 wetlands 38% 1367 wetlands are degraded and 449 wetlands are in the erstwhile Kamrup district. From the total wetland of erstwhile Kamrup district only three beels namely Kapla beel, Jalikhora beel and Deepar beel are purposively selected on the ground that these beels haven degraded due to many man-made and natural activities and these beels are said to be the backbone of the wetland dependent community including the fishing community .

2.3 Total and Sample villages

There are altogether 74 villages in and around the sample wetlands viz. A. Kapla beel, B. Jalikhora beel and C. Deepar beel .Out of these villages 24 villages are near Jalikhora beel and 26 villages are near Kapla beel and another 34 villages are near

Deepar beel. From the total villages under each beel we have selected 25 per cent or 20 villages purposively as sample.Table 1.1 presents the number of sample villages against the total and the names of sample villages.

Table 1.1 reveals that beel-wise out of 20 sample villages, 8 are near Kapla beel, 6 villages each near Jalikhora beel and Deepar beel.

2.4 Selection of households as sample

In the sample villages there are 15 00 households .Out of these only 20 or cent or 300 households have been selected . Selection of households has been made on the basis of four educational categories In doing so first the heads of the households collected from the sample villages through first point survey have been classified into four educational categories namely illiterate, primary, secondary and higher education. According to systematic sampling method ,from the total of each educational category 20 per cent or 300 households have been selected. Table 1.2 presents the sample households against the total of each educational category.

Thus we have selected 142 households as sample from 716 illiterate households,96 households from 478 households of primary standard,45 households from 223 households of secondary level and 17 households from 83 households of higher level education .

C. Experimental research design or methodology for water testing

The methodology to be used for environmental degradation of wetlands or water pollutants and land pollutants is experimental method where laboratory testing of water and soil samples of the area have been taken up to supplement descriptive and historical account .The different parameters used for water analysis are morphometric parameters for wetland water surface like area, bathymetry and depth , physical parameters like movement and colour of water and water quality parameters like colour of water, Ph, DO, turbidity etc.. For soil sediment analysis we take physical parameters like bulk, density, chemical parameters like hydrogen ion Concentration (pH). Experimental research design involves the following steps:

(a) Sample collection and chemical analysis -Sample plots

In order to test water and soil and other organisms first we have collected water, soil and other required organisms from the three sample wetland namely Kapla beel, Jalikhora beel and Deepar beel .Field sampling of water, macrophyte and fish were conducted in Pre-monsoon, Monsoon and Post-monsoon by the standard sampling methods like phytosociological studies for plants, vegetation biomass sampling, and chemical analysis of water.

(b) Stations: Three sampling stations were identified: Three sampling stations were identified from each of the wetland namely A1, A2,A3 (Kapla beel) ,B1,B2,B3 (Jalikhora beel) and C1,C2,C3 (Deepor beel) to estimate the abundance and diversity of macrophytes, abundance and diversity of fishes and to analyze the water parameters of the study sites. All stations were 50 meter distance from each other.

(c) Collection of Macrophytes : Macrophytes are collected using long handed hooks nets or by hand. For quantification of sample in a given area the floating or sinking type of quadrates of known sizes (1m × 1m) made up of wood are used. These quadrates are placed in the macrophyte locality to mark the area from which sample is to be taken. Macrophytes taken out are thoroughly washed, excess water is absorbed on a cloth or filter paper, and then the macrophytes are kept in a herbarium sheet for the preparation of herbarium and then these macrophytes are identified with the help of pertinent literature.

(d)Macrophyte biomass sampling : Biomass is the dry weight of the total vegetation or target species inside a quadrat. Sampling consists of clipping the vegetation to ground level, sorting by species, oven drying the sorted clippings, and weighing.

(e) Water test : Samples are collected to provide a representation of carried water conditions present on the site including the unvegetated areas. Acidity (pH), Free CO2, Dissolve Oxygen, Total Alkalinity, BOD are tested with standard method in the laboratory. Air temperature, Water temperature, Time, Transparency are recorded during the time of field visit.

4. Method of data collection

The study depends more on primary data than that of secondary ones derived from the documentary evidences, government publications, papers, relevant books and journals, government records etc. Here, for data collection four research methods have adopted namely (A) case study method, (B) descriptive method and (C) observation method

(A)Case study method: a two-point survey

Case study refers to the intensive investigation of a particular unit. Here the case or the unit consists of fishing community which depends on wetlands for its livelihood. This method is qualitative in nature. In this method both inductive as well deductive methods are used.

The primary data will be collected through a case study method i.e. a two point survey: First continuous survey at the wetland and household levels; and second, sample survey at the sample household level. Here by the term continuous survey‘ we mean complete survey over the 300 sample households in and around the three sample wetlands viz. A. Kapla beel , B. Jalikhora beel and C. Deepar beel . These beels have been selected purposively from the erstwhile Kamrup district. In the first point survey we have gathered primary data regarding the different parameters required for the study and the factors of environmental degradation of wetlands. In the second point survey, the sample households were canvassed with a special set of schedule for gathering our requisite data.

(B) Descriptive method: It is an attempt to analyze, interpret and report of the present status of an area like the areas of the wetlands, or dependent community of wetland like fishing community. The sources of data collection are direct observation as in the interview, indirect and observation through questionnaire.

(C) **Observation method**: Besides experimental method we made use of observation method for data collection relating to flora and fauna with their identification and for knowing the impact of environmental degradation of wetland upon the different organisms and on human being. Observation is one of the basic methods of data collection. Observation may take place in natural setting or in laboratory condition.

I. Water quality observations: In order to know the quality of water we have to observe whether the water of the wetland is clear or turbid. If it clear, then penetration of light into the water would be more, therefore green aquatic plants will be growing better. The primary productivity will be high. If it is turbid, it affects the primary productivity of the wetland and turbidity obstructs sunlight penetration.

