Chapter One

INTRODUCTION

This chapter presents an introduction to the study. To start with, numerous important issues associated with inland water fishery in the Indian context are first discussed. Relevant statistics relating to the fishery sector in Assam are also briefly discussed. The discussions take into account the present scenario and the quantity of fish production in Assam, along with its technological aspects. Issues related to fishing techniques and methods, including fishing tools, gears, vessels etc. are appropriately described. Discussions also cover restrictions on catch across fishing seasons, catch and sale of under-sized fish (under grown), restrictions on the use of nets in inland fishery and associated issues. Socio-economic backwardness of the fishing community of the study region is a key aspect in as because the study has been conducted on a backward fishing community of Karimganj district in southern Assam, namely Sone Beel fishermen. The socio-economic features of the fishing community are also outlined. The functions and role of Sone Beel Fishery Cooperative Society are also reviewed. The study region is well portrayed in terms of its geographical location, agro-climatic conditions, and demographic feature. Maps are provided to illustrate the exact location of the study region. The necessity, scope and importance of the present work are then outlined. The justification of the present work is written in this subsection. This is followed by a brief overview of theoretical and conceptual framework of the study. The objectives and hypotheses of the study are then

described along with the rationale behind their adoption. The introductory chapter is a prelude to the present study.

1. Introduction

1.1 Present Scenario of fishery in India vis-a-vis Assam

Fishing as an occupation is being practiced in India since time immemorial. Fishing has been regarded as the primary source of livelihood of a significant proportion of rural population. This is especially so in the coastal areas[1] where a significant section of the rural population[2] depend on fishing and fish sales for their livelihood. For obvious reasons the majority of the population dependent on fishing lie either below or very close to the line of poverty implying that they earn just subsistence income, with little or no surplus after consumption. Fishery sector has been recognized as a powerful income and employment generator for a section of the rural population dependent on the unorganized sector in India. This sector acts as a source of cheap and nutritious food for the masses on the one hand and is an instrument of livelihood of a large section of economically backward population on the other. Indian fisheries occupy an important place in the global fishery map, with India being the second largest producer of fish in the world[3]. With the rise of Indian tourism and hospitality industry, regional Indian fishes are being made increasingly palatable for both national and global tourists (or visitors) who are constantly exposed to regional Indian specialties and delicacies that include fish as well. Moreover the expansion of the

[1] The total length of coastline in India is 7516.6 km. There are 69 coastal districts in mainland India, three in Andaman & Nicobar and one in Lakshadweep. Source: Centre for Coastal Zone Management and Coastal Shelter Belt. Ministry of Environment, Forest and Climate Change, Government of India. Retrieved from (http://iomenvis.nic.in/index2.aspx?slid=758&sublinkid=119&langid=1&mid=1)

[2] About 4 million population comprising 864,550 families directly or indirectly dependent on marine fisheries. Source: Central Marine Fisheries Research Institute, Indian Council of Agricultural Research. Retrieved from (http://www.cmfri.org.in/division/fishery-economics.html)

[3] Handbook on Fisheries Statistic, 2014. Department of Animal Husbandry, Dairying and Fisheries, Government of India, Retrieved from (http://dahd.nic.in/sites/default/files/India%20Profile%20updated.docx).

export market during the post – globalization era is a significant development from the point of view of commercialization of Indian fishery sector. Currently certain varieties of marine, estuarine and fresh-water fishes are being cultured exclusively for the export market by domestic fishery owner[4]. For most nations there are two important sub-sectors in fisheries namely, marine fishery and inland fishery. Both sectors play an important role in the Indian economy and the fishery sector. Marine fishery is an important sub-sector of the nation's economy supporting the livelihoods of millions of people inhabiting India's eight thousand kilometer coast-line[5]. Inland fishery is no less important. Inland water resources in India are diverse and comprise of various inland water bodies namely rivers, lakes, natural wet lands, ponds, artificial tanks etc. India's inland fresh water resources consist of 1.95 lakh km of rivers and canals, 2.9 million hectares of minor and major reservoirs, 2.4 million hectares of ponds and lakes, and about 0.8 million hectares of flood-plains, wetlands and water bodies. Inland fishery provides employment and livelihood for fishermen who are either solely or partly dependent on it.

Assam is bestowed with enormous water resources covering as much as 3.90 lakh hectares of water spread areas. This constitutes about one twelfth of the country's inland water resources. However, the rich biodiversity of the freshwater fish of Assam has been rapidly dwindling because of increasing degradation of inland water (Chakravartty et. al., 2012)[6]. Furthermore, Assam is gifted with numerous medium and small perennial rivers and extensive inland water bodies in the form of wet-lands

[4] The Marine Products Export Development Authority, Ministry of Commerce and Industry, Government of India. Retrieved from (http://164.100.150.120/mpeda/marine_products_exports.php#)
[5] Government of India, 2011; Report of the Working Group on Fisheries, for the Twelfth Five Year Plan (2012-2017), New Delhi, Planning Commission, 2011, Retrieved from http://planningcommission.nic.in/aboutus/committee/wrkgrp12/agri/wgrep_fish.pdf
[6] Chakravartty, P., Chakravartty, M., & Sharma, S. (2012). A Survey on the Fish Diversity with Special Reference to the Classified Ornamental Fishes and their Prospects in the Kapla Beel of Barpeta District. *The Science Probe A Quarterly Refereed Online Research Journal*, 1(2), 12-21.

or catchment areas. Such catchment areas which spread immensely during monsoon months and shrink during winter months are commonly known as beels (large wet lands but not fresh water lake) in the region. Usually beels in Southern Assam or Barak valley region are connected with small rivers and canals. As such, the beels along with numerous small rivers act as the breeding ground (or home) for both sweet and fresh water fish. Clearly, beels, rivers among other wetlands are major sources of fish in the state. Planned fisheries have also come up in the state in recent years and have started contributing to the region's fish output. Planned fisheries together with the open access fishing in both rivers and beels, currently contribute to about 25 percent of the marketed fish (quantity that is made available for sale meant for final consumption) in Assam (Chakravartty et al., 2012)[7]. The rest (75 percent) of marketed fish are procured and transported from the rest of India, primarily from Andhra Pradesh, Uttar Pradesh, Odisha, Bihar and West Bengal. Being a predominantly fish consuming state, the demand for fish is very high in Assam. Interestingly a very different picture is obtained from the secondary sources, especially from the Reports of the State government. As per the Department of Fisheries, Government of Assam, Assam produced 2.97 lakh metric tons fish during 2015-16 against the demand or requirement of 3.31 lakh metric tons during the same period[8]. Thus there exists a supply deficit of 0.34 lakh metric ton in 2015-16, which in fact is highly satisfactory as a minor percentage of state-level demand has to be transported from the rest of India (i.e., 0.17 lakh metric tons are imported from outside the state). In other words the government reports seem to claim that Assam is almost self sufficient is fish production and consumption which is quite contrary to the observations and perceptions across the state.

[7] op. cit.
[8] Department of Fisheries Government of Assam; http://fishassam.gov.in/statistics.html

In another estimate[9], about 90 percent of the state population of Assam is fish eaters and consequently there is a persistent excess demand for fish in the state. The present per capita consumption of fish in the state is 9 kg per annum. Vast quantities of fish are procured and transported from nearby states like West Bengal (WB), Andhra Pradesh (AP), and Uttar Pradesh (UP) and even from Odisha. As, per the report prepared by Marketing Inspector and Marketing officer, Fisheries (Department of Fishery, Government of Assam, 2012)[10], about 15 - 20 tons of fish on an average per day is being procured and transported from Andhra Pradesh, simultaneously about 7 - 8 tons from UP, and almost a similar quantity from West Bengal, into Assam. In sum, around 0.17 lakh metric tons of fish per annum have to be procured and transported into Assam from outside the state to fulfill the state-level demand. Thus, secondary sources clearly indicate that there exists a significant gap between state-level consumption demand and production of fish. In other words there exists a perpetual excess demand for fish.

