CHAPTER-I

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1.1. Introduction:

Wetlands are the gifts of nature, having much importance at local, national and international perspectives. Undoubtedly, the wetland ecosystems are the most important ecosystems on the earth. These are sometimes described as 'Kidneys of the Landscape' because they function as the downstream recipient of water and wastes from both natural and human sources (William J. Mitsch and James G. Gosselink, 2000). Wetlands perform some useful functions in the maintenance of an overall balance of nature. (IIP Digital, 2012).The interdependence of wetlands and man is obvious. Different individuals, institutions or agencies have defined wetlands differently for different purposes depending on their objectives and needs. As per the definition accepted by the international conservation on wetland held at Ramsar (Iran), 1971 "*wetlands are areas of submerged or water saturated land, whether both natural or artificial or permanent or temporary and whether the waters is static or flowing or fresh brackish or saline including areas of marine waters, the depth of which at low tide does not exceed six meters*." This means that a wetland is neither truly aquatic nor terrestrial; it is possible that wetlands can be both at the same time depending on seasonal variability. Wetlands include rivers, lakes, reservoirs, etc (Panigrahy, 2012) and marshes, swamps, bogs and similar areas (Ramachandra, 2001). Thus, wetlands exhibit enormous diversity according to their genesis, geographical locations, water regime and dominant plants, soil or sediment characteristics. Because of their transitional nature, the boundaries of wetlands are often difficult to define.

During the last thirty years, there has been a great interest in wetland on account of the realisation and demonstration of its significant role in biological productivity, flood control, ground water recharge and discharge, regulation of water quality, treatment of waste water, and other activities. In the study area, there are around 486 wetlands and they all play important roles in their surroundings. However, their very existence has been threatened by natural and anthropogenic activities. In the last century, a large percentage of wetlands have been lost with drainage and land clearance as a consequence of agricultural, urban and industrial development activities (Frenken, 2005, Williams, et. al, 2007, Tijani, et. al, 2011). A comparison with the

19th century estimate reveals that approximately 50% of the world's wetlands have been lost (Ramachandra, 2001). Therefore, the present study of wetlands has its goals in terms of their classification, distribution, present use as well as environmental status, causes of degradation (natural and human-induced) and management strategies.

1.2. Statement of the Problem:

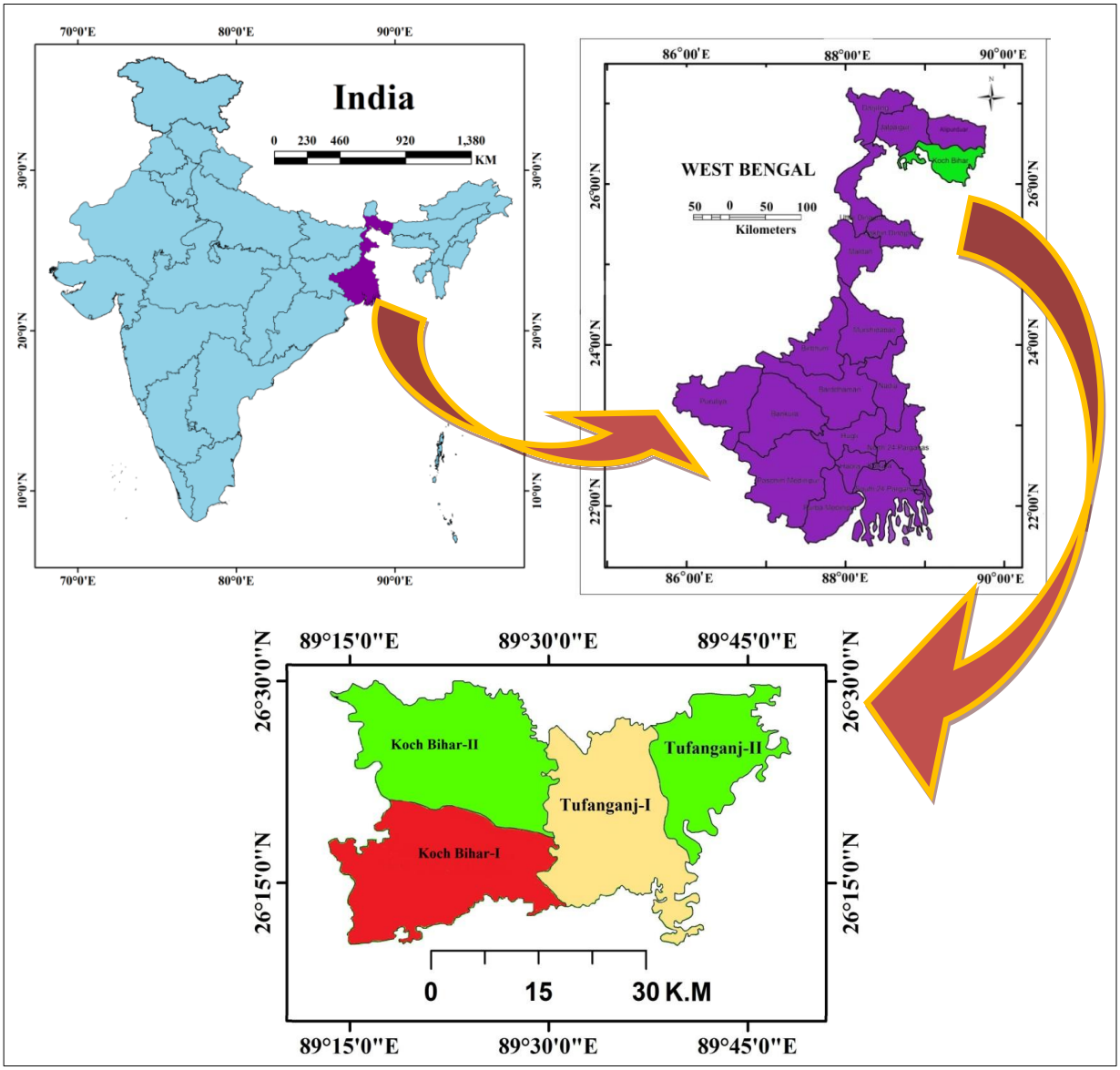
Earlier, Koch Bihar was termed as the "Lake City". The study area of Koch Bihar district abounds in numerous wetlands that exist as marshes, *Beels*, and pools of stagnant water bodies and Tanks or Ponds. Except for Tanks or Ponds, these are mainly the remnants of the old beds of the river. They are named as '*Chhara', 'Dara', 'Doba', 'Jheel', 'Beel', 'jampoi', and 'Kura'.* They are essentially a part of the surrounding ecological areas, bear more or less all the characteristics of wetland, and play an important role in maintaining physical set up and economic base of the area.

But, the wetlands are presently facing a serious threat to its survival due to shrinkage of area, land and water pollution through urban developmental activities and agricultural and piscicultural practices, which alter their physical, chemical and biological characteristics. Indifferent conversion of these wetlands due to human habitation, agricultural and industrial purposes is the main cause of Wetland extinction.

The uses of chemical fertilizers, organic fertilizers and biocides in the agricultural fields of the wetland surroundings and in some wetlands when converted into agricultural land in the dry season result in the disturbance of the wetland ecosystem. Construction of weirs, dams or barrages upset the free movement of water and cause siltation of wetlands.