II. Temperature of water with a thermometer or thermo probe: We have to note the temperature of water with a thermometer or thermo probe.

(a) If the temperature of the water of the wetland is quit high (>5 C than the ambient water temperature) , then we can find out the causes of any thermal pollution occurring in the wetlands due to discharge of effluents from some industries.

(b) We have to determine the Ph of water. The Ph would normally range between 6.5 to 8.5 . If the Ph is quit low i.e. acidic waters, it indicates pollution by industries. If the Ph is quit high i.e. alkaline , it indicates contamination by municipal sewage .

(c) We also observe any froth and foam or dark coloured or greasy substances in the wetland so that we may find out the likely sources of the pollutants.

5. **Interpretation and Analysis of data**

Data so tabulated were arranged for interpretation as well as analysis by using statistical tools like ratio, percentage and water and soil test. The analysis of data was made in the form of an article and it was completed by 8-1-2013.

Results and Discussion

Part –II

Socio-economic plight of the Sample Households of the Wetland Dependent Fishing Community

Here in this part an effort is made to highlight the socio-economic parameters like demography :(a) size of population, (b) sex ratio, (c)educational status, (d) migration ,2.occupational status - 2.1 primary sector, 2.2 pottery - traditional rural industry as secondary occupation , 2.3 tertiary occupation, 3 landing , 4 structure of households, and 5. types of houses

1. Demography

(a) Size of population: In 300 sample households of twenty sample villages there are as many as 1699 population. Out of this 805 population are under the sample villages associated with Jalikhora beel,498 population are under the sample villages associated with Kapla beel and 396 population are under the sample villages associated with the Deepar beel .

(b) Sex ratio: Out of the total population 865 are males and 834 are females. So the sex ratio is 864. The sex ratio is as high as 968 among the sample households of the sample villages under Kapla beel while it is as low as 960 among the sample households of the sample villages near Deepar beel.

(c)Educational status: Out of 300 heads of the households only 158 or 52.7 per cent households who primarily depend on fishing are literates. The literacy rate is higher among the sample households associated with Deepar beel (57.0 %) due to urbanization than those of the households associated with the Kapla beel (48.2%) and Jalikhora beel (52.9%) .

Out of the total households 32.0 per cent are households are primary standard , 15.0 per cent are educated households with secondary level and only 5.7 per cent have higher education. Wetland-wise the households associated with Jalikhora and Deepar beel the literacy rate in case of higher education is 6.5 per cent and 6.3 per cent respectively while it is 3.6 per cent for the households associated with Kapla beel. In case of secondary level of education the literacy rate of the households which depend on the Deepar beel for fishing (21.5%) is higher than that of the households associated with Jalikhora beels (13.0%) and of the sample households associated with the Kapla beel (12.0%) . It indicates that though they are literates yet they are bout to depend upon the wetlands because of lack of alternative occupation other than fishing .

(d) Migration:Inter-district migration has taken place among the members of the fishing community. Out of total sample households 21 heads or 7 per cent households have migrated from other nearby districts of Assam. Inter-district migration is as high as 10.8 per cent among the sample households under the Kapla beel while it is as low as 3.6 per cent among the households under the Jalokhora beel.

2. Occupational status

2.1 **Primary sector**: Table 2.1 reveals that 69.7 per cent of the total sample households in sample villages are dependent on sample beels for fishing as their primary livelihood. They earn their livelihood by fish harvesting and cultivation practice in the nearby field. As high as 74.6 per cent sample households associated with Jalikhora beel are engaged in earning more from the primary sector of occupation while as low as 58.2 per cent sample households associated with Deepar beel are engaged in primary sector of occupation .

Due to the increased human pressure, construction of roads and houses there has been mobility of their people from the occupation of fishing to other occupations .However the poor of them have no alternative but to engage in their tradition occupation .So they are engaged in fishing in the Jalikhora beel and only community fishing is permitted once in year by the governing authority. But a section of rich class takes some parts of the beel on lease and employs S.C people for fishing and harvesting. Thus lion's share of profits from them goes to the pockets of the richer section of the people.

In comparison to the fishermen who depend on the Jalokhora beel and Deepar beel, the percentage of fishermen depend on Kapla beel for fishing is high (48.2 per cent). Along with different fish, both floa and fauna of the Jalikhora beel have been affected by the effluents of the Hindustan Paper Corporation, Jagirod, Assam. As a result the demand for the fish collected from these beels have decreased and therefore their prices have fallen .So the fishermen are bound to shift their profession. Table 2.1 reveals that though the percentage of people of fishing community engaged in fishing is still high though there has been diversification of their occupation .

2.2 Pottery - traditional rural industry as secondary occupation

Table 2.1 reveals that out of the total sample households about 7 per cent or 21` households are engaged in secondary sector specially in pottery . Being a traditional rural industry, pottery industry is being practised from generation to generation on family basis with inherited skills The potters in Nalbari and Kamrup districts collect Hira soil for their industry mainly from Deepor Beel.

2.3 **Tertiary occupation**: Table 2.1 reveals that out of the total households 23.3 per cent 70 households are engaged in tertiary occupation either as service holders or as businessman. The percentage of sample households engaged in tertiary sector is higher among the households associated with the Deepar beel (32.9%) than the households associated with the Kapla beel (16.8%) and Jalikhora beel (21.7%) .

3 Landing: Out of the total sample households 60.3 per cent are landless households having land less than three bighas , 19.3 pr cent are marginal landholders having land more than three bighas but less than seven bighas ,13.3 per cent households are small landholders with land more than seven bighas and less than 15 bighas and only 7 per cent households are big landholders having land 15 bighas or more than that. This indicates that only the small and big landholders have operational landholding either for cultivation or for construction of tank or pond for rearing fish.