Table 1.1.1. India's share in World fish production for the year 2009 (metric tons)

Name of Country	Capture	Culture	Total Production	Percentage of Share
Total world	8,89,18,040	5,56,80,738	14,45,98,778	
China	1,49,19,596	3,47,79,870	4,96,99,466	34.37
India	40,53,241	37,91,920	78,45,161	5.43
Peru	69,14,452	-	69,14,452	4.78
Indonesia	50,99,355	17,33,434	68,32,789	4.73
Vietnam	22,43,100	25,56,200	47,99,300	3.32

Source: Handbook on Fisheries Statistic, 2014. Department of Animal Husbandry, Dairying and Fisheries, Government of India, (http://dahd.nic.in/sites/default/files/India%20Profile%20updated.docx).
Notes: Data for culture of Peru was unavailable.

[9] Rashtriya Krishi Vikash Yojana, Department of Agriculture, Government of Assam; www.rkvyassam.in)
[10] December 2012; Department of Fisheries Government of Assam, http://fishassam.gov.in/doc/fish_Price_Statistics.pdf

The global and Indian fish production is reported in table 1.1.1. Fish production in India touched 7.84 million tons in 2009 from mere 5.96 million tons in 2001-02. The share of India in global fish production is second after China. While China has 34.37 percent of global share, India has just 5.43 percent, followed by Peru (4.78 percent) and Indonesia (4.73 percent) respectively. The global patterns of fish production owe much to the activities of China (which reports production in weight) that accounts for 34.37 percent of the total world fish output. Other major producer countries are India, Peru, Indonesia, and Vietnam. The growth rate of fish production in India has been accelerated due to increasing contributions from inland fisheries.

Table 1.1.2. Fish production, growth rate and fish seed production in India (2004-05 to 2014-15)

Year	Inland (lakh tonnes)	Growth rate (%)	Marine (lakh tonnes)	Growth rate (%)	Total production (lakh tonnes)	Growth Rate (%)	Fish seeds Produced In million fry
2004-05	35.26	1.96	27.79	-5.53	63.05	-1.48	20790.64
2005-06	37.56	6.52	28.16	1.33	65.72	4.23	21988.30
2006-07	38.45	2.37	30.24	7.39	68.69	4.52	23647.95
2007-08	42.07	9.41	29.20	-3.44	71.27	3.76	24143.57
2008-09	46.38	10.24	29.78	1.99	76.16	6.87	32177.21
2009-10	48.94	5.52	31.04	4.23	79.98	5.02	29313.17
2010-11	49.81	1.78	32.50	4.70	82.31	2.91	34110.83
2011-12	52.95	6.29	33.71	3.76	86.66	5.29	36566.43
2012-13	57.20	8.03	33.20	-1.51	90.40	4.32	34921.80
2013-14	61.36	7.28	34.43	3.68	95.79	5.96	41450.00
2014-15**(P)**	65.77	7.30	34.91	1.40	100.69	5.2	43390.62

Source: Handbook on Fisheries statistics, 2014, Department of Animal Husbandry, Dairying and Fisheries, Government of India, (http://dahd.nic.in/sites/default/files/India%20Profile%20updated.docx).

Fish production in the country has shown an increasing trend and has reached a record level of 10.06 million tons in 2014-15. Table 1.1.2 shows the annual absolute production and the annual growth rates of both inland and marine fishery in India. Fish seed productions during 2004-05 to 2014-15, are also shown. The growth rate of inland fish production has been faster during last decade compared to marine fisheries. The progress in the inland fisheries sector during the last decade has been commendable. It seems that marine fisheries production has reached a plateau and at

best it can register only a marginal increase in the near future. On the other hand, inland fish production is still on the rise. The inland fisheries in India include both capture and culture fisheries. The production of fish seeds in India has also increased steadily over the last decade. This is shown in the last column of the table 1.1.2.

Table 1.1.3. Fish production trends, growth rate and seed production in Assam during 2004-05 to 2015-16.

Year	Inland Fish production		Fish Seed Production	
	Fish production ('000 tons)	Growth rate (%)	No of fish seeds produced(million fry)	Growth rate (%)
2004-05	186.31	2.9	2471.47	23.0
2005-06	188.01	0.9	3207.99	29.8
2006-07	181.48	-4.5	3062.00	-4.6
2007-08	190.32	4.8	3206.00	5.9
2008-09	206.15	8.3	3429.00	6.95
2009-10	218.82	6.15	3326.00	-3.00
2010-11	227.24	3.85	4263.00	28.17
2011-12	228.62	0.61	3624.00	-14.99
2012-13	254.27	11.22	4364.00	20.42
2013-14	266.70	4.88	4546.00	4.17
2014-15	282.00	5.74	5793.00	27.43
2015-16 (P)	297.00	5.32	5995.00	3.48

Source: Fishery sector at a glance, Assam, 2015-16. Department of Fisheries, Government of Assam, 2015-16. Retrieved from http://fishassam.gov.in/doc/FIshery%20At%20a%20Glance,%202015-16.pdf

The statistics on annual fish production and fish seed production in Assam are presented in the table 1.1.3. The state fish production has increased over the last five years with highest growth rate of 11.22 percent achieved in 2012-13. In 2006-07 the production was 181.48 thousand metric tons (MT) which was lower than that in 2005-06 (188.01 thousand metric tons). In 2013-14 it grew to 266.70 thousand MT. As discussed before, the current production of fish is not sufficient to meet the annual demand for fish at the state level and may at best cater to the demand of 90 percent fish consumers of the state. Consequently around 0.25 lakh tons of fish have to be imported on an annual basis (purchased and transported from other states, namely Andhra Pradesh, U.P., Orissa and West Bengal). Yet another observation is that the growth rate of fish seeds is not steadily increasing. In 2006-07, 2009-10 and 2011-12 there negative growth rates of fish seed production were observed in Assam.

Table 1.1.4. Some statistics of Fishery in Assam, 2014-15

Type	2014-15 (absolute numbers)	Water Spread Area (in hect.) /River and tributaries (in km.) 2014-15
1. River Fisheries		
(i) Main Rivers	2	4820 (Area in km.)
(ii) Tributaries	53	
2. Beels		
(i) Registered Beels	430	60215 ha.
(ii) Unregistered Beels	767	40600 ha.
3. Forest Fisheries	71	5017 ha.
4. Reservoir Fisheries	2	2553
5. Ponds and Tanks	368014	60391

Source: Fishery Resources in Assam, 2014-15. Department of Fisheries, Government of Assam, (*URL:* http://fishassam.gov.in/resources.html).

According to the report of Statistics of Fisheries on Inland Water Bodies in Assam, 2014-15, the total area of river fisheries is 4820 sq km comprising of two main rivers (*Brahmaputra and Barak*) and 53 tributaries in Assam. The total number of registered Beels in Assam is 430 and unregistered beels are 767 as reported in table 1.1.4. Moreover the water spread area under registered and un-registered beels are 60215 and 40600 hectares (ha) respectively. The forest fisheries occupy an area of 5017 ha and number stands at 71. There are two reservoir fisheries covering an area of 2553 ha. As per the data there are a total of 368014 ponds and tanks and together occupy 60391 ha (Table 1.1.4). The resources of these wetlands are important for human nutrition and the economy as they provide a habitat for a number of aquatic flora and fauna, including migratory and indigenous birds. Fishing is the main economic activity of populations settled in the neighbourhood of the beels. Rice and vegetables are cultivated in the catchment areas or beel type areas during pre and post monsoon seasons.

1.2 Statement of the Problem

For a long time, fishing has been regarded as one of the most important means of livelihood of thousands of households living in the neighborhood of the Sone Beel in

Karimganj district of Assam. The Sone Beel is the largest wet land and catchment area of the region. Numerous small rivers and canals in the region flow into the Sone Beel. The fisheries sector in Karimganj is almost entirely dominated by small scale, poor fishing households dwelling in the vicinity of the Sone Beel. In fact total fish catch in the Sone Beel can account for around 70 percent of the total fresh water fish catch of the district[11]. Most informed people in the region (that includes fishermen) have a perception that there has been over-crowding of catchers in the Sone Beel in recent years the due to the complete absence of entry restrictions during the peak fishing season. Moreover lack of modern skills, capital and knowhow prevents the fishing households to go beyond the traditional methods. With the scarce resources and growing fish demand, decision makers (policy makers and households) face the challenge of developing a sustainable small-scale fisheries sector, which can integrate socio-economic and environmental objectives in their planning decisions.