Besides, some wetlands have been used as sites for dumping of organic and inorganic wastes generated from the nearby markets as well as surrounding areas. This has led to gross shrinkage of the *Beel* area. Thus, understanding of the problems of area shrinkage, land and water pollution, disruption of the wetland ecosystem and drainage congestion of the wetland is vital. Consequently, for regulation of these problems, there is a dire need for geo-environmental study and research in the field of wetland. It is in this context, the present study on

"**WETLANDS OF TUFANGANJ AND KOCH BIHAR SADAR SUB-DIVISIONS IN THE KOCH BIHAR DISTRICT, WEST BENGAL: A GEO-ENVIRONMENTAL STUDY**" has been taken up.



Map1.1: Locational Map of the Study Area, Source: NRSC, Hyderabad, India

1.3. Location of the Study Area:

The northeastern part of the Koch Bihar district, located within the latitude of 26º09´08´´N to 26º29´24´´N and the longitude of 89º17´34´´E to 89º51´50´´E has been chosen as the study area. It comprises of two sub-divisions namely Koch Bihar Sadar and Tufanganj covering an

area of 1313.56 sq km. Mathabhanga and Dinhata sub-divisions of the same district bound the western and the southern boundaries of the study area, while the northern and the eastern boundaries are determined by Jalpaiguri district of West Bengal and Bongaigaon district of Assam respectively. In a small stretch in the southeast direction, its boundary is shared with Bangladesh.

1.4. Objectives of the Study:

The major objectives of the present study are:

a) To classify and study the distributional pattern of the wetlands.

b) To investigate the present use of wetlands of the study area.

c) To examine the present environmental status of the wetlands.

d) To assess the nature and dimension of degradation of the wetlands within the study area.

e) To provide a conservation framework and management strategies for the wetlands.

1.5. Hypothesis:

In order to fulfill the above objectives of the present study following hypotheses have been adopted:

1. The distributional pattern of wetlands of the study area mainly conforms to the fluvial characteristics of the surrounding region.
2. The present agricultural and Pisciculture practices play a significant role in changing the wetlands.
3. Unwise developmental activities are responsible for degradation of wetlands.

1.6. Database and Methodology:

Database and Methodology is the main structure of a research. To fulfill this objective and solve the hypothesis discussed above, the researcher has adopted a rationalistic and scientific approach. The database and methodology of the present study are described as follows:

1.6.1. Primary Database:

An initial survey was done during the first quarter of the year 2012 ending in the year 2017. Data on pisciculture, agriculture, uses of wetlands, flora and fauna endemic to the wetlands and

land use in the fringe area of the wetlands were collected through questionnaires especially designed for the purpose. Water and soil sample of some selected wetlands in different seasons were collected to analyze the soil and water condition of wetlands. Different species of flora were collected and herbariums were prepared for the identification process. Faunal information was collected with the help of observation and photography method.

1.6.1.1. Criteria for Selecting the Representative Wetlands:

The following criterions were kept in mind while selecting the 10 wetlands as the representatives of the study area:

a) Urban wetland (Sagar Dighi and Chandan Dighi) and rural wetland (Baignanbari Chhara) had been considered separately.

b) The most well managed urban wetland (Sagar Dighi) and the most neglected wetland (Chandan Dighi) were included with it.

c) The wetland of brick kiln industrial areas (Dhangdhar Chhara) was included.

d) The wetland of protected forest areas (Rasomati Jheel) in which fishing is strictly prohibited had been selected.

e) Wetlands under National Wetland Management and Conservation (Rasik Beel wetland complex& Rasomati Jheel) and non-restricted wetland (Baignanbari Chhara) had been selected separately.

f) In it, natural wetland (Rasik Beel wetland complex) and man-made wetland (Sagar Dighi) were also included.

g) Agriculture predominant wetland (Baignanbari Chhara) and Pisciculture oriented wetland (Atiamochar Beel) were included in it.

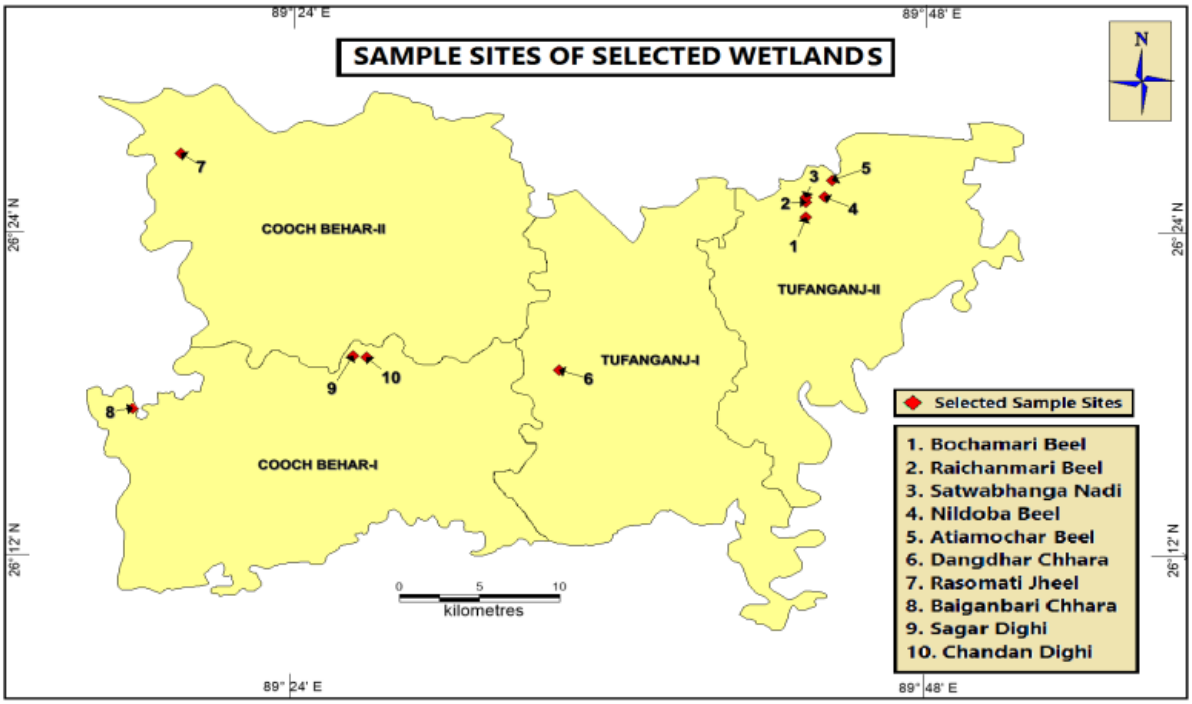
h) Pisciculture predominant wetland (Atiamochor Beel) and subsistence fishing based wetland (Bochamari Beel) were included in it.

i) Moreover, it was kept in mind that the wetlands had to be selected from all blocks of the study area.

j) Besides, the above mentioned 10 wetlands, some other adjacent wetlands had been selected for the study of existing flora and fauna.