4 Structure of households: With the growth of urbanization , materialistic outlook and the growing of individualistic characteristics of the people there has been undergone a change of the family structure from joint family to nuclear family . So in the sample households the percentage of joint family is low (26.3 %) while the percentage of nuclear family is high (73,7%) .

5. Types of houses : A good number of households are living without house and land i.e. they are homeless. As much as 41.7 per cent of the total sample households have thatched houses while only 17.7 per cent of the total sample households have Assam Type house and 40.7 per cent have one roofed thin made houses.

Part III

Physiochemical Parameters of the Sample Beels

On the basis of data collected sample during the pre monsoon and monsoon season have been presented in tabular form and then the results have been discussed and analyzed as follows :

i. Air and Water Temperature: Spatio-temporal variation of air temperature recorded in Kapla, Jalikhora and Deepor wetlands have been presented in the table 3.1, table 3.2, table 3.3, table 3.4, table 3.5 and table 3.6. The air temperature of Kapla ranged from 34^0c to 36^0c during pre-monsoon season. Where it is ranged from 31.5^0c to 32.5^0c in Jalikhora wetland and 29 ^{0}c to 31^0c in Deepor wetland during pre-monsoon season.

During the monsoon season the air temperature ranges from 32^0c to 33^0c in Kapla wetland, 33^0c to 34^0c in Jalikhora wetland and 29^0c to 30^0c in Deepar wetland respectively.

The water temperature ranges from 34 ^{0}c to 35^0c in Kapla wetland, 29^0c to 31^0c in Jalikhora wetland and 28^0c to 29^0c in Deepor wetland respectively during the pre monsoon season.

During the monsoon season the water temperature ranges from 29^0c to 31^0c in Kapla wetland, 31 ^{0}c to 32^0c in Jalikhora wetland and 29^0c to 30^0c in Deepor wetland respectively.

P^H : Spatio temporal variation of P^H in three wetlands ranged from acidic to slightly alkaline (From Table 3.1 to Table 3.6). Highest P^H values were obtained from Kapla wetland of 7.20 in Pre- monsoon season and the lowest value was obtained from Deepor wetland during monsoon season which was 6.05

Dissolved Oxygen: Considerable variation in dissolved oxygen in the water of three wetlands was noted during the period of study. Dissolved Oxygen in Kapla wetland ranged between 1.4 mg/l(station1, Monsoon) to 2.4 mg/l (station 2, Pre-monsoon) and in case of Jalikhora wetland the value ranges between 1.8 mg/l (station 3, monsoon) to 4.7 mg/l (station 3, pre monsoon) respectively. In case of Deepor wetland the value ranged between 1.2 mg/l (station 3, monsoon) to 2.8 mg/l (station 1, pre monsoon).

Free CO_2 : The patterns of changes of Free carbon dioxide in three wetlands were more or less similar (table1 to table 6) . The value fluctuated from 17.6 mg/l (station 2, monsoon) to 26.4 mg/l (station 3, monsoon) in Kapla wetland. In Jalikhora wetland it varies from 13.2 mg/l (station 3, monsoon) to 21.2 mg/l (station 2, pre monsoon). In Deepor wetland the value ranged between 11mg/l 9 (station 1 and 3, pre monsoon) to 26.4 mg/l (station 2, monsoon) respectively.

Transparency: The highest value of transparency was observed as 60 cm in Jalikhora wetland (station 1, monsoon) and lowest value obtained as 23.5 cm (station 2) in Kapla wetland (station 2, pre monsoon) .

Total Alkalinity: The highest value of total alkalinity was observed as 472 mg/l in Kapla wetland during pre monsoon season (station 1) and lowest value obtained as 299 mg/l in Deepor wetland during monsoon season (station 1) .

Part -V

Role of Wetland ,Causes of Degradation of Wetland Ecosystem and Suggestions

Assam is gifted with many extensive water bodies such as rivers and freshwater wetlands. In recent years, there has been large scale destruction of wetlands in Assam by man's activities. Despite the tremendous economic benefits offered by wetlands, the attention being accorded towards its preservation and sustainability is the least. The large scale wetland loss has largely affected the socio-economic condition of the dependent community. Assam falls in the North-East India biodiversity hot-spot region. The large floral and faunal diversity of the region needs to be explored to conserve them from extinction and to maintain ecological balance.

Despite tremendous contribution, the developmental planning has failed to recognize the role of wetlands in regional economy. As a result, wetlands are affected by hydrological changes, pollution, siltation, encroachments and other anthropogenic pressures which have led to long-term livelihood problems and poverty among the marginalized sections of the society who depend on wetlands for their sustenance.

The present research work on "Degradation of Wetland Eco-system in Assam and Its Impact on the wetland dependent communitye : A Case Study in erstwhile Kamrup District" is the result of research work over a three sample wetlands and 300 fishing households.

4.1 Role of wetland in Assam :

In Assam wetlands are very important from the geographical point of view because Assam has possessed the maximum number and water area in India under floodplain wetlands, mainly associated with the rivers Brahmaputra and Barak, locally known as beel. As an important part of ecosystem, wetlands play immense role to perform a number of vital functions, like flood control, stabilization of storm by way of acting as natural barriers, water storage, erosion control, ground water recharge and discharge and provide water for human consumption, water purification due to the presence of certain plants species in the ecosystem, retention of sediments and nutrients and stabilization of local climatic condition.