The key issues of concern as identified by the fishermen themselves include poor and inefficient fishing gears and vessels, lack of capital, poor fisheries management, limited access to larger markets (e.g. Silchar, Guwahati and Agartala) coupled with poor handling facilities, poor infrastructure and high post-harvest losses. Lack of alternative employment opportunities and rising number of fishing households have possibly been the main cause of over-crowding of catchers leading to over-exploitation of the resource and degradation of fish stock. Almost all fishing households around the Sone Beel continue to be trapped in poverty and this has been their status over generations. The key objective of planners and policy makers of the district and region is to create sufficient levels of non-fishing employment opportunities for fishing households so that no one is forced to take up fishing as the

[11] Comprehensive District Agricultural Plan Report of 2011-12, District of Karimganj, Government of Assam.

only livelihood. This would also address the problem of overcrowding in the Sone Beel.

However the efficiency of fish catch may in turn depend on several factors that are not used as inputs by fishermen. In other words several non-input socio-economic factors may influence the efficiency of fish catch. These include health status (level of physical fitness and physical capability) of the fishermen, experience, knowledge and awareness, standards of living, indebtedness, understanding within the fishing team members and income sources other than fishing, e.g. agricultural or petty business income. Thus the present study also looks into how these non-input socio-economic variables influence the technical efficiency of fish catch.

A production frontier represents the minimum input bundles required to produce different levels of output. Not all producers are successful in producing the maximum output using given levels of inputs or are able to use the minimum levels of inputs to produce a target level of output for a given technology. Both are tantamount to production below the production frontier. In other words not all producers are technically efficient. The presence of inefficiency in the production process leads to four major consequences. First, it reduces the quantity of output for a given set of inputs. Second, some of the inputs will be either under-utilised or over-utilised. Third, it raises the cost of production. Finally, there will be a loss in profit. Efficiency is classified into three categories, technical, allocative and scale. Technical efficiency refers to production of actual output relative to the frontier output for a given quantity of inputs. Allocative efficiency is related to producer's choice of optimal input combination. And finally, scale efficiency is a situation of choice of right quantity of output, where price and marginal cost of production are assumed to be equal.

1.3 Necessity Scope and Importance of the Study

The necessity of the present research has to be justified. The people living in the surroundings of the Sone Beel in Karimganj district consists primarily of traditional fishermen. The Sone Beel is the largest wet land and catchment area in the region. The traditional fishermen or the people dependent on fishing for their principal livelihood have lived in the region for several generations. This fishing community is visibly socio-economically backward, having access to subsistent levels of earning only. More than 35 thousands families are directly dependent on the beel for fishing. About 300 families fully depend on income from boat services for six months and similar numbers of families are engaged in traditional fishing equipments[12]. Since, the principal occupation of these people is fishing, (more specifically inland freshwater fishing), sustainable livelihood, standards of living and hence overall quality of life of the fishing household is indisputably linked with,

(i) The productivity and efficiency of fish catch with respect to catch-effort or labour time spent, along with the income from it and,

(ii) The income from any non-fishing occupation – say for example agriculture and allied activities, or other petty businesses

However the efficiency of fish catch and also that in other occupations depend in turn on

(i) The health status (level of physical fitness and physical capability) of the fishermen.

(ii) Host of other socio-economic factors as knowledge, awareness and overall quality of life.

(iii) Income sources other than fishing. E.g. agricultural or petty business income.

[12] National Wetland Atlas: Assam (2010), Sponsored by Ministry of Environment and Forests, Government of India April 2010. Retrieved from (http://envfor.nic.in/sites/default/files/NWIA_Assam_Atlas.pdf)

The present research on the traditional fishing population of Karimganj district of Assam aims to assess the viability of a sustainable source of living through fishing in the Sone Beel on the one hand and how standards of living and overall quality of life influence the technical efficiency of fish catch on the other. Non-input factors that may influence the efficiency are age and experience of the fisherman, education, non-fishing income, among others.

The study is based on primary data that have been collected in a household level socio-economic survey surrounding the Sone Beel covering all the Gram Panchayats surrounding the Sone Beel. The data has been collected using a well structured pretested schedule by employing the direct interview method.

First, existing literature suggests that stochastic production frontier models and their estimation in Indian fisheries are rare. Second, influences of standards of living, overall quality of life and other selected socio-economic variables on the level of technical efficiency of fish catch are rarely studied by researchers. Thus the research gap in this area is quite evident and obvious. Third, no micro-econometric studies on fishing efficiency have been conducted in the North-East till date.

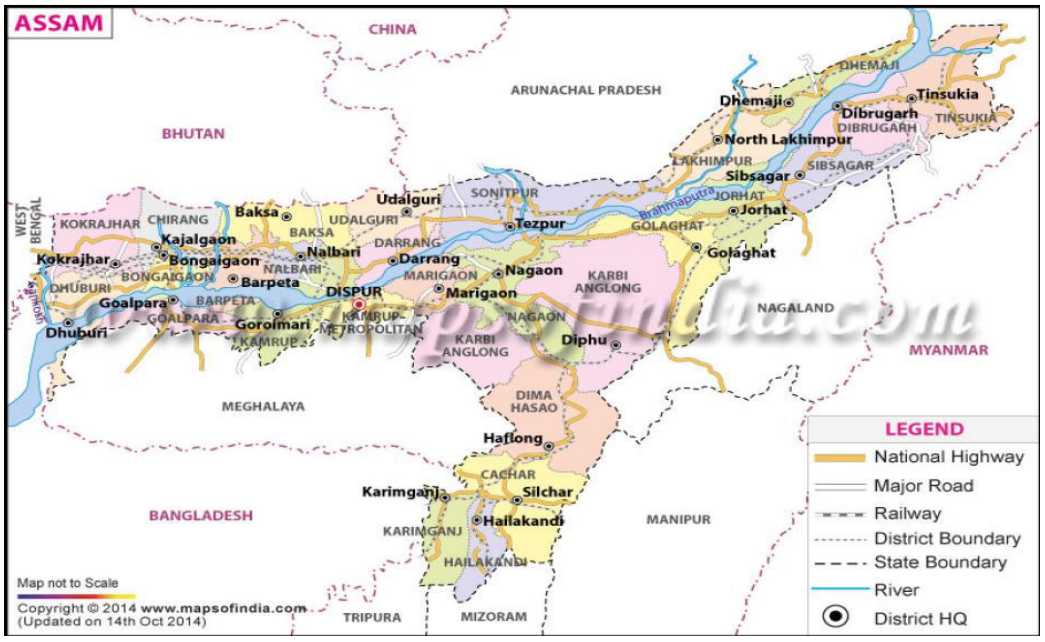
The present study has pointed out the key reasons behind socio-economic backwardness of fishing households and thus provides invaluable policy suggestions with the sole objective of promoting efficiency of fish catch, the standards of living and thus the overall quality of life of this age old fishing community of Southern Assam.

The study has used the well known econometric tool of Stochastic Production Frontier. The inefficiency effects model after Kumbhakar, Ghosh and McGuckin (1991) is used for this purpose whereby a set of socioeconomic variables including some dummy variables are used to explain inter-personal variations in the level of

efficiency of fish catch. The study focuses on the key reasons behind socio-economic backwardness of fishing households and thus provides invaluable policy suggestions with the sole objective of promoting the standards of living and thus the overall quality of life of this age old fishing community of Southern Assam.

1.4 A Brief Profile of the State of Assam

Assam is situated in the North-East region of India and one of the seven states of northeast India[13]. It is located between $24^0$8'N and 28^0.18 N latitudes and 89^0 42'E and $96^0$0'E longitudes. The State is surrounded by parts of Arunachal Pradesh in the East, alongside Nagaland, Manipur and Myanmar, the states of Mizoram, Tripura and Meghalaya in the South, Bangladesh and West Bengal in the West and Bhutan and Arunachal Pradesh in the North. The state is surrounded by many hills in all directions.