Table 1.1: Description of the Sample Sites of Selected Wetlands

Site No.	Site Name	Sample Site	(Block/ Municipality)
1	Bochamari Beel	26°24´30´´N, 89°43´15´´E	Tufanganj-II
2	Raichanmari Beel	26°25´03´´N, 89°43´21´´E	Tufanganj-II
3	Satwabhanga Nadi	26°25´13´´N, 89°43´21´´E	Tufanganj-II
4	Nildoba Beel	26°25´14´´N, 89°44´02´´E,	Tufanganj-II
5	Atiamochar Beel	26°25´51´´N, 89°44´19´´E	Tufanganj-II
6	Dangdhar Chhara	26°18´48´´N, 89°34´07´´E	Tufanganj-I
7	Rasomati Jheel	26°26´51´´N, 89°19´56´´E	Koch Bihar-II
8	Baiganbari Chhara	26°17´24´´N, 89°18´13´´E	Koch Bihar -I
9	Sagar Dighi	26°19´21´´N, 89°26´24´´E	Koch Bihar Municipality
10	Chandan Dighi	26°19´18´´N, 89°26´54´´E	Koch Bihar Municipality



Map 1.2: Sample Sites of Selected Wetlands

1.6.1.2. Questionnaire and Interview:

Data on pisciculture, agriculture, use of wetland, flora and fauna endemic to the wetlands and land use in the fringe areas of the wetlands were collected through questionnaires especially

designed for the purpose. Interactions with the agricultural workers, fisherman, the local people, aged people of the area, Panchayat personnel, secretary and other members of concerned fisherman co-operative society and other officials associated directly or indirectly with the subject concerned had been interviewed.

1.6.1.3. Soil Nutrient Data:

1.6.1.3.1. Collection of Soil Sample:

Soil samples were collected during pre-monsoon (May, 2017) period from the above selected sites of the study area. The soil samples were collected by using a spade; a ditch had been dug with a depth of 6-9 inches by setting the soil aside. Then a thin slice of soil was taken from the hole. From the centre of this slice, a 1-inch-wide sub-sample (squared core) was cut from top to bottom. The sub-sample was placed in the clean plastic bucket. 4 to 6 soil samples were collected from each selected wetland and then retaining all sub-samples together in the container. The soil was evenly divided into 4 squares. Then again, two opposite sides were rejected and the other two sides had been mixed up. The process was repeated till about half kg of the soil was remaining. Then soil sample was dried up in shadow for laboratory testing. Finally, soil samples were tested in the laboratory of Department of Soil Science and Agricultural Chemistry, Uttar Banga Krishi Viswavidyalaya, Pundibari, Koch Bihar, West Bengal.

1.6.1.3.2. Soil Analysis Methods:

Soil samples were tested according to the following methods-

1. Organic Carbon (OC) by Walkley and Black Method
2. Available Potassium (K) by Neutral Normal Ammonium acetate method
3. Available Phosphorus (P) by Bray and Kurtz method
4. Available Nitrogen (N) by $KMNO_4$ extraction method
5. PH (1:2.5 soil: water ratio) by Hanna portable pH meter
6. EC (1:2.5 soil: water ratio) by Hanna portable EC meter

1.6.1.4. Water Quality Data:

1.6.1.4.1. Water Sample Collection:

Water samples were collected in pre-monsoon (May, 2016 &May, 2017) and post-monsoon (September 2016 &September 2017) period from above selected sites of the study area. Collection of samples took place at 10:30 am by dipping well labeled sterilized plastic and glass containers at the approximate depth of 1.00 ft. The water samples were collected in three bottles: two glass bottles with the capacity of 100ml and one of them containing a solution of 2ml of $MnSO_4$ and 2ml alkaline iodide solution and a PVC container with a capacity of 1 liter. These bottles were carefully and steadily sunk in the water so that no air bubbles could get inside. With an exception of BOD, all physico-chemical parameters were analyzed in the laboratory of Department of Chemistry, Dinhata College, Koch Bihar, West Bengal on the same day. The value of TDS, EC, pH and Water temperature were calculated on spot by the digital metre.

1.6.1.4.2. Water Analysis Methods:

Method Adopted or Instrument Used for Water Quality Analysis are given in the table1.2.

Table 1.2: Method Adopted or Instruments Used for Water Quality Analysis.

Sl no.	Parameters	Method Adopted/Instrument used
1	Dissolved O2(DO)	Winkler's Method
2	BOD	Titrimetric Method (five days incubation),APHA,2005
3	Free $CO_{2:}$	Titration Method
4	Total Alkalinity	Titration Method
5	Bi-carbonate	Titration Method
6	Carbonate	Titration Method
7	Total Hardness as CaCO3	Conventional titration method.
8	Irone	Spectrophotometric Method
9	Chloride	Argent metric Method
10	pH	HM Digitals pH Hydro tester (Model pH-80)
11	Electrical Conductivity	HM Digitals Aquapro digital water tester (Model AP-2)
12	Total Dissolved Solids(TDS)	HM Digitals Aquapro digital water tester (Model AP-1)
13	Water temperature	Hanna portable Temperature meter (HI 98128)

1.6.1.5. Floristic Survey:

The floristic survey includes all the Macrophytes growing over the different wetlands and its surrounding areas in different seasons of the year. To understand the proper floristic structure of the study area, random sampling has been adopted for collection of plants from selected wetlands of the study area at least three predominant seasons and for a period of 5 years, from 2013 to 2017. During summer, many plants growing in exposed land within the wetland were also collected. Specimens were collected in triplicate cases. The collected specimens were tagged and necessary field data like flower colour, local names, uses, parts used, habitat, distribution pattern, flowering and fruiting etc. were also recorded in the Field Note Book. The collected plant specimens were dried in blotting paper first and then transferred to old newsprint or blotting papers within a short time. The blotting papers or old newsprint were changed every 24 hours or even in shorter intervals for the first three days and then in expected intervals till the plants were properly dried. Then specimens were mounted on herbarium boards using glue and then properly stitched with thread, wherever necessary. But, soft fleshy aquatic (submerged, free-floating plant etc.) plants were treated with aqueous 10 % formaldehyde (HCHO) solution to check the fungal growth. Identification of collected specimens was done primarily with the help of different literature including *Flora of Bhutan* (Grierson and Long, 1983, 1987, 1991, 1994, 1999, 2001; Noltie, 1994, 2000), *Flora of India* (Sharma *et al*, 1993; Sharma and Balakrishnan, 1993; Sharma and Sanjappa, 1993; Hajra *et al*, 1995, 1997), *Flora of West Bengal* (Anonymus, 1997), *Flora of Eastern Himalaya* (Hara, 1966, 1971; Ohashi, 1975).

1.6.1.6. Faunal Survey:

The conventional method through observation and photography of bird species and other major fauna was used during the survey. Faunal Survey through random sampling from selected wetlands of the study area at least three predominant seasons and for a period of 5 years, (2013 to 2017) was undertaken. Avifauna survey was carried out by direct sighting with field binoculars and pictorial guides. Stress was given on recording the calls of the bird, collection of feathers and observing the nests. The avifauna was identified with the aid of Ali and Ripley (1968 – 1974, 1996), Ripley (1982), Ali and Futehally (2004) and Grimmett *et al.* (2007). Waterfowl census was undertaken following Venkataraman (1995). Direct day sighting, night

watching, the help of local experienced people and fishermen's knowledge were applied to record and identify the other major faunal species. Aquatic fauna was collected with the help of bag-nets, cast-nets, fishing hooks, and with the help of fisherman. They were identified with the aid of Jhingran (1991), Sen (1992) and Menon (1987 & 1992), as well as some websites likehttp://bn.bdfish.org. The data on the history of occurrence or distribution of the major fauna was cross checked with the local people.