Wetland plays multifarious role in raising both the socio-economic plight of the fishing community and of the quality of the wetland dependent community on the following ground:

i. Fisheries and employment related pisciculture for fishermen and other people : The flood plain wetlands in Assam are most important as natural fish producing belt. These are very rich in aquatic plants and animals and are also suitable for

development of fisheries and employment related pisciculture so important for both fishermen and other people. According to 1991 Census Report, out of the total Schedule Caste people in Assam, more than 80% are fishermen who more or less depend on wetland for their livelihood. Besides these communities, there are some tribal communities such as Boros and other general caste people who occasionally depend on wetland for various purposes such as catching of fish either for sale or family consumption, collecting grasses for cattle, kuhila trees for making idols and other aquatic weeds for the purpose of fuel. Thus, the fresh water wetlands i.e. the beels have immense socio-economic and biological values to the local people and the fishermen.

ii. Raw material for pottery craft : Apart from these, wetlands provide raw material for pottery craft like Hira-clay, a special type of clay used by the Hira people (potters) to make different types of earthen pots.

iii. Storage basin for water: The beels have geomorphological importance as the storage basin for water during floods.

iv. Providing the habitat: The wetlands also provide the habitat for a large variety of aquatic plants, fish, migratory birds and threatened or endangered species and offering breeding, feeding and nursery ground to others .

v. Meeting the demand for dry fish and fresh fish : Assam as fish producing belt **,t**he primary producers who depend on beel fishery supply both dry-fish as well as raw fish to the markets of North-East India, specially the Jagiroad dry-fish market under Morigaon district of Assam, to meet the growing demand of the people of North-East region for dry-fish since its inception in particular and raw fish in general .

vi. A**esthetic value:** Along with the use of the wetlands for such various economic activities as agriculture, horticulture, fisheries or cottage industries, the wetland has its own aesthetic value, often hidden under the dry term non-consumptive use value. The most important non-consumptive value of wetland lies in its providing the aesthetic setting for cultural and recreational activities.

vii. Recreational values: Wetlands as visually and educationally rich environments because of their ecological interest and diversity. Other important wetland related activities are swimming, fishing, bird watching, hunting or **"**simply relaxing at nature's beauty**"**.

viii. Auspicious occasions and religious rites: Among all the plants available on earth, only the wetland plants are used for auspicious occasions and religious rites.

ix. S**ites for recreation and an ideal place for tourist attraction:** Clean water wetlands and flocks of swans swimming wetlands are attractive sites for recreation and an ideal place for tourist attraction.

x. **Socio-cultural and ritual practices:** Some ritual and cultural practices are also associated with these wetlands and these include taking their cattle to the wetlands for bathing and washing during the Bohag Bihu, collecting water for marriage ceremony, community fishing during Makar Sankranti (Magh Bihu), performing drama during Ras Festival in winter season on its banks etc. Moreover, wetlands are rich in plant and animal resources. Hence, people often visit the wetlands to collect their traditional medicinal plant species, raw materials for small scale and cottage industries, vegetables, flowers, seeds and fodder etc. For all these and other reasons, wetlands were considered the abode of gods (Pathak,2012).

The demand for the products or services provided by wetland arises because of its economic values assigned by different user-groups to fulfill their certain purposes.

4.2 Factors Responsible For Degradation of Ecosystem of three Sample beels

1. Common Factors responsible for the wetland fisheries degradation in Assam

The factors responsible for the wetland fisheries degradation in Assam in general and in Kamrup district in particular are explained as follows:

i. Growing human activities leading to encroachment of shallow marginal areas :

The growth of population increases the demand for land either for establishment of new residential quarters, various offices and institutions or for agricultural purposes in the vicinity of the wetlands. In order to meet the increasing demand for land the people are bound to raise their activities like encroachment of shallow marginal areas for agricultural purposes , felling of trees, cutting and burning of vegetation ,overgrazing, deforestation, heavy deposit of aquatic weeds in the beels ,multi-use of wetland water for drinking ,industry, agriculture and recreation which are posing a serious threat to the wetland and its different species of flora and fauna. As a result, the condition of the wetland eco-system is deteriorating fast.

ii. Absence of proper boundary demarcation :Most of the beels have no proper boundary demarcation leading to encroachment.Most of the wetlands are being subjected to continuous shrinkage every year due to impeachment, siltation and changes in river courses. Moreover, various flood control measures like embankments and sluice gates etc. help in controlling the menace of flood, but many of the wetlands are cut off from the parent rivers thereby preventing autostocking and annual flushing and thus remain choked with weeds.

iii. Siltation of Beels and Inlets: Siltation has raised the bed of the wetlands which reduced the water depth in the beels. As a result, fish stock and fish seed are being lost every year. Moreover, siltation has facilitated encroachment upon wetlands. Siltation arises because of more man's unscientific activities such as earth cutting, deforestation and rock quarrying in catchments areas than that of natural impact . Heavy amount of sediments are carried to the beel by running water through the inlets. Moreover, the inlets of the beel are also blocked with earth boulders and stones separated from hills.

The ecological degradation of beels actually started with the arrival of the water hyacinth a century ago. Rampant growth of the fast-growing weeds obstructs the penetration of sunlight. It contributes to eutrophication by slowing down water currents and thus helps deposition of debris at the bottom. Major portions of such wetlands have been rendered unproductive as a result of excessive siltation and growth of weeds and only about 33 percent of the potential is being utilised for fisheries. Due to loss of habitat as a result of siltation fish catch in this wetland decreased from 233.44 tonnes in 2003 to 111.0 tonnes in 2005 (Pathak : 2010).

Extensive growth of water hyacinth prevents sunlight from entering the micro flora which helps in the deposition of debris at the bottom of the beel. The floating vegetation and silt carried by rain water from catchment area caused slowing down of water current. It results in faster eutrophication of the beel. The chemical fertilisers and pesticides used in the nearby paddy fields

have accelerated the process of eutrophication. This has helped in the over growth of aquatic weeds and it is now becoming a serious problem responsible for wetland degradation in Assam.

iv.Dumping of pollutants : Untreated substances and waste products from domestic, industrial and commercial areas released into the beels are major pollutants responsible for wetlands loss. These pollutants may result from :

(a) Domestic wastes resulting from residential areas of fringe villages and localities.