Map 1: District map of Assam (Source: www.mapsofindia.com)

[13] Maps of India. Retrieved from http://www.mapsofindia.com/assam/geography.html

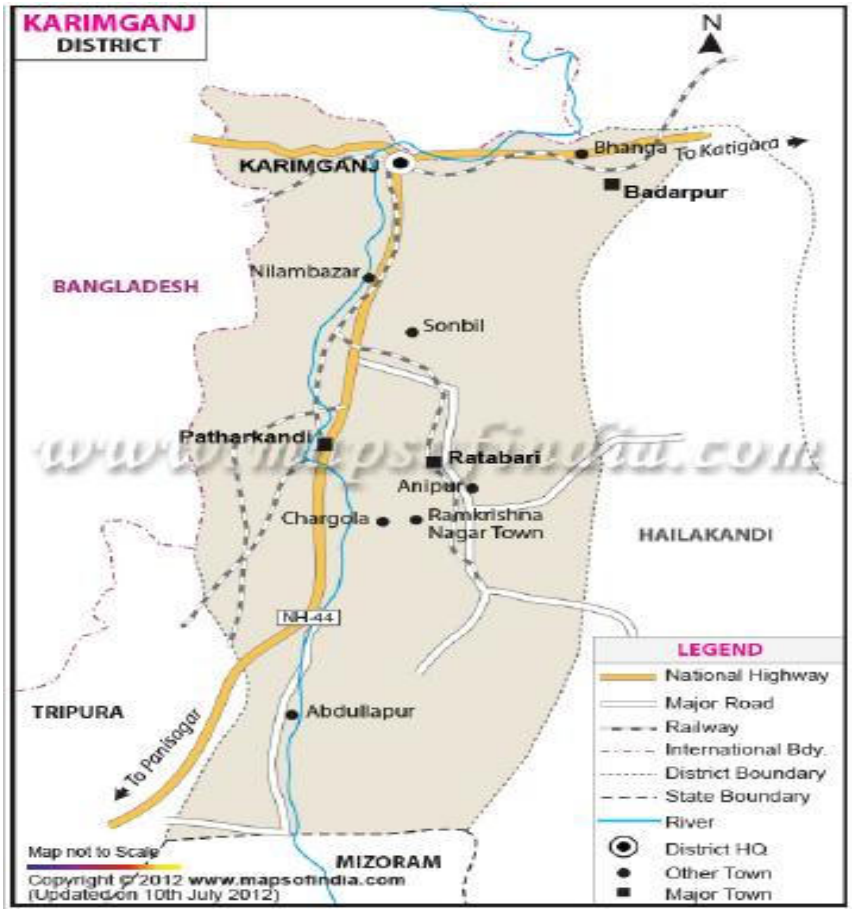
The total geographic area of Assam is 78,438 sq. km of which 98.4 percent area is rural. Assam occupies two main rivers viz, the *Brahmaputra* and the *Barak* flow through the state with each having 40 and 7 major tributaries, respectively. The Brahmaputra valley is an alluvial plain having varying topography. The Barak River flows from east to west through undulating plains, the river originating at Manipur.

There are two hill districts viz, Karbi Anglong and North Cachar Hills in the state occupying about 1.5 million hectares of hilly areas. The hills constitute a part of the Barail and the East Khasi and West Garo ranges of Meghalaya with maximum altitude of about 1000 meters above sea level. Thus the state has three distinct physiographic units - the river plains or flood plains, the plateaus and the hills. The state has its climatic and physiographic features favorable for rice cultivation and the crop is grown in a wide range of agro-ecological situations. Assam is a state of heterogeneous population with socio cultural and ethnic diversity[14]. According to the Census of India, 2011 the population of Assam stands at 3.12 Crores, of which 15939443 are male and 15266133 are females. The density of the population of Assam has increased to 398 persons in 2011 from 340 persons in 2001 Census.

1.5 Demographic outline of the Karimganj district

The Sone Beel is the largest wet land of southern Assam. It is located in Karimganj district – one of the three districts of southern Assam. Southern Assam is also known as Barak valley as it is a flood plain generated by the river Barak due to its peculiar meandering nature.

[14] Economic Survey Assam 2014-15, Directorate of Economics and Statistics, Assam Planning and Development Department Government of Assam *URL*: (http://planassam.info/admin/files/economic_survey_assam_2014-2015.pdf



Map 2: District map of Karimganj (Source: www.maps of india.com)

The study region is depicted in map 2. Karimganj district is one of the southernmost districts of Assam located in the valley of Barak. It is situated between longitude $91^0$15' and $93^0$15' east latitude $24^0$8' and $25^0$8' north. In terms of geographical area the total area of the district is 1809 square km and the rank of the district is 21 compared to other districts of Assam. The terrain of the district consists of flood plains, wetlands, hills and forests. The district is surrounded by Bangladesh and Cachar district of Assam in the north, Mizoram in the south, Bangladesh and Tripura in the west and Hailakandi district of Assam in the east. The district is comprised of 936 villages with 7 Community Development Blocks[15]. The district possesses 5

[15] Census of India 2011, Assam, District Census Handbook Karimganj, (http://www.censusindia.gov.in/2011census/dchb/1818_PART_B_DCHB_KARIMGANJ.pdf

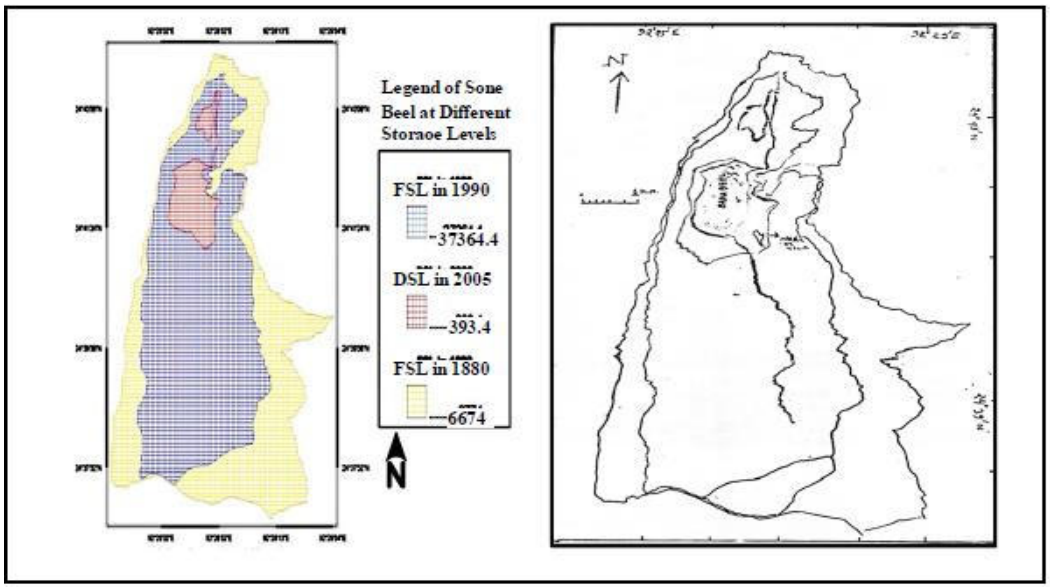
revenue Circles namely, Karimganj, Badarpur, Nilambazar, Patherkandi and Ramkrishna Nagar. Sone Beel and its adjacent villages fall under Ranmkrishna Nagar Revenue Circle. In Karimganj district, Ramkrishna nagar revenue Circle is the most populous having 281864 persons while Badarpur is the least populous Revenue Circle having 164703 persons. According to the 2011 census[16] the population of the district was 1,228,686 out of which proportion of rural population was 91.07 per cent and urban population was 8.93 per cent. The decadal growth rate of population is estimated at 21.90 per cent. Sex ratio of the district was 963 females per 1000 males as per the census of 2011 compared to 2001 census of 947. Although the decadal growth rate of population appears quite alarming, the sex ratio has slightly moved in a desirable direction compared to that in 2001. Further, according to the Census 2011, population density of Karimganj district was 679 per sq km compared to 557 per sq km in 2001 which is clearly higher than that of the corresponding figure of 2001. The population distribution of religion wise Muslim community (56.36 percent) dominates the population of the district followed by the Hindu community (42.48 percent). About 13 percent population in the district belongs to scheduled caste community. Overall literacy rate of Karimganj in 2011 was 78.22 per cent compared to 66.24 per cent in 2001. Understandably the overall literacy rate would vary substantially across gender, caste, occupation and income classes. There still remains a wide disparity between male and female literacy. Bengali is the major language of the district and the region and is officially recognized as the official language. Sone Beel is around 17 km away (south) from Karimganj town which is lies on the northern border of the district.