1.6.2. Secondary Database:

Secondary data regarding the wetlands, study area and other related issues were collected from different published books, journals, Maps like National Wetland Atlas (West Bengal,2010), National Wetland Atlas (India,2011), Hand Book on Government Water Bodies, West Bengal, Hand Book on Fisheries statistics (2014-2015 & 2015-2016), Koch Bihar, Statistical Hand Book, Koch Bihar, 2013, District Bureau of Economics & Statistics Govt. of W.B, District Census handbook, Govt. of India, District Gazetteer, maps of Institute of Environmental Studies and Wetland Management, Kolkata Topographical Maps, Satellite imageries, Land Use Map (Department of Science and Technology), District Disaster Management Plan, Cooch Behar, 2016 etc. Other relevant information or data are collected from various secondary sources such as District Fishery Department, B.L R.O and D.L.R.O office.

1.6.3. Data Analysis and Interpretation:

Collected data have been presented with different cartographic technique and a statistical method (like Standard deviation, Karl Pearson co-relation, GIS technique).

1.6.3.1. Wetland Mapping Technique:

The map of the wetland has been prepared from the topographical map, Google Earth, Bhuban platform, Satellite imageries and ground survey data. Satellite imageries of 2017 were analyzed using Global Mapper, QGIS and Arc GIS software and resultant classification was verified by ground verification. Available records and maps of the National Wetland Atlas, 2011 and National Wetland Atlas, West Bengal, 2010 have been consulted for the purpose. Intensive fieldwork had to be conducted for field verification of wetland identification and mapping, to gather information and evidence relating to micro-study of some selected wetlands.

1.6.3.2. Karl Pearson Co-efficient of Co-relation (1896):

The co-efficient of co-relation formulae according to Karl Pearson (1896) has been used.

$$r = \frac{\sum xy}{\sqrt{\sum X^2 \times \sum Y^2}}$$

Where, X= Deviation from x series, Y= Deviation from y series.

1.6.3.3. Z test:

Z score is the number of standard deviation (SD) from the population mean, it measures how many SD below or above the population mean. It is also known as standard score and it can be represented on a normal distribution curve. Z scores value range from -3SD to +3SD. Zero value of Z score indicates the exact value of the population means.

$$Z = \frac{X - \bar{X}}{\sigma}$$

Where Z= Z score, X= Population mean, $\bar{X}$= Sample mean, σ= Standard Deviation.

1.6.3.4. ANOVA:

Ronald Fisher has introduced the analysis of variance. ANOVA is also known as Fisher analysis of Variance, and it is the extension of the t- and z-test. The one-way ANOVA is used to analyze whether there were any statistically significant differences between the means of the three or more independent groups.

1.6.4.5. Standard Deviation:

Karl Pearson introduced the standard deviation concept in 1823. Standard deviation is the square root of the arithmetic average of the squares of all the deviations taken from the mean. The standard deviation measures the absolute dispersion. The greater value of standard deviation indicates the magnitude of the deviations of the values from their mean.

$\sigma = \sqrt{(\frac{\Sigma X^2}{N})}$ where, σ= Standard deviation

$x^2 = X - \bar{X}$ (Deviation of the item from the mean)

N= Number of the observation

1.6.3.6. Standard Error of Estimate:

The Standard Error of Estimate is a measure of dispersion of all the y-value around the regression equation. It is, therefore, a general or overall measure of dispersion indicating the dependability of estimate. It is in equation form-

$SE_{yx} = \sigma_x\sqrt{1 - \mathrm{r}^2})$ where, SE_{yx}= Standard Error of Estimate of Y on X,

σ_x= Standard deviation of X,

r= Correlation Co-efficient

1.6.3.7. The chi-square (χ^2) Square Test:

The χ^2 square test is one of the simplest and most widely used non-parametric tests in statistical work. The χ^2 test was first used by Karl Pearson in the year 1900. The quantity χ^2 describes the magnitude of the discrepancy between theory and observation. It is defined as-

$$\chi^2 = \sum \frac{(\mathrm{O} - \mathrm{E})^2}{\mathrm{E}}$$

Where O refers to the observed frequencies and E refers to the expected frequencies.

1.6.3.8. Water Quality Index:

A Water Quality Index (WQI) is a compilation of a number of parameters that can be used to determine the overall quality. Here the calculation of the WQI was done using weighted arithmetic water quality index which was originally proposed by Horton (1965) and developed by Brown et al (1972) in the following form:

WQI = **Σ**QiWi /**Σ**Wi

Where,

Qi = 100 {(Va-Vi)/ (Vs-Vi)}

Va = actual value of the water quality parameter obtained from laboratory analysis.

Vi = ideal value of the water quality parameter obtained from the standard tables.

Vs = recommended standard value of i^{th} parameter.

Wi = K / Vs

K is proportionality constant.

1.7. Significance of the Study:

Wetlands are most productive of aquatic environments; providing a wide range of economic, social, environmental and cultural benefits (Costanza, et. al. 1997) or services to mankind. Even in the recent past wetlands were considered as wasteland and hence today they are the most threatened of all ecosystems. However presently, awareness about the hydrological, physical, chemical, biological, and socio-economic importance of wetlands is being acknowledged both by the academicians and researchers. Sometimes the degradation of wetlands is unavoidable as a result of increasing pressure on land but a majority of it occurs because the true values of wetlands are misunderstood.

The wetlands of the study area have enormous potential for environmental and socio-economic development of the region. Besides, study on the geographical and environmental perspective of wetlands has a great significance from academic as well as societal point of view. In addition, many of the *beels* in the study area are used for cultural and recreational activities. Moreover, wetlands are used as a source of water for irrigation in the dry season, especially for boro paddy cultivation. Generally, the *Beels* are rich in biodiversity, where many species of aquatic plants, fishes, and insects, residential and migratory birds are observed.

Haphazard and rampant growth of settlements and establishment of brick kiln industries causes the large-scale deforestation and massive soil erosion. Soil quarrying for brick kilns and siltation by recurrent flood also leads to wetland degredation. Moreover, the construction of roads, railways and embankments are the serious concern for wetlands. Hunting of migratory birds as well as residential birds, conversion of wetlands into agricultural lands and dissociation or fragmentation of wetland into small ponds for pisciculture poses a serious threat to the wetlands of the region. As a result, the ecosystem and biodiversity of the wetland as well as the surrounding regions is being disrupted. The lowering of the retention-capacity of storm water during flood season is one of the serious issues in the study area. Therefore, it is needless to mention why the wetlands have to be conserved.