(b) Municipal and commercial wastes produced from markets, hotels and tea stalls, garage, workshops etc. contribute largely to damage of wetlands.

(c) Industrial effluents, both solid and liquid, from the oil industries and refineries

(d) Agricultural wastes and chemicals containing fertilizers and pesticides used in paddy fields in the periphery of the beel and also along the banks of the inlets enter the beels through run off during flood.

(e) Moreover, various types of hospital wastes like plastic items, bottles also find their ways into the water bodies.

The Central Pollution Control Board (CPCB) based on its monitoring has identified among others, Bharalu, Kalong, Deepor Beel and Buridihing as polluted river stretches and water bodies (Assam Tribune, 14th March, 2012)

v. Over fishing : Traditionally wetlands have been fishing grounds of village people. Communities from fringe villages practise fishing since time immemorial. Besides fishing, the tribal and Muslim communities also depend on wetlands for collecting food (like snails,crabs, green leaves etc.), fodder and other weeds.On certain occasions like Bihu and local festivals, people do community fishing even in small fishing grounds. Moreover, the fishermen community depend exclusively on wetlands for their livelihood.Thus, fishing is year round activity and the breeding period and probable impact from over fishing etc. are completely ignored by the people. All these significantly affect the sustainability of wetland resources.

vi. Discharging untreated effluents: The Pollution Control Board also was of the opinion that Oil Companies working in Assam were contaminating ground water by dumping sludge in ponds and polluting a major river by discharging untreated effluents, posing health risks to millions of people. According to Mr. Jawahar Lal Dutta, Chairman, APCB, for more than 40 years, Oil Companies have been polluting the State like anything. Assam is a major producer of crude oil in the country and the State produces about 15 per cent of India's onshore crude with State-owned exploration companies. Oil India Limited and Oil and Natural Gas Commission (ONGC) Limited are supplying crude oil to State and run Indian oil refineries. But little attention is paid to the environmental problems that are affecting the States water bodies by its activities. It is revealed in the investigation report that refineries in Assam were discharging bio-chemical waste such as oil and grease, phenolic substances and sulphide into the Brahmaputra river and its tributaries, well above permissible limits. The Brahmaputra, one of the major rivers in the country, is the home to the endangered Gangetic dolphin and other marine life. It originates in Tibet and runs through Assam and Bangladesh before flowing into the Bay of Bengal. India's economy has been growing at an average of 8 per cent over the past few years and the country is in need of more energy. To increase the energy stock, the country is making the Oil and Gas Companies to step-up their exploration efforts in new areas. These increased activities of oil companies have added fuel to the fire of environmental pollution in the State.

vii. Unrestricted use of poison: Due to scanty rainfall, when the water level in most of the rivers in Assam is low, some unscrupulous people are encouraged to resort to rampant fishing From Nagabali-Kumarpatty area of Golaghat town up to Kamargaon Numaligarh of the town, some people use poison which pollutes the water and kills fish in large numbers. The unrestricted use of poison that is manufactured specially for use in tea gardens causes death of fish and floating of dead fish on the river water has become a common feature. Neither the concerned authority in the Fishery Department, nor the local administration or various conservation NGOs are seen to be bothered by these rampant practices (Assam Tribune, 30 April, 2011)[278].

vii**i. Recurring floods:** Recurring floods cause water pollution and to get fresh drinking water becomes a problem during as well as immediately after floods.

ix. Industrial establishments: Industrial establishments like Salakati Thermal Project, Bongaigaon Refinery and Petro-chemicals, the Chandrapur Internal Project, the Hindustan Paper ,Mills of Jagiroad; the Nampur Fertilizer Plants etc have been causing water pollution at an alarming rate .

x. Men's unscientific and ruthless activities : In recent years, in Assam there had been degradation of wetland fisheries because of factors like destruction of habitation and exploitation of wetlands by men's unscientific and ruthless activities, conversion of water bodies into more profitable aquaculture ponds wherein only selected fast growing fish species are reared.

xi. Method of leasing : Another cause responsible for the unsustainable exploitation of the beels in Assam lies in the method of leasing. Most of the wetlands that exist in this region are leased out for a certain period ranging from 5 to 7 years. The lessees exploit the fishery resources during the lease period according to their own will, but little is done for the conservation and development of the wetland ecosystem.

xii. Removal of marginal areas of the wetlands : The removal of marginal areas of the wetlands causes a rise in the water temperature and loss of indigenous flora and fauna .

xiii. Use net lylon : The net lylon used by fishermen has caused near extinction condition of even the tiny fish and organisms and other aquatic plant and animals .

xiv. Introduction of exotic fish : Moreover, introduction of exotic fish in this region particularly ,Thai-magur ,big head carp threat the native fish fanau in terms of competition, disease and hybrization.

xv. Lack of proper wetland management conservation plan and co-ordination

Lack of co-ordination among the Government., Fishery Department, local people regarding formulation, execution and conceptualization of the schemes is also contributing to wetland loss in Assam.

xvi. Lack of resources and training : The wetland fisheries is degrading day by day due to poor management, planning and implementation of wetland policy and schemes arising out of inadequacy of trained, skilled and dedicated manpower and due to lack of a sound database providing right information

xvii.Absence of local community participation: In all schemes relating to the development, monitoring,evaluation and even in the implementation and conservation of wetlands, one of the most serious constraint in the effective implementation and management of wetlands is the lack of participation of local communities at all levels. So any project relating to wetland management cannot be effectively implemented without active involvement of various stakeholder groups and wetlamd dependent communities and local people who are directly involved for various purposes .