[16] Karimganj District: Census 2011 data. (http://www.census2011.co.in/census/district/158-karimganj.html

1.6 Profile of the Study Area

1.6.1 Geographical location of Sone Beel region

The Sone Beel is the largest freshwater tectonic wet land of southern Assam. It is located between 92°24'50" – 92°28'25" East and 24°36'40" – 24°44'30" North in Karimganj district of Assam (a major state in northeastern India) and falls in a valley geologically called syncline. The physiography of the district consists of small hillocks intervened by wide low valleys. The hillocks have northeast – southwest and northeast – south southwest trend near the Borail range and north – south trend towards south away from the Borail range.



Map 3. Boundary contour Map of Sone Beel at different storage levels. (Source: Das et al., 2014), *URL*: (file:///C:/Users/user/Downloads/JeradDLId0587vol008issue003%20(2).pdf)

Notably, Sone Beel, the biggest 'Beel' (wetland) in Assam is situated in between two hill ranges, viz., the Badarpur-Saraspur range and the Chowkirmukh-Dohalia range. The maximum length and breadth of the wetland at Live Storage Level (LSL) are measured at 12.5 km and 3.9 km respectively during June to September. Interestingly, these values reduce to 4.07 km and 2.22 km respectively at its Dead Storage Level

(DSL) during December to April. The area of Sone Beel at LSL is 3458.12 hectares while at DSL, the area diminishes to only 409.37 hectares. Thus, there is enormous variation of water volume in the Sone Beel across the monsoon and winter months. The length of the shoreline is measured at 35.4 km while mean depth is 0.29 metres (Kar et al., 2008)[17]. Sone Beel can be approached from either the district of Karimganj or Hailakandi, the nearest major urban location being the district Head Quarter town of Hailakandi. Hailakandi town is located approximately 20 km to the east of the Sone Beel and is road-way connected. Due to the proximity of Hailakandi town, majority of fish caught in the Sone Beel is marketed in Hailakandi.

1.6.2 Social History of People of Sone Beel

Fishermen belonging to four principal communities have been recorded in the 39 villages around Sone Beel (Kar, 1990, 2013)[18]. These are the 'Kaibarta', the 'Patni', the 'Maimal' and the 'Namasudra'. Majority of the people living at Son beel are Kaibarta who belong to Scheduled Caste community. About Kaibartas, Risley (1891) states that they are a large fishing and cultivating caste of Bengal proper, ranked below the Nava Shakha. Nava Shakha constitutes a group of nine castes from whose hands Brahman take water. The dharma shastras also enlisted them as a fishing community. They are called as Kevartta in the Jatakas ('Ke' water, and 'varta' livelihood). This means that the Kaibartas derive their livelihood from water.

Patni, another scheduled caste community, is also found in surrounding villages. Patni is settled mainly in three villages of east part of Sone beel viz Anandapur, Devaddar and Gamaria. Patni settled in these villages during British period. They were brought

[17] Kar, D., Barbhuiya, A. H. & Saha, B. (2008). Wetland Diversity of Assam: Their Present Statue. http://www.moef.nic.in/sites/default/files/nlcp/Indian%20Case%20Studies/Q-11.pdf
[18] Risley. H.H. (1891). The Tribes and Castes of Bengal. 2, 375-82. Retrieved from https://archive.org/stream/tribesandcastes00rislgoog/tribesandcastes00rislgoog_djvu.txt

from Jaldhup locality of undivided Bangladesh by the than Zamindar Kumar Bahadur. The Kaibartas are the aboriginal inhabitants of Assam. They are one of the sixteen Scheduled Castes of the state as per Constitution (Scheduled Castes) Order, 1950. The origin and migration of the Kaibartas are still shrouded with mystery (Chandana et al., 2005)[19].

Their traditional occupation was boating and fishing. Gradually they started agriculture in the unused land of upper part of the Sone Beel. Kaibarta faced lot of difficulties in the initial stage of their settlement. Initially they were helped by other Hindus particularly Patni and Namasudra residing in surrounding villages. Kaibartas were expert in fishing but they immediately did not get fish market in locality because local people used to catch fish for their own consumption. Therefore, in the initial stage of their settlement, they were in tremendous need and support of local people. Patni, Namasudra and other Hindus helped them with some resources needed for their livelihood. They also got government support to cope with the new situation. Kaibarta started fishing and worked hard for selling fish in nearby markets. Gradually fishing becomes their permanent occupation Muslim fishermen; Hindus other than Patni and Kaibarta are also residing in Sone Beel. Namasudhra, another Scheduled Caste community is found in some of the villages. Upper caste Hindus are very rare and mainly residing in nearby markets.

Form the survey it was known that Namasudhra community people are mainly involved in making traditional fishing equipments for example fishing boats, webbing fishing nets and some other non net fishing tool like *dori* and *kathi*. However fishing

[19] Sarma, Chandana & Ali, A.N.M. Irshad. (2005). The Kaibartas: A Fishing Community of Assam, Their Society and Economy. *Journal of Human Ecology*. 17(3), 205-209.
URL http://www.krepublishers.com/02-Journals/JHE/JHE-17-0-000-000-2005-Web/JHE-17-3-161-236-2005-Abst-PDF/JHE-17-3-205-209-2005-1222-Sarma-C/JHE-17-3-205-209-2005-1222-Sarma-C.pdf

skills catch efficiency and selling related activities are prominently dominated by Kaibarta (traditional fisher folk) community. There are variety of fishing methods applied during peak season in Sone Beel with carrying different fishing tools and equipments. The boats, net and other fishing equipments are fishers' most productive assets.

Fishing is considered to be the only important occupation by the fishing community residing in the immediate surroundings of the Sone Beel even though it is largely a seasonal occupation. The Kaibartas of Sone Beel follow the Hindu calendar for various fishing activities. The Kaibartas depend on the fishing implements and the beel (natural large wetland). Each individual family possesses their own required fishing implements. The Kaibartas of Sone Beel employ different fishing techniques such as traps, nets, fishing by rod and line and so on. The simplest type of trap used by them is the polo (cage trap), pelain made of bamboo strips. It is generally used in knee-deep still water usually in the beels. Fishes hidden in the mud are usually caught by this trap. Sometimes an artificial dam is prepared in shallow running water leaving a small passage. The fisherman places a chepa (valve trap) at the passage where the fishes exist and blocks the open mouth of the trap, placing the valve against the current of water. The fishes are lured into the trap with the water and are trapped. Different types of nets are by the fishermen during peak season. Gill nets are of three varieties puthilangi, garelangi and kawoilangi. Handnet (*haatjaal*) is also used to catch fish in shallow water. Dip net (*dhekijaal*) is a variety of hand operated net but it is used in deep water. Mahajal (encircling gears), is large and can cover a huge area. Other implements used by them are rod and line (*borhi*), basket trap (*jakoi*) and fishing basket (*khaloi*). There is another indigenous method of catching fish among these fishermen. In the months of late October when water body shrinks to limited

area, fishermen catch fish in the paddy fields and inland pools. The fishermen attach earthworms to hooks tied in ropes. These ropes are laid out in the paddy fields or inland pool and small fishes that come to eat those earthworms are caught by the hooks. They then gather those ropes and collect the fishes. The fishermen do not possess individual fisheries. They catch fish in nearby beel owned by the Fishery Co-operative Society of the village which is auctioned by the Government in every three years.