The study represents a lucid attempt to examine scientifically some of the basic issues pertaining to the geo-environmental status of wetlands in Tufanganj and Koch Bihar sadar

subdivision of Koch Bihar district, West Bengal. In this study, an attempt to analyse the classification and distributional pattern of wetlands, presents use of wetlands of the study area, environmental status of the selected wetlands, the wetland degradation processes, consequences of the wetlands degradation and finally the recommendations and management strategies. As such this study will not only help in understanding the wetland environment in the region but also in other parts of the state or country. In the study, a critical analysis of the water and soil quality, status of flora and fauna, land use, anthropogenic activities etc. are done aiming at conservation and development of wetlands. As such this study may be helpful to mitigate the problems faced by the wetlands and wetland dependent people of the study area. This will undoubtedly have both academic significance and practical relevance. Investigation of the existing status of wetlands in the region would open new vistas for further research in this field. Further, it is expected that the data and information collected for this study will definitely help the future research works and academic activities of students and researchers.

1.8. Review of the Related Literature:

Research on wetlands of Koch Bihar is not scanty. Consequently, there is no dearth of related literature in the field and its allied areas. This literature review abounds in short articles. Major works on the wetland services are not adequate in the field. The types of literature are many and varied. Some works deal with the Physical and chemical parameters of wetlands, while others deal with the problems of the degradation, impact of wetlands on environment etc. The various scholars have performed numerous studies dealing with various aspects of wetlands across the countries. A search in the field of literature for the proposed work unearthed the following works.

Allen (1956) in his article "The Flamingos: Their Life History and Survival their Life History and Survival" stated that the birds living in the water are very much closely related to the hydrological and limnological conditions. The present author showed that the breeding of Flamingos (Phoenicopteridae) are closely associated with habitat condition and food availability. Similar studies have been performed by Zweers et.al (1995), Cazini and Derlindati (2000) on the feeding mechanism of Flamingos and their biological threat due to human interference.

Ara, Khan, and Jargar (2003) studied the "Physico-chemical characteristics of Dal lake water Kashmir valley, India". In this article, they have clearly depicted significant changes in physico-chemical characteristics in the Dal lake water of Kashmir valley during last two decades and also noticed highest dissolved oxygen value during January and concentration of nitrate-nitrogen during June. Excessive use of houseboats and high concentration of weeds led to the significant changes of physic-chemical characteristics of water of Dal Lake in Kashmir Valley.

Baghdadi, Barnier, Gauthier, and Neeson (1999) in their study "Evaluation of C-Band SAR data for wetlands mapping" have attempted to map out the wetlands in Mer Bleue region (Ottawa, Canada) and observed a significant change of that wetland during the vegetation season. They also reported the results of an experiment carried out to examine the potentials of Polarimetric C-band Synthetic Aperture Radar (SAR) for mapping various wetland classes. The Mer Bleue region was surveyed by the C-band (5.3 GHz) Polarimetric (HH, HV, VH, VV) SAR of the Canada Centre for Remote Sensing (CCRS) 3 times within the vegetation season 16 June (spring flush), 6 July (mature growth) and 3 October 1995. Signatures of 6 different cover types (forested and non-forested peat bog, marsh, open water, clearings, and forests) have been derived as a function of incidence angle. A supervised classification was used for wetland mapping by means of multi ploidization data. This study demonstrated some of the capabilities of SAR at C-band for mapping of wetlands.

Bamakanta, Sunakar, Satyabhama, and Prasad (2013) in their article "Seasonal Variation of Nagavali River Water Quality at the Vicinity of Paper Mill near Aykaypur, Odisha, India" made a comparative analysis of the seasonal variation of the physic-chemical characteristics of the Nagavali River of Odisha. The authors found significant fluctuation in the river water quality like pH, conductivity, hardness, DO, COD, TDS, and TSS on seasonal variation.

Bandopadhyay and Mukherjee (2005) in their study "Diversity of Aquatic and Wetland Vascular Plants of Koch Bihar District, West Bengal" revealed 172 aquatic and wetland plant species in various wetlands of Koch Bihar district. They identified 8 eight categories of plants

like Epihydates, Helophytes, Hyperhydrate, Plankton, Pleustophytes, Rosulate, Tenagophytes and Vittate, An extensive field study among various wetlands has been performed by the authors during 1995-1998. They opined that aquatic and wetland plants play a vital role in the ecosystem as well as humankind. In the conclusion, they suggested taking proper management for conserving the aquatic plants and habitats.

Begam, Purushothama, Narayana, and Kumar (2006) in their article "Water quality studies of TV station reservoir at Davangere City, Karnataka (India) described that there were variations in physico-chemical concentrations during rainy season and except turbidity all other physicochemical parameters of water resided within the permissible limits in the reservoir at Davangere city, Karnataka (India).

Bhat and Sharma (2015) in their article "Physico-Chemical Analyisis of Ground water Quality of Adjoining Areas of Sambar lake, A Ramsar Wetland of Rajasthan, India" studied the water quality of different sites of lake periphery and in the catchment areas of Sambar lake. The test result of various chemical parameters are : pH= 7.4-8.6 ; EC= 1723 µs/cm-23400 µs/cm; Total hardness = 402.0 mg/L-3657.0 mg/L; Chloride = 103.21 mg/L-943.43 mg/L; Mg= 35.11 mg/L-316.0 mg/L; TDS= 1175 mg/L -14900 mg/L; Sulphate = 117.6 mg/L-943.98 mg/L; Fluoride = .69 mg/L-2.01 mg/L etc. They have also compared the result with the relevant standard value.

Biswas. Das and Paul (2013) in their article "Floristic diversity of Rasik Beel and its adjoining areas in Cooch Behar district of West Bengal, India" had identified 614 species of plants, belonging 421 genera of 146 families. Of these, 456 species are belonging to Magnoliopsida, 119 species for Liliopsida, 3 species of gymnosperms and Pteridophytes are represented by 36 species in the Rasik Bill complex. The authors have performed a random survey in different seasons during 2007-2013. They noticed 124 species of angiosperm, 456 Magnoliopsida, 119 Liliopsida and 36 Pteridophyta in the Rasik Beel Complex. A detailed study has been conducted and tabulated in this article. Tourism and picnic in the present study area changed the overall morphology of the Rasik Beel wetland complex. They suggested to

declare the place as in situ conservatories and demanded to modify the Rasik Beel Complex as Ramsar Sites.

Chatterjee, Adhikari, Barik and Mukhopadhyay (2013) in their article "The Mid-Winter Assemblage and Diversity of Bird Populations at Patlakhawa Protected Forest, Cooch Behar, West Bengal, India" presented their observation of avian community at Patlakhaoa Protected forest. They identified 154 bird species belonging to the 41 families. Out of all the species, 22 lived in the grasslands and swamp forest. 46 in Riverine forest, 52 in different trees, 43 at the outer periphery of the forest, and 51 species lived in the Rasomati Beel. They also categorized the birds as Insectivorous (53), carnivorous (40), omnivorous (29) and frugivorous (15). Patlakhawa protected forest is located at the riverbank of Torsha in Cooch Behar district. The forest is regarded as "Eastern Wet Alluvial Grassland" according to Champion and Seth's classification (1968). They opined that the bird species of Rasomati Beel is being threatened. The authors tried to map the bird density in the forest and discussed the structure of the avian community. The authors suggested converting the protected forest into Wildlife Sanctuary for conserving the ecosystem and retaining the species diversity.