4.3 Parameters affecting wetland-ecosystem in Assam

There are some other parameters affecting wetland-ecosystem are as follows :

1.Local community (local area) : The local inhabitants are concerned about destruction or conservation of the wetland eco-system
2. Neighborhood livability : Pleasantness of surroundings of the wetlands
3.Poverty : Poverty compels the people to destroy the ecosystem
4.Demography: The rapid growth of population leads to destruction of wetland-eco-system.
5.Religious and educational institutions: Due to establishment of religious as well as educational institutions, the wet-land-ecosystem may deteriorate .
6.Recreational facilities : Wetland-ecosystem may also decline due to recreational facilities in the form of hunting, fishing, boating, swimming, camping, and hiking , picnicking , resorts etc.
7..Size of occupational area : Larger the size of occupational area near the wetlands, larger is the degradation of wetland ecosystem.
8.Occupational mobility : Due to mobility of the people from their occupation to the occupation of fishing, there has been threat to the endangered species of flora and fauna .
9.Life pattern : Change of life pattern of the people in terms of employment opportunity, housing, leads to the threat to the wetland-ecosystem.
10.Urbanisation and industrialization : The growing urbanization and industrialisation leads to the decline of the quality of the wetland dependent community .

4.4. Distinguish factors responsible for degradation of wetland ecosystem of sample beels

1. Degradation of the Deepar Beel

Deepor beet is a large natural wetland situated in the southwest of the Brahmaputra river near Guwahati city. The beet harbours several species of flora and fauna and are a repository of several species of migratory birds. At present, the beel is subjected to environmental degradation due to natural and anthropogenic factors. Deepor bed was designated as Ramsar Wetland Site in 2002.

Deepor Beel is the largest natural wetland of lower Assam and it has tremendous biological and environmental importance. It is a former channel of the Brahmaputra river. The fishermen villages (Keotpara, Kalipara, and Koibartapara) demarcate the Western Boundary of the beel.

The special floral and faunal value of Deepor Beel finds place in consideration for its inclusion among the wetlands of international importance. The huge congregation of birds, both migratory and residential, is best known all over the world.

Among other economic benefits derived from this beel is that Deepor Beel is very important as a good source for the supply of 'Hira Clay' a special the of soil used by the Hira community for making various earthen pots. Hira pottery industry is mainly a kind of cottage industry where a large section of the female population of the Hira community is engaged themselves in the production of earthen pots while the male people carry these pots to the markets for sale.

Fishing in Deepor Beel is generally operated throughout the year, though the peak season is during winter i.e. December to February. But it extends up to March. However, community fishing is a traditional practice observed generally during festival i.e. mainly Magh Bihu. Community fishing festival is locally known as Beel Baish.

Causes of degradation of wetland ecosystem: Some of the major natural and anthropogenic factors that are degrading the Deepor Beel are :

i. The feeding channel, Khalajan carries putrefied matters from the catchments resulting siltation. As a result there has been the loss of biodiversity and the auto-stocking has been hampered .

ii. Deepor beel is connected with Basistha Bahini, a city canal, . It carries heavy pollutants, municipal sewage, industrial effluents and anthropogenic which are being released from Basistha to the beel and as a result the environmental conditions of the beel has been deteriorating resulting loss of bio-diversity .In Deepoar beel siltation increases day by day from the surrounding hill areas due to illegal felling of trees, accumulation of all types of filth and wastes from the Bharalu and Bahini rivers, dumping of city garbage nearby.

iii. The wetland ecosystem of the Deepor beel has been disturbed due to construction of railway line along the southern boundary of the beel .

iv. The farmers or the fishermen use marginal areas of beel for cultivation and hence the water area of the beel has been lessened .

v. Due to unchecked rapid deforestation and cutting of soil in Chakardoi and Jhalukbari hills erosion takes places . As a result silt and sediments are added to the beel.

vi. Industrial development within the periphery of the beel leads to the destruction of the wetland ecosystem.

vii. Large scale encroachment within the Deepor Beel area has caused a threat to the ecosystem of the Deepor beel. .

viii. Allotment of Government vacant land to private parties by Government Settlement Department has also disturbed the ecosystem of the Deepor beel .

ix. The various biotic and non-biotic organisms of the beel have been threatened due to brick kiln and earth cutting within the beel ecosystem.

x. Different fish ,birds, flora and fauna of the beel have been in extinction due to hunting, trapping and killing of birds and mammals within and in the adjoining areas of Deepor Beel

xi. Pesticides and fertilizers are largely used in the adjacent agricultural land.The fertilizers have led to the degradation of the wetland ecosystem

xii. The core area of the beel is used as picnic spot by local people. The Plastic items and other wastes used by the picnic parties also enter into the beel water in course of time which also add to water pollution of the beel every year.

2. Kapla beel :

i. Construction Tihu Palla road through the beel
ii. Occupation of the land area by the Muslim migrants.

3. Jalikhora beel :

i. Construction road from Maloibari to Khetri thrugh the Jalokhora beel
ii. Release of water from Jagiroad paper mill into the Jalikhora beel .