Fishing is the principal source of livelihood for majority of the villagers residing in the vicinity of the Sone Beel. People engage themselves in fishing starting from the month of April till late October or early November every year. From the month of January onwards water volume shrinks enormously and Sone Beel turns into a vast cultivable fertile land favourable for paddy. Limited volumes of water remains trapped in small pockets making irrigation possible even without rain. Such small pond-like formations also enable fish growing and breeding during the dry season. Cultivators (many of them are also fishermen during monsoon months) cultivate regional varieties of paddy, broadly known as *boro paddy*, during winter. The winter crop or *boro* crop is harvested at the end of spring, mostly during early April. Harvesting of *boro* depends on weather to a large extent. Cultivators often have to face massive crop losses in case of untimely and excessive rain with hailstorms or even thunderstorm during the end of March. Crop loss occurs in case of plots located in relatively low lying areas which flood very fast during heavy showers. Cultivators operating on relatively higher plains in the same area are somehow able to save their crops but not during hail storms which destroy acres of crops within hours. Vegetable cultivation is very limited in the Sone Beel region. In brief during the winter months planned fisheries grow selected varieties of fish in small and medium sized ponds

which are partitioned and leased in by the share holders (mostly wealthy businessmen of the region) from the Sone Beel Fisherman's Co-operative Society, a registered society under Government of Assam. Other flat but low lying regions remain moist and are extremely fertile making it suitable for small to medium scale paddy cultivation. Irrigation is available due to the numerous small pockets of water which do not dry even during winter months. Interestingly, cultivators are mostly the fishermen themselves with very few exceptions. This implies that the people engaged in fishing during peak season most have three broad occupations during the slack or dry season. First, wealthy fishermen are engaged in planned fish growing and fish breeding in small ponds and partitioned water bodies. Second, small, marginal and medium land holders in the region cultivate paddy during December to April. And third, the remaining who either have no land or have uneconomical sized holding migrate to nearby urban and semi urban areas most in semi skilled unorganized sector jobs, sometimes even as casual labour in the urban sector. The present study does not focus on economic activities of the slack season. Rather it deals with measurement of technical efficiency of fish catch during the peak fishing season.

Communication system improves during summer for people residing in the eastern and northern part of the Sone beel. People residing in one corner can easily reach to other parts by means of motorized boats. Some boats are run manually by boatmen. People residing on the eastern banks part suffer a lot to reach the district Head Quarter town of Karimganj during winter. Hence during summer they reach the district town by train via Fakua Gram railway station situated in western part of the Sone beel.

1.6.3 Ecology of Sone Beel

Sone Beel is the largest wetland in Assam having an area of 3458.12 ha. During winter season water level of this wetland shrinks to an area of 409.37 ha. Length of

the beel is around 13.2 km and breadth is 4.2 km. The beel is mainly fed by river Singla. The beel is bounded by Chargola of Karimganj districts towards north, Kalibari bazar towards east Basantapur and other villages towards south and hillocks of Dhohalia hill range and villages towards west. There are around twenty four villages in the neighbourhood of the beel.

The ecology of this region has direct influence on life and livelihood of the people of Sone Beel and its surrounding localities. Ecological situation of this region couple of years back was not similar with the contemporary situation. Sone Beel is connected with two major rivers of the valley namely Singhla and Kochua. Other small rivers and cannels are also connected. But the river Singla contributes almost eighty percent of water of Sone Beel. Depth of river Singhla is gradually decreasing due to deforestation, soil erosion and land sliding in the hills of Mizoram from where it originates. Consequently low lying land of the river basin including Sone Beel is getting filled with sand and humus. Flood caused by overflow of river water in summer was a major problem of this region few decades back which was partially controlled by government through embankment and other alternative measures. From 1998's onwards severe flood caused by overflow of river water is not witnessed by people of this locality (Das and Bhattacharjee, 2015)[20]. But the problem which most of the people of southern part of Sone Beel have been experiencing since recent past is problem of water logging in the cultivable field during summer. Rain water gets logged due to mismanagement of cannels by local people and lack of maintenance of river embankment. Depth of Sone Beel is decreasing day by day due to several

[20] Das, S., & Bhattacharjee, J. (2015). Climate Change and Livelihood Problem of Fishing Communities who are living in largest wetland of Assam named as Sone Beel. *European Scientific Journal,* 1, 27-36. http://eujournal.org/index.php/esj/article/view/5710/5516

reasons. Siltation is one of the major factors followed by dumping of garbage and disposal of sewage which causes reduction of depth of the beel. Huge amount of sand and humus is getting deposited by the river Singla in the beel. Moreover, due to shortage of rainfall, water does not remain in entire beel throughout the year. During winter water level reaches to the deepest part of the Beel and the upper part becomes a vast cultivable land. There are number of small Beel fisheries in the deepest parts which do not remain common property of fishermen in winter. These small beels fisheries are either government fisheries or private fisheries under possession of wealthy people of the region. Government Beel fisheries are under control of an organization named as Sone Beel Fishermen Co-operative Society Limited (SFCSL). The registered members of this organization can fish anywhere in the government Beel fisheries. SFCSL takes lease of the Beel fisheries from Assam Fishery Development Corporation, government of Assam during the dry season or winter months. In summer season the entire Sone Beel is filled with river water which flow-in from adjoining areas, and the entire Sone Beel becomes common property of the fishermen. Fishing is now a seasonal occupation for most of the fishermen. They search for other alternative occupations during dry season.

Due to changing ecological situations, flora and fauna are getting extinct day by day. Different variety of fish, for which Sone Beel was popular in the locality earlier, are not available now a days[21]. From the field investigation it was found that two varieties of fish locally known as *lacho* fish (cirrhinus reba) and *chapila* fish (gudusia chapra) are hardly found now. Variety as well as the quantity of fish is gradually decreasing. Bushes of plants were visible earlier but these are not available now a days. Varieties of grass were available earlier for which the farmers from distant places used to

[21] Op. cit. pp. 31.

migrate temporarily with their cattle and buffalo in dry seasons. But now grass is not available like earlier times and migrants do not come for rearing cattle in the field. Trees named as hijol (baringtonia actangula) were available in huge numbers throughout entire Sone Beel but these are very rare now. Migratory birds particularly Siberian birds used to visit Sone Beel during winter but these are hardly found at present.

1.6.4 Fishery Co-operative Society

In Assam, there are a total of 261 primary level Fisheries Co-operative Societies and under Karimganj district there are two Fisheries Co-Operative societies[22]. Sone Beel Fisherman's Co-operative Society Limited is one of the most remarkable fishing societies in Assam. This society, located in Karimganj District was registered on 14th February 1975 under Co-operative Societies Act, 1949 (Assam Act I of 1950). Sone Beel Fisherman's Co-operative Society Limited covers eight Gram Panchyats (GP). These are Anandapur, Gamaria, Nagendra Nagar, Bhairav Nagar, Nayatilla, Gandhi Naghar, Baruala, Sailo Nagar. Among these, the three most important GP's from the point of view of fishing concentration in this area are Anandapur, Gamaria, Nagendra Nagar. This society consists of 4934 registered fishermen (share holders)[23], till date (2013) who are dwelling in the adjacent village of Sone Beel. They belong to traditional fishing community. Fishing is the major or in many cases, only source of income for majority of the residents of this region. To be a shareholder of this society they are required to register their name under this society. The society is constituted by some group of members that includes statutory positions like the President, Vice President, Secretary, and other official stuff. The members are elected by the

[22] Director Fishery Department, Assam, http://fishassam.gov.in/doc/Fishery%20%20co-operative%20societies.pdf

[23] The information was collected from the secretary of Sone Beel Fishery Cooperative Society Ltd. during field survey.

shareholders for a period of three years. An annual meeting is held by the society members every year for the purpose of better management of the society.

With regard to fishing, the entire year is divided into two seasons – peak season and slack season. During peak season the wet land acts as a catchment area and hence water volume rises many folds. During peak season the fishermen are allowed free access to fishing and therefore are motivated to have maximum haul or catch as because no fishing permits are required during this period. During the peak season some major techniques of fish catch are applied.