Carter, (1996) found in the article "Technical Aspects of Wetlands, Wetland hydrology, Water Quality and Associated functions" that Wetlands were often found in places where the water table was close to the surface, resulting in fluctuating discharge or recharge of groundwater supplies. Moreover, Wetlands also reduce waves and shoreline erosion owing to their interlocking root system of vegetation that stabilizes soil at the water edge and enhances soil accumulation through sediment trapping. According to him, this reduces erosion by damping wave action and slowing water currents.

Das and Barat (2014) in their study " Fishing Gears operated in lentic and lotic water bodies of Cooch Behar district, West Bengal, India" tried to explore the various types of fishing gears in Cooch Behar district. They have identified 22 such type of gears that are modified by the anglers resulting in the depletion of fish diversity in different wetlands. They have visited 12 fishermen villages during their field survey. They have categorized the fishing gears as Fishing Net gears and miscellaneous traditional gears. Fishing Net Gears include Chhabi Jal,

Phansi Jal, Sitki Jal, Masari Jal, Tana jal, Thela jal, Haath jal etc and traditional miscellaneous gears include Koncha, Shuli, Zakoi, pala, Jhoka, Chak, Tyapai, buring, Khatal etc. They have discussed in detail about these gears with their pros and cons. The authors suggested some measures for enhancing the fish harvesting. They also opined that mesh size of fishing net gears should be greater than 1 centimetre and fishing should be restricted during the breeding season of the fishes.

Das, Sen, and Mitra (2012) in their proceeding article "Biodiversity of Rasik Beel Wetland Complex (WB, India)" tried to explore the biodiversity of Rasikbeel Complex. They have recorded 171 bird species, 53 ichthyofaunas, 4 annelids, 49 arthropods including 24 butterflies, 6 molluscans, 5 amphibians, 6 reptilians, 9 mammalians in this wetland complex. They had also analyzed the Physical and chemical properties of Rasik Beel wetland complex. They identified various hydrophytes, thallophytes, 23 types of planktons in these wetlands. The authors suggested proper management plan for sustainable development of wetlands.

Dawaki, Noma, and Aliyu (2014) studied on "Heavy Metals and Physico-chemical Properties of Soils in Kano Urban Agricultural Lands." For this purpose they have chosen three metropolitan and suburban rivers namely Challawa, Jakarta and Watari in Kano, Kano State, Nigeria to determine the total, exchangeable and soluble concentrations of the heavy metals Cu, Cr, Ni, Zn, Pb, and Cd. The results showed that the soils of the study areas were at risk of contamination from those metals, which are gradually being released into the rivers from adjacent urban centers. They observed the low to medium values of CEC, organic matter, clay and the slightly alkaline nature of the pH; as well as the higher levels of the metals detected at some sites of the study. They also found the trace of such toxic elements in the plants that grow or are planted in the vicinity of the rivers.

Devaraju, Venkatesha, and Singh (2005) in their article "Studies on the physicochemical parameters of Maddur Lake with reference to suitability for aquaculture" investigated the gradual decline of endemic fish varieties. They have chosen Maddur Lake situated in southern Karnataka for studying the physico-chemical analysis of water and vulnerability of aquaculture for some selected aquatic species. Their studies also showed the fluctuation of water physico-

chemical parameters such as highest DO in October. The higher concentration of DO during October largely depends upon photosynthetic activity and microbial decomposition. The phosphate concentration was usually higher during summer and lowest during winter.

Dey, Nur, Sarkar, and Barat (2015) in their article "Ichthyofauna Diversity of River Kaljani in Cooch Behar District of West Bengal, India" studied the diversity of Ichthyofauna in the Kaljani River. The study was conducted in four sites namely Amlaguri, Chhatoa, Jaigir Chilakhana and Chhat Bhelakopa during August 2012 to August 2014. They have collected samples with the help of local fishermen by using different fishing nets. They have identified 138 indigenous fish species of 31 families. They opined that out of all species, 58 have ornamental value and 55 species have food value. They also tried to enlist 1as critically endangered, 13 as endangered, 41 as vulnerable, 35 having lower risk or nearly threatened, 41 as least affected and 7 species have not been evaluated due to deficiency of data or related issues. They concluded that due to the rampant catching of fish with the fine geared fishing net and agricultural pesticide and chemicals the fish species more vulnerable in the Kaljani river.

Dipson,(2012) in his doctoral dissertation "Spatio-Temporal Changes in the Wetland Ecosystem of Cochin City using Remote Sensing and GIS (Unpublished thesis)" highlighted the land use, land cover and change detection in the study area. For this purpose, he used various temporal satellite data and integrated secondary data from various sources. He also prepared a vulnerability map of the wetlands. He outlined the reasons for reclamation of wetland in Kerala. He made some suggestions or strategies for sustainable use of wetlands and directed some future scope of the study on wetlands.

Feyssa, Njoka, Asfaw and Nyangito (2011) in their study "Physico-chemical Soil Properties of Semiarid Ethiopia in Two Land Use Systems: Implications to Crop Production" tried to explore the major soil fertility status of semi-arid part of East Shewa in Ethiopia. They have chosen six study sites (3 from each district) and thirty composite soil samples of five plots from each site for determination of the major soil physical and chemical parameters and the variation of soil properties across locations. The results indicated that shifting land use system

was more eco-friendly than the land use of settled farmers which was confirmed by the little soil bulk density and high soil organic carbon.

Ghavzan, Gunale and Trivedy (2006) in their study "Limnological evaluation of an urban freshwater river with special reference to phytoplankton" investigated the high value of BOD, COD, Chloride, Phosphate, Nitrate, Sulphate and fCO2 in the Mutha River. They concluded that temperature played an important role in controlling the occurrences and abundance of algal diversity and phosphate has been considered as one of the important nutrients limiting the growth of phytoplankton.

Gopal and Sharma's (1994) investigation deals with the Sambar lake of Rajasthan. They identified the various macrophytes around the lake area which underwent severe anthropogenic pressure due to fodder and fuel demand. They have also thrown light on the natural vegetation in the catchment area of the Sambhar Lake which mainly consists of thorny scrub, typical to the arid and semi-arid zones. The surrounding Aravalli's are covered in Anogeissus pendula, Boswellia sp, and Euphorbia caducifolia, plain areas have trees like Prosopis spicigera, Acacia nilotica, A. senegal, Capparis deciduas and C. aphylla and shrubs like Salvadora persica and S. oleoides. Coarse grasses such as Saccharum sp ontaneum and S. bengalense are common and the species Cenchrus sp. is widely grazed on by the cattles.

Goswami, Pal and Palit (2010) in their article "Studies on the Physico-Chemical characteristics, Macrophyte Diversity and their Economic Prospect in Rajmata Dighi: A wetland in Cooch Behar District, West Bengal, India" studied the seasonal changing nature of macrophytes diversity and physic-chemical properties of Rajmata Dighi (man-made and Government owned) wetland of Cooch Bahar district. They studied 10physico-chemical properties and have identified 48 species in that wetland during pre, on, and post-monsoon periods. They used Margalef's index, Simpson's index, Shannon's index and Pielou's index for their study. They also tested water pH, DO, BOD, free CO2, Soil pH, EC, nitrate-Nitrogen (SN2), PO4 and Carbon – Nitrogen Ratio(C/N). They found the specific relation of macrophyte diversity with physico-chemical parameters of water and soil in the wetland.