4.5 Environmental Impact Assessment (EIA)

Possible Environmental Impact Assessment (EIA) of Degradation of wetland eco-system on the following aspects :

i. Effects on the resiliency and fitness of ecosystem types.
ii. Effects on population density of fish.
iii. Effects on sediment load on fish growth.
iv. Effects on sediment load on spawning.
v. Effects on migratory game bird species.
vi. Effects on sport fishing and hunting.
vii. Effects on water quality and dependent biota.
viii. Effects on species diversity of the terrestrial biota.
ix. Effects on the endangered species of both flora and fauna
x. Effects on the occupation of the dependent community.
xi. Effects on the socio-economic status of the people relating to the wetlands
xii. Effects on the marketing of both raw fish and dry fish in North East India
xiii. Effects on the demand and supply of fish of both raw and dry fish.
xiv. Effects on the Primary producers, whole-sellers, retailers,and consumers of fish

5. Conclusion

Under this background, there is a need to formulate suitable and sustainable strategies for conservation and development of beel fisheries and the need to address the ecological , economic and social objectives . Thus, there is a need to conserve the ecological character of the wetlands with the biodiversity of the flora and fauna associated with these ecosystems. Preservation of wetlands is necessary for the continued existence of diverse populations of wildlife and plant species. So,it is important for the local community and the corporate sector to come together for an effective management plan. Since wetlands are common property with multi-purpose utility, their protection and management also need to be a common responsibility.In order to achieve any sustainable success in the protection and conservation of the beel fisheries it is necessary to create awareness among the concerned people ,the local villagers, the general public, educational and corporate institutions about the importance of the wetlands and to make them equal partners in the conservation process.

There is a need for enforcement of the legislations to conserve the rich aquatic biodiversity and for community participation in its truest sense . It is necessary to develop a community-based co-management model for the beels of Assam . Such models have been formulated and applied in the reservoir fisheries in northeastern Brazil with considerable level of success (Christensen et.al. 1995) .In Assam , the Junbeel can pave the way for formulating proper community-based co-management for beel fisheries in Assam as it under the direct control of Tiwa community.

6. Suggestion

1.The people of the fishing community should be encouraged for spatial mobility of their labour force from one geographical location to another or for occupational mobility from the occupation of fishing to another occupation like cultivation so that the labour force can raise their social status as well as earn greater income from employment in the new occupation.

2. .Encroachment for any other purpose on the fisheries other than fishery purpose should be stopped immediately and effectively.

3.Application of pesticide for agricultural crops should not affect fisheries.

4. Proper demarcation on fishery area should be marked as early as possible for its existence for all times to come.

5. Methods of fish culture by appropriate gears for the operation of capture fisheries should be standardized.

6.In order to remove the bottlenecks associated with fish markets and to get reasonable price of their product there should be cold storage facilities, extension and improvement of the transport facilities. Besides cold storage, fish-caning machineries, marketing of both dry fish and raw fish should be developed in organised form so that the fisherman can develop the fishery as an industry.

7. In order to increase the fish production in beel fisheries the following suggestions can be given :

(a)State government should make earnest efforts to permanently demarcate and protect wetland boundary .

(b)Importance should be given to different management techniques for open and close beels.The open beels which has connection with channels should be strengthened, effectively maintained and these beels should be provided with a sluice or lock gate if necessary for controlling ingress and egress of water and fish stock.

(c)The marginal areas of the open beels should be developed into culture fisheries by appropriate embankment constructions to be best done in dry season.

(d) The deeper central portion of the open beels should be used as capture fisheries.

(e)Close beels should be developed into strong culture fisheries for fishes like grass and silver carps.

(f)The beels should be provided in lease to the lessee for a long period, say for a period of from 5 to 10 years by fixing the lease money value in terms of productive potential of each beel so that they may enjoy incentive to construct beel's developmental infrastructure.

8.**Fishery development and people's participation:** Fishery development requires such steps as (a) improving technology (both gear and fishing vessels;(b)improved post-harvest processing and marketing;(c) provision of credit;(d)improving fishery management through allocation of users rights and access control;(e) reallocation of fishery resources (e.g. between small-scale and large-scale fisheries ;(f) enhancing fishery resources through restock;(g) increasing aquaculture to relieve pressure on captive fisheries ;(h) improving resource and environmental conservation measures;(i)focusing on management through community-based initiatives;(j)adopting new participatory and co-management approach;(k)training and capacity building;(l) raising awareness of the importance of the contribution of small-scale fisheries to livelihoods, food security and quality of life ;(m) increasing economic growth and providing a wider diversity of employment and livelihoods; and (n) providing assisting in setting policies with their supporting legislation and institutions

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Reference Tables :

Table 1.1: No.of Sample Villages Against the Total villages

Name of sample villages	Total no. village	No .of Sample	Name of villages
A. Kapla beel	26	8	1. Chinadi,2. Haldhibari,3. Amrikhowa,4.. Bargopa,5. Kamalabari,6. Beshkuchi.,7. Bainakuci,8. Kaplagao,.
B. Jalikhora beel	24	6	9. Mitani,10. Teteliguri, 11.Rebamaheswar, 12.Golap 13.Maloibari, 14. Sotaipathar
C. Deepar beel	24	6	15.Azra,16. Mikirpara chokorda,17. Pamhee 18. Tetelia,19. Pubbaragaon,20. Pachim baragaon
Total	74	20	

Table 1.2:Educational category-wise Sample Households against the total of Each Category

Educational categories	Kapla beel		Jalikhora beel		Deepar beel		All	
	Total	Sample	Total	Sample	Total	Sample	Total	Sample
i. Illiterate	215	43	325	65	176	34	716	142
ii. Primary	135	27	230	46	113	23	478	96
iii. Secondary	50	10	90	18	83	17	223	45
iv. Higher	15	3	45	9	23	5	83	17
Total	415	83	690	138	395	79	1500	300