However during slack season the water body shrinks in size this is mostly happen during September to May in every year, fish stock is limited and the area under water is partitioned into a number of segments or sub-areas. The maximum length (L) and breadth (B) of the wetland at Live Storage Level (LSL) were measured as 12.5 km and 3.9 km respectively (June-September), the average depth of the wetland was found to vary from 0.07 to 5.69 meters. Interestingly, these values reduce to 4.07 km and 2.22 km respectively (November-April) at its Dead Storage Level (DSL), where the most of this area comes under the paddy cultivation. However, at DSL, when the water spread area of the Beel shrinks, and the Beel becomes shallow, intensive fishing activities are restricted mainly to eight distinct deeper 'Fishing Centre', which are locally called '*Bundhs*'. Every year, at DSL of the Beel, these '*Bundhs*' are leased out principally to the Kaibarta fishermen living around the Sone Beel, who fish in the '*Bundhs*' mostly during the period November to April. Such *Bundhs*, lying at deeper portions of the Beel at DSL, are generally kept encircle with bamboo mat (locally called '*Khati bundh'*), of height varying from 2.0-8.0 m; and, fishes are captured and marketed regularly, as required, during the entire period of operation. Part of the culture fish be sold as earning, rest be released into Beel to replenish stock. There are

almost 24 fishing areas which are located for fishing convenience. Free or open access fishing is not allowed during this period. These partitions or sub-areas vary in size from around 0.7 bigha to 4 bigha (Kar, 2007). During the slack season the common property fishing grounds have been leased to Sone Beel fisherman's cooperative society at some 5 to 6 lakh rupees as lease[24]. The cooperative society fully monetizes and manages this fishing ground in different sub areas. Small groups of fishing teams take fishing permits from the society. Therefore leasing public water body to cooperative society puts restrictions on the rights of access or fishing entitlement of traditional fishermen during slack season or winter months. According to the secondary information, in Assam, the Beels are under the control of the Revenue Department (Settlement). Since 1977, a substantial number of Beels have been handed over to the Assam Fisheries Development Corporation (AFDC) for maintenance. Under the present system of management both the Revenue Department and AFDC lease out the Beels for a period of five years at a time. The prime objective is to earn revenue for the State's exchequer.

1.6.5 Classification of wetlands in Assam

'Wetlands' are, thus, basically 'wet- lands' where the soil is saturated with water for sometime during the year. According to IUCN (1970), wetlands are areas of marsh, fen, etc., temporary or permanent; natural or artificial mass of water, the depth of which generally does not exceed 6 m. Wetlands are areas which contain substantial amount of standing water and little flow. In Assam, and in adjoining regions of

[24] Information was collected from the secretary of Sone Beel Cooperative Society limited during the survey.

Tripura and Bangladesh, three kinds of wetlands are generally found. They are as follows (Kar, 2007)[25].

(a) 'Beel': Perennial wetlands which contain water throughout the year.

(b) 'Haor': Seasonal wetlands which contain water for some period of the year only, particularly, during the rainy season. As such, they are also called `floodplain wetlands'.

(c) 'Anua': These are peculiar river-formed perennial oxbow-type wetlands which are generally formed due to change in river course and which may or may not retain connection with the original river.

1.6.6 Fishermen in Sone Beel

Fishermen belonging to four principal communities have been recorded in the 39 villages around Sone Beel (Kar, 1990, 2014)[26]. These are the 'kaibarta', the 'Patni', the 'Maimal' and the 'Namasudra'. Briefly, the three categories of fishermen are:

- Occasional fishermen: the take resource to fishing only when an occasion arises or when the situation compels. Such categories of fishermen are prevalent in Sone Beel generally during the dry days when the fishing sites are easily accessible on foot.

[25] Kar, D. (2007). Fundamentals of Limnology and Aquaculture Biotechnology, vi+609, Daya Publishing House (New Delhi), ISBN: 81-7035-455-2

[26] Kar, Devashish. (1990). Limnology and fisheries of lake sone in the Cachar district of Assam India. Retrieved from http://hdl.handle.net/10603/68289.
Kar, Devashish. (2014). Application of GIS for the study of the Fish Diversity and Habitat Parameters in the Wetlands of Barak Valley with special Emphasis on Sone Beel; The Biggest Wetland of Assam. Lake2014; Conference on Conservation and sustainable Management of Wetland Ecosystems in Western ghats.
Retrieved from http://wgbis.ces.iisc.ernet.in/energy/lake2014/proceedings/7_Kar_Lake%202014-R.pdf

- Part-time fishermen: this non-nomadic group of fishermen constitutes 15 percent of the fisher-folk population of Sone Beel. They fish only during part of a year and consider this activity as equal to or inferior to other activities of the group.
- Professional fishermen: this is the largest group among the fishing communities in Sone Beel constituting 70 percent of the total fishermen population around the Beel. Both poor and rich fishermen belong to this group. They fish throughout the year with the help of diverse types of fishing gears and devices without any restriction or reservation of fishing sites.

Fishing is considered to be the only important occupation by the people of Sone Beel even though it is largely a seasonal occupation. There are about 45 varieties of fish that are caught by the fishermen in the Sone Beel. Generally, some of the varieties are available only during the peak fishing season (mid September to mid May) while the other varieties are found all the year round though in fewer quantities. Some of the varieties like *kanduli* (Notopterus notopterus), *mirga* (Cirrhinus mrigala), *bhakua* (catla catla), *sol* (Channa striata), borali (Wallago attu) and *chital* (Chitala chitala) are available only from September middle to mid May. The Kaibartas of Sone Beel follow the Hindu calendar for various fishing activities. The Kaibartas depend on the fishing implements and the beel (natural large wetland). Each individual family possesses their own required fishing implements. The Fishery Co-operative Society of the village also provides boats and fishing nets to those fishermen who cannot afford to have of their own. While fishing gear is purchased but repaired by the fisher folk themselves, boats are constructed by carpenters. Equipment and accessories such as yarn, hooks, etc. are sold in shops which are rarely run by members of the fisher folk community. The Kaibartas of Sone Beel employ different fishing techniques such as traps, nets, fishing by rod and line and so on. The simplest type of trap used by them

is the polo (cage trap) made of bamboo strips. It is generally used in knee-deep still water usually in the beels. Fishes hidden in the mud are usually caught by this trap. Sometimes an artificial dam is prepared in shallow running water leaving a small passage. The fisherman places a chepa (valve trap) at the passage where the fishes exist and blocks the open mouth of the trap, placing the valve against the current of water. The fishes are lured into the trap with the water and are trapped. Nets are generally of various types and the fishermen of Boripara use nets mainly during their peak fishing season. Gill nets are of three varieties, puthilangi, garelangi and kawoilangi. Handnet (haatjaal) is also used to catch fish in shallow water. Dip net (dhekijaal) is a variety of hand operated net but it is used in deep water. Cast net (acharajaal) is large and can cover a huge area. Other implements used by them are rod and line (borhi), basket trap (jakoi) and fishing basket (khaloi).There is another indigenous method of catching fish among these fishermen. During the months of July and August when fish becomes scarce, they catch fish in the paddy fields and inland pool. The fishermen attach earthworms to hooks tied in ropes. These ropes are laid out in the paddy fields or inland pool and small fishes that come to eat those earthworms are caught by the hooks.

1.6.7 Fishing gears and Fish Catch Methods in Sone Beel

Use of improper gears for fishing can hamper the fish population and potentiality of the Beel cannot be utilized properly. Keeping these in mind, the study conducts a detailed survey about different type of fishing gears and instruments used in fishing. The impact of these fishing gears in the fish population will be determined at the same time.

A diverse range of fishing gears and methods have been evolved over a long period of time by the fishermen of Sone Beel to capture a wide range of fish species. Various

fishing gears are applied for the catching of fish in the Beel. The fishermen select the fishing gears according to the situation. But most of the fishing gears are of primitive type. The total potentiality of the Beel can be enhanced by applying the modern fishing gears.