In the similar study "Diversity and Distribution of Bird Species in Cooch Behar District of West Bengal" Das, et.al. has identified 226 species of the avifauna of 141 genera with 43 families and 16 orders in Cooch Behar district. They identified one critically endangered, 3 endangered 3 nearly threatened species in the study area. They have pointed out the vulnerability of such avifauna and suggested appropriate measures for conserving the indigenous as well as migratory bird species in the district.

Jain, Das, and Goyal (2005) in their thesis "Conservation Planning of Sambhar Lake, Rajasthan using Satellite Remote Sensing and GIS" discussed the conservation eco-sensitive zone within 3 km buffer from the Sambhar lake boundary in Rajasthan. They identified the land cover and land use patterns in the catchment area of the lake by using remote sensing and GIS methods. The study area covered a total area of about 550 sq. km including the lake itself. The land use within this limited area was estimated as: Open forest (3.47%), Dry lake bed (16.23 %), Salt-affected land (5.77%), Saltpans (other than SSL 3.98%), Saltpans (SSL) (3.04%), Fallow land (22.19%), Agricultural land (10.63%), Settlements (1.52%), Scrub (19.88 %) and Water (13.29%)..

Joshi and Shringi, (2014) in their study "Floristic Diversity with Special Reference to Rare and Threatened Plants of Jawahar Sagar Sanctuary Area near Kota Rajasthan" analyzed the floristic diversity of Jawahar Sagar, which is one of the richest floristic regions of Rajasthan. In the floristic analysis, 422 species of angiosperms were documented, 37 plant species were recorded as rare or endangered. They also highlighted some rare or endangered plants abundantly found in Jawahar Sagar area.

Khatri (1992) in his article "Seasonal distribution of zooplankton in Lakhotia lake, Rajasthan" conducted a study on zooplankton at Lakhotia Lake of Pali city located in the Western part of Rajasthan. The study was conducted in three seasons: summer, monsoon, and winter. The zooplankton comprised of Cladocera, Ostracoda, Copepoda, and Rotifera. The first peak was mainly occupied by Copepoda while the second and third peak was shared by Copepoda and Rotifera respectively. Among zooplanktons, Moina sp, Cypris sp, Cyclops sp,

Diaptomus sp, Nauplius larvae and Brachionus sp were permanent in occurrence whereas Daphnia sp and Ceriodaphnia sp appeared occasionally.

Krause, Bock, Weiers, & Braun(2004) in their article "Mapping Land-Cover and Mangrove Structures with Remote Sensing Techniques: A Contribution to a Synoptic GIS in Support of Coastal Management in North Brazil" assessed the changes in the mangrove coverage observed during 1991 to 1999 in North Brazil using Landsat TM - 5, ETM, ASTER DEM data. His mapping data helped in the evaluation of the heterogeneous data sets of the inter-disciplinary scientific research program MADAM (Mangrove Dynamics and Management). The main objective of the study is to formulate an integrated coastal management scheme for the mangrove ecosystem at Braganca (North Brazil). An assessment of temporal and spatial changes of the mangroves, the type of mangrove structure, land-use cover analysis, as well as the adjacent rural socio-economic impacts were tested using various innovative processing techniques and different scale-resolution levels. They identified the differentiation of the strong and weak patterns of coastal morphodynamics and mangrove ecosystem in North Brazil.

Kumar and Kumar, (2013) focused on the physicochemical contamination of groundwater in Jhansi (Goramachia), of Uttar Pradesh due to the granite mines situated in the vicinity. The result was derived based on sample testing on six different sites situated at various distances from the mines. The physico-chemical parameters such as pH, D.O., E.C., T.D.S., alkalinity, turbidity, Ca (calcium) and Mg (magnesium) hardness, total hardness, NO3 (nitrate), F (fluoride), Fe+3 (iron) and Cl- (chloride) were tested and it was found that those parameters were not within the limit as compared with the WHO standards.

Kumawat and Jawale (2003) in their article "Phytoplankters of a fish pond at Anjale, Maharastra" discussed the abundance, periodicity, and composition of phytoplankton in relation to physico-chemical factors in the fish ponds at Anjale, Maharastra. They had opined that the abundance of algae in a pond increased progressively during late winter and early summer and water temperature is not a significant factor in determining the total algal abundance. The presence of high pH and DO during winter was correlated with the abundance of phytoplankton

and the high value of dissolved oxygen indicated growth that is more algal. The maximum number of blue-green algae was recorded in January when pH, dissolved oxygen, chemical oxygen demand and electrical conductivity were more, while water temperature, chloride, silicate, and nitrate were less and the phytoplankton communities depended directly or indirectly on different physicochemical factors.

Mathur, Patan, Sharma Nair, & Shobhawat, (2010) in their study "Assessment of Physico-Chemical properties of Anasagar Lake of Ajmer (India)" discussed the variation of physico-chemical characteristics of Anasagar Lake in Ajmer city of Rajasthan. They have tested Water Temperature (Avg- 27.9 oC), Transperancy (Avg- 5.8 cm), ph (9.8), EC (3.18 (mmhos/cm), TDS (1762 mg /L), DO (9.2 mg/L), Alkalinity (627.3 mg/L), TH (476.4 mg/L), Ca Hardness (107.7 mg/L), Mg Hardness (418.05 mg/L), phosphate (1.8 mg/L), Sodium (42.96 mg/L), Potassium (24.7 mg/L), COD (169 mg/L). In this study, the authors have identified the fluctuation of the said parameters in different seasons.

Mitsch and Gosselink (1993) in their book Wetlands, (Third Edition) stated that Wetlands are the most biologically productive ecosystem in the temperate grassland and tropical rainforest regions. The wetlands play a vital role in the biological productivity derived from their ability to recycle nutrients and energy. Their research also revealed that Wetlands provide habitat for fish and wildlife. Most freshwater fish depend on wetlands as wetlands serve as nursery grounds for many species such as Alewife, Blue-black herring. They concluded that wetland habitats are critical for the survival of species threatened or endangered with extinction, primarily because of habitat loss.

Moayeri, Mokarram, Hamzeh, and Zaheri (2012) in the article "Change Detection of Wetland Development with Satellite Data and GIS" conducted change detection during 1990 to 2005 at HurolAzim wetland located in the southwestern Khuzestan province, bordering Iran and Iraq using principal components analysis of TM and ETM+ sensor of Landsat imagery. Wetland water supply sources include Karkheh River and its tributaries, Mime, Doiraj subsets of Iran and the Tigris in Iraq. Landsat satellite images revealed that Hurol Azim wetland area has shrunk in recent decades. The study showed that this wetland area has shrunk from 515.4

km2 in 1990 to 230.59 km2 in 2000. The main reasons for the reduced water levels are the dam of Karkheh and frequent droughts.

Mushtaq and Pandey, (2014)in their article "Assessment of land use/land cover dynamics vis-à-vis hydrometeorological variability in Wular Lake environs Kashmir Valley, India using multi-temporal satellite data" discussed the degradation of Wular lake of J& K. They also examined the anthropogenic impact and changes in the land use and land cover and hydrometeorology of the lake region. They used satellite images, which were acquired during the year 1992, 2001, 2005, and 2008, for determining changes in the LULC in a buffer area of 5 km^2 around the Wular Lake. The lake area has been reduced to 24 km2 in 1992 to 9 km2 in 2008 (−62.5 %).