Table 2.1 :Socio-Economic Parameters of the Wetland Dependent Fishing Community

Socio-economic parameters	Kapla beel		Jalikhora beel		Deepar beel		All	
1.Demography Total households	415		690		395		1500	
Sample households(SH)	83		138		79		300	
Population of SH	498		805		396		1699	
Male	253		410		202		865	
Female	245		395		194		834	
Sex ratio	968		963		960		864	
Migration	9 (10.8)		5 (3.6)		21(7%)		21 (7.0%)	
2. Occupational status	T	%	T	%	T	%	T	%
(a) Primary sector	60	72.3	103	74.6	46	58.2	209	69.7
i. Fishing	40	48.2	58	42.0	33	41.8	131	43.7
ii.Agricultural Practice	20	24.1	45	32.6	13	16.5	78	26.0
(b)Secondary sector	9	10.8	5	3.6	7	8.9	21	7.0
iii. Pottery	9	10.8	5	3.6	7	8.9	21	7.0
(c)Tertiary sector	14	16.8	30	21.7	26	32.9	70	23.3
iv. Services	8	9.6	20	14.5	14	17.7	42	14.0
v. Business	6	7.2	10	7.2	12	15.2	28	9.3
Total	83	100.0	138	100.0	79	100.0	300	100.0
3. family with landholding								
(a)Landless (0-3 bighas)	51	61.4	72	52.2	58	73.4	181	60.3
(b)Marginal (3-7 bighas)	16	19.3	31	22.5	11	13.9	58	19.3
(c) Small (7-15 bighas)	11	13.3	22	15.9	7	8.9	40	13.3
(d)Big(15 bighas and above)	5	6.0	13	9.4	3	3.8	21	7.0
Total	83	100.0	138	100.0	79	100.0	300	99.9
4.Type of family								
(a)Joint	26	31.3	37	26.8	16	20.3	79	26.3
(b) Nuclear	57	68.7	101	73.2	63	79.7	221	73.7
5.Types of houses								
i. Assam type	12	14.5	27	19.6	14	17.7	53	17.7
ii. Thatched	35	42.2	59	42.8	31	39.2	125	41.7
iii. Tin-roofed	36	43.4	52	37.8	34	43.0	122	40.7
i. Illiterate	43	51.8	65	47.1	34	43.0	142	47.3
ii. Primary	27	32.5	46	33.3	23	29.1	96	32.0
iii. Secondary	10	12.0	18	13.0	17	21.5	45	15.0
iv. Higher education	3	3.6	9	6.5	5	6.3	17	5.7
Total	83	99.9	138	99.9	79	99.9	300	100.0

Source : Field Survey

Table: 3.1:Physico-Chemical parameters of water samples in Pre Monsoon period A (Kapla beel)

Parameters	Wetland A	Wetland A	Wetland A
	Station 1	Station 2	Station 3
Time	11.30 am	12.30 pm	1.30 pm
Air Temperature (0c)	34	36	35
Water Temperature (0c)	35	36	34
PH	7.20	7.05	7.09
Free CO2 (mg/l)	19.5	21	23.6
DO (mg/l)	2.35	2.40	2.15
Transparency (cm)	24.5	23.5	24.0
Total Alkalinity (mg/l)	472	455	430

Table: 3.2: Physico-Chemical parameters of water samples in Pre Monsoon period, B (Jalikhora beel)

Parameters	Wetland B	Wetland B	Wetland B
	Station 1	Station 2	Station 3
Time	10.30 am	11.30 am	12.30 pm
Air temperature (^{0}c)	32	32.5	31.5
Water temperature (^{0}c)	30.5	31	29
P^H	6.4	6.3	6.4
Free $CO_{2(mg/l)}$	14.2	21.2	15.6
DO (mg/l)	3.3	4.5	4.7
Transparency (cm)	29.5	31.5	30.0
Total Alkalinity (mg/l)	374	340	351

Table: 3.3 : Physico-Chemical parameters of water samples in Pre Monsoon period C (Deepor beel)

Parameters	Wetland C	Wetland C	Wetland C
	Station 1	Station 2	Station 3
Time	9.15 am	9.45 am	10.30 pm
Air temperature (^{0}c)	29	30	31
Water temperature (^{0}c)	28	28	29
P^H	6.35	6.62	6.56
Free $CO_{2(mg/l)}$	11	15.4	11
DO (mg/l)	2.8	2.6	2.2
Transparency (cm)	32.5	31	33
Total Alkalinity (mg/l)	350	330	345

Table: 3.4: Physico-Chemical parameters of water samples in Monsoon period, A (Kapla beel)

Parameters	Wetland A	Wetland A	Wetland A
	Station 1	Station 2	Station 3
Time	9.55 am	10.25 am	10.45 pm
Air temperature (^{0}c)	32	33	32
Water temperature (^{0}c)	29	31	30
P^H	6.92	6.82	6.78
Free $CO_{2(mg/l)}$	22	17.6	26.4
DO (mg/l)	1.4	1.5	2.1
Transparency (cm)	45.5	46	41.5
Total Alkalinity (mg/l)	305	301	304

Table: 3.5: Physico-Chemical parameters of water samples in Monsoon period, B (Jalikhora beel)

Parameters	Wetland B	Wetland B	Wetland B
	Station 1	Station 2	Station 3
Time	9.25 am	9. 50 am	10.15 pm
Air temperature (^{0}c)	33	33	34
Water temperature (^{0}c)	32	31	32
P^H	6.69	6.73	6.87
Free $CO_{2(mg/l)}$	17.6	17.6	13.2
DO (mg/l)	2.2	2.4	1.8
Transparency (cm)	60	55.5	48
Total Alkalinity (mg/l)	311	307	309

Table: 3.6: Physico-Chemical parameters of water samples in Monsoon period ,C (Deepor beel)

Parameters	Wetland C	Wetland C	Wetland C
	Station 1	Station 2	Station 3
Time	10.40 am	10.55 am	11.20 am
Air temperature (^{0}c)	29	29	30
Water temperature (^{0}c)	30	29	29
P^H	6.94	6.99	6.05
Free $CO_{2(mg/l)}$	17.6	26.4	13.2
DO (mg/l)	1.7	1.3	1.2
Transparency (cm)	45.5	45.5	42.5
Total Alkalinity (mg/l)	299	303	300