Pal, Das and Chakraborty (2015) in their article "Colour optimization of the Secchi disk and assessment of the water quality in consideration of light extinction coefficient of some selected water bodies at Cooch Behar, West Bengal" made the assessment of water quality of some selected water bodies in Cooch Bihar using Secchi disk method. For this study, they have chosen 5 wetlands namely Mali dighi, Bairagi dighi, Sagar dighi, Narasingha dighi, Panishala Beel. Besides the determination of water transparency, they also determined TDS in all the wetlands. They observed that Panishala beel was least turbid and Mali dighi had the highest turbidity and they opined that White-Yellow disk type shows more efficiency than the other colored disks.

Patel and Parikh, (2013) in their article "Physico-chemical parameters of the Mahiriver" investigated on the physico-chemical parameters of the Mahi river water during summer, monsoon, and winter. The results showed deterioration in water quality during winter due to increase in organic load as result of anthropogenic activities.

Saha, T.K. (2004) in his article "Net plankton diversity in coal mining areas of Jharkhand" analyzed the community structure and diversity of phytoplankton and zooplankton in North Kanpura ponds. The maximum richness index value was observed during May in the ponds of North Kanpura and the minimum value in the Jharia ponds. The phytoplankton

richness index was maximum in August and the minimum value was observed in November and February. The high and low evenness value for phytoplankton and zooplankton was in August, June, and October respectively in the North Kanpura ponds.

Sajeeva and Subramanian (2003) in their article"Land use/land cover changes in Ashtamudi wetland region of Kerala - A study using remote sensing and GIS" have used IRS-1A LISS-II, and IRS-1C LISS III images and SOI topographic maps to quantify LULC changes in the Ashtamudi wetland region from 1967 to 1997. Based on their research it was seen that the area shrinkage was due to increasing population density, changes in the family system, extensive coconut husk retting and deposition of husk waste along the margin of the estuary, solid waste deposition from factories, and reclamation of the estuary by the local population and low profit obtained from paddy cultivation. Thus, the author tried to correlate unwise and land use/ land cover and encroachment in the wetland region with its environmental degradation in the study area.

Singh, and Panday, (1991) in their article "Water quality of stagnant water bodies of North Bihar" analyzed the water quality of 13 stagnant water bodies of North Bihar and reported high-temperature range (24-30°C) affecting the dissolved oxygen concentration and alkalinity of water with the fair amount of carbonate and bicarbonate concentrations.

Sinha (2012) in her article "Scenario of Rasik bill Wetland, Cooch Behar District: A Geographical Perspective" studied the general description of Rasik beel wetland complex. In her study, Miss Sinha tried to explore the present status, diverse habitat& ecosystem, and degradation of Rasik beel wetland complex. She measured water salinity, pH, Ox-red potential, DO, COD, and BOD of Rasik beel. She also identified 3 Pteridophytes, 31 Dicotyledons, 41 Monocotyledons species of flora and 125 various species of Fauna in this wetland complex. Finally, she suggested various management plans to conserve the biodiversity of Rasik beel wetland complex.

Sirajudeen, Manikandan and Manivel (2013) in their study "Water quality index of groundwater around Ampikapuram area near Uyyakondan channel Tiruchirappalli District,

Tamil Nadu, India" evaluated the Water Quality Index (WQI) of groundwater samples collected in Ampikapuram area near Uyyakondan channel of Tiruchirappalli district. They have selected the parameters like pH, E.C, T.D.S, Total hardness, D.O, C.O.D, B.O.D, Cl-, NO3, and Mg. The WQI for these samples ranged between is 244 to 383.8 and hence they concluded that the groundwater of the area needed some degree of treatment before consumption and that it needed to be protected from the hazard of wastewater contamination.

Teferi, Uhlenbrook, Bewket, Wenninger, and Simane, (2010) in their article "The use of remote sensing to quantify wetland loss in the Choke Mountain range, Upper Blue Nile basin, Ethiopia" had quantified the wetland dynamics during the period 1986-2005. They showed that about 17.443 km2 area of the Choke Mountain range in the Upper Blue Nile basin has been lost due to human interference. They have used a hybrid unsupervised classification approach for classifying the LULC. The results showed that 607 km2 of seasonal wetland with low moisture and 22.4 km2 of open water were lost in the study area during the period 1986 to 2005.

Verma and Khan, (2014) in their article "Biodiversity assessment of aquatic plants in Jhunjhunu district of Rajasthan, India" studied the aquatic angiosperm diversity of Jhunjhunu district of Rajasthan. They have identified 15 aquatic angiosperm plant species belonging to 11 families. Among five morpho-ecological groups, free-floating with 40% dominated in the study areas followed by anchored submerged (20%), anchored floating (20%), emergent amphibious (13%) and free submerged with only 6.66%.

The various scholars have performed numerous studies dealing with various aspects of wetlands across the countries. However, only a few works have been done so far on the wetlands of Koch Bihar. De (1999) studied the ecological aspects of the Sundarbans while Singh (1988) discussed the development of wetlands in the Manipur valley. Energy flow in the aquatic systems was studied by Ganapati (1970), Natarajan and Pathak (1983). Jhingram (1987), Pathak and others (1985), highlighted the pattern of energy utilization in beel system. Westlake (1963, 1957) stated that the wetlands were naturally fertile areas for their year-round primary productivity. They have been ranked third highest in the net primary production of the

entire world ecosystem. Pieczynska (1975) commented in the similar study that wetlands play an important role in hydrology. A large number of national and international organizations have prepared various epitomes on wetland

1.9. Research Gaps:

Now problems of wetland are a burning issue. A number of researchers highlighted several issues concerning the wetland. It is observed from the review of the above-mentioned literature that different scholars approach the domain of wetlands in different countries or different parts of India differently but there is still a necessity of more exploration and need for in depth study. Certain research gaps identified by the present researcher are laid down as follows.

1. Most of the researchers highlighted the physico-chemical properties of Wetlands.
2. A considerable number of the researchers have considered one or two component/s like water or soil, floral diversity or faunal distribution; temporal or chronological change of the wetlands.
3. Some of the studies dealt with the causes and consequences of wetland degradation and only a few studies were conducted on Water Quality Index.
4. Some of the studies were descriptive and exploratory in nature. In neither of the studies, the effort had been taken to explore the variation in the wetland in the different geographical locations.
5. None of the studies have been documented on the wetland services and its spatial variations.
6. Many of the scholars classified wetlands but a few have combined the types of wetlands with their distributional pattern.
7. Fragmentation of wetlands into smaller ponds is a serious concern towards degradation of wetlands. No one of the researchers has addressed this issue.
8. Lastly, none of the available studies has been conducted in the present area of study i.e. in Koch Bihar District.

Therefore, there is a need to take a holistic view of this issue and view it from a policy perspective. The present researcher has taken into consideration on almost all the components such as water quality, soil quality, the status of flora and fauna, the temporal change of

wetlands. The study also focuses on the causes and consequences of wetland degradation in the present study area.

1.10. Conclusion:

The present chapter deals with statement of the problem, the location of the study area, hypothesis, objectives, methodology and significance of the study. Also, brief reviews of literatures that are directly or indirectly related to the study have been outlined.

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