Fish Catching Devices in the wetland of north-East India (Kar, 2013); the various types of fishing gears used in Sone Beel are given below.

- Hook and line gear: Lar barshi, Kupa barshi, Tanga barshi;
- Traps: Dori, Gui, Paran, Khati bundh
- Trawls: Chhat jal, Pelain
- Scooping gears: Dheki jal,Dorar jal, Kuchrung jal
- Entangling gears: Patan jal, Haran jal
- Encircling gears: maha jal, Dal jal, Chat jal, Ghuran jal, Jhaki jal, Rekh jal, Tana jal.
- Miscellaneous types of gears: Arar jal, Fal jal, Impoundment, without bailing vessel (locally called 'Debli'), Dhagamara.

Of the 24 categories of fishing gears recorded in Sone Beel, all but Pelain could be regarded as belonging to commercial types. Notwithstanding the above, seasonality in operation of some of the types of gears is of special significance. The monsoon varieties include the chat jal, Dorar jal, haran jal, kupa barshi, Tanga barshi, Gui, Paran, Dal jal, Rekh jal, Arar jal and Fal jal are the gears which are operated mainly during the winter. Dheki jal, Chat jal and Ghuran jal are seen in operation during both monsoon and dry seasons. Indeed, the Lar barshi, Dori, Pelain, Kuchrung jal, Patan jal and Jhaki jal has no seasonality and are found in use throughout the year. Some of the traditional fishing gears used by the fishermen are briefly described below.

Fishing lines

Fishing lines are widely used in traditional fisheries. Main principle of capture fishes is based on the feeding behavior of the target species. Fishing rods are locally known as “Borshi” which consist of a lone and slender bamboo rod slightly curved at the tip. Fine cotton or nylon thread with a hook is tied at the curved tip of the bamboo rod. Also floats are tied in nylon thread and bait generally consists of earthworms, small fishes, insects etc.

Fish hooks (*Borshi* and *lar*)

Besides these fishing gears, fishermen in sone beel use hooks and fish gorges locally known as *Borshi* and *Lar* (fig. b) for catching fishes at the household level. In *borshi*, the hook containing bait is attached to a bamboo pole in hanging position via a cotton thread, whereas in *Lar* it is at the end part of long jute threads and is operated from boat only.

Dori and kathi

Dori and kati which are shown in (fig. b) it is most commonly used during monsoon period. It is cylindrical shaped sieved bamboo trap, tapering at both ends. It is 0.6 to 1 meter length. It is placed in fast moving down small canal. It does not require any manipulation by hand. Some of these gears have valves at one end. When fitted to gentle water current, fish enters through the valves and get trapped inside the gear. They have to be kept along the water current. *Doris* are mainly fitted between the *kati band* (fig.a) with maintain some gaps. This type gears capture a very small size of fishes.

Lift nets or Bhelka Jal

These are the nets, shown in (fig.e) where fish swims or are maneuvered over a flat or bag like piece of netting and are then caught by lifting the net. It is a triangular lift net fixed with bamboo poles operated from a bamboo platform built along the canal that brings in or drains out water from a beel or in a floodplain area with gentle flowing water.

Cast net

Cast net it is a large circular type of net which is used to catch large and medium sized fishes. It is made up of cotton or indigenous fiber. It's look like an umbrella type. A strong cord is attached to the apex of the bell shaped net and a number of iron balls are fixed all along the margin. The mesh size of the net ranges from 1 cm. to 2.5 cm respectively. It is mostly used throughout the year in the Bekis River.

Berjal

It is a large rectangular seine net as surrounding net is also known as *maha jal* (fig. j). The method of operation is very much similar to that of mahorijal. The net is shut in a semi circle with the shore as based and is hauled up on to the land by gradually pulling in either end. Two boats each of which carries half of the net do the paying of the net. The boat proceeds to an appropriate distance from the shore turn to both side and raw towards the shore, simultaneously realizing the net. The net is then hauled up and the catch is collected at the middle point of the net. Operation of Berjal required 10-15 fishermen along 2 boats. The catch composition comprises mainly the surface and column feeders like Labeo spp., Cirrhinus sp., Mystus spp, Channa spp., Wallago attu, Ompok spp. and Rita rita.

Phansijal

Phansijal is a common gill net. Phansijal nets are rectangular nets which are provided with head and foot edges. This small meshed drift net is more effective in entangling the fish. Its length varies from 100 m while the breath from 0.5 to 1.5m. Smaller bamboo sticks are used as floats while burned clay are used as sinkers. It is thrown over the water particularly from one shore to another. Sometimes the net is tied against the current and allowed to drift over night. Fishes gets entangle in the net by their operculum.

These fishermen carry their fishing operations in the Sone Beel about 3 and 4 km respectively, away from the village. There are 20 individually owned fisheries in Sone Beel. Generally, the fishermen start for the Beel in the evening so as to reach there in time. On reaching, they fix the nets and sleep. Getting up at midnight they haul the nets, mend the holes if necessary and fix it again. When the net is fixed they eat their meals consisting of rice and fish either cooked at home or cooked on the banks itself. In the morning they haul the net and return to the shore with the entire catch of the two hauls. As soon as they reach the shore, the men go home for bath and meals while the other members of the household or group carry the catch home and hand it over to the women. They spread the used nets for drying, replacing them with fresh ones.

Two or three fishermen belonging to different families would then share a boat and carry these ropes and leave them in water either in the inland pool or in paddy fields, which are filled, with water. Later, fish caught is then equally distributed among the different members.

Production among the fishermen of the study area generally means their daily and seasonal catches. These catches range from low catch, average catch to big catch. During the peak fishing season, that is, mid May to mid September, the fishermen's

catch range from big to average. During these big catches fishes like *rou, kos, borali, mirga, sol*, etc., are caught. On an average catch, they catch fishes like *rou, goroi, kawoi, magur, singora, baami* and so on. When they catch *moa, dorikona, saleconi, puthi, tora* and so on their catch is low. In Sone beel, the big catches for a single vessel generally range between 150 to 200 kg per day. On an average the catch ranges from 80 kg to 100 kg. However, it is observed that low catch does not exceed 80 kg per day when fish becomes scarce during the slack season, i.e., from October to March.

Traditional fishing gears used by the fishermen in Sone Beel

Fig.(a) Khati bundh.

Fig. (b) Lar barshi

Fig. (c) Dori and Khati

Fig.(d) Sailing boat

Fig. (e) Bhelka jal (lift net)

Fig.(f) Pelain

Fig. (g) Jhaki jal

Fig. (h) Ghuran Jal

Fig. (i) Fishing boat

Fig. (j) Maha jal

Fig. (k) Boat landing site

1.6.8 Standard Techniques of Fish Catch in Sone Beel during Peak Season

Fish are caught by the fishermen operating under the co-operative society by applying the following principal methods although few other methods are also in vogue.

(i) Single boat with single catcher

(ii) Single boat with two to three catchers

(iii) Paired boats with six to eight catchers

In first method of fish catch with single catcher and a single boat, is mainly practiced during all seasons. A single fisherman takes some traditional fishing equipment and spends at least 4 to 5 hours in fishing every day. The second method is also practiced with the help of traditional fishing equipments. One man covers a particular area by pulling the net and encircling a region depending on length of the net. The other two men involve in catching fish just after making encircling. This method is mainly practiced during the peak season only, when the water volume is maximum and the catchment area is flooded. Further, fishermen make a group of six and take a couple of large size boats. They use the two boats to encircle a curvilinear distance of around 500 to 1200 meters. The net used in this method is covering a large size. This technique involves a huge cost per unit labour effort and thus is practiced by only the financially capable fishermen.

Finally, the fourth method is the largest method of fish catch by size of the scale of operations in this region. This is also applied during peak season only. It requires 6 to 8 member even may go up to 12 members with two mechanized boats and big size drag net that covers entirely a big areas of the water body. It covers an area of around one square kilometer. The way of fish catch is very similar to method described

previously. Most interestingly no weighing of the fish catch is done by the fishermen after fishing. Hence pricing and valuation methods are vague and primitive.

1.6.9 Government Restrictions on fish catch related issues in Assam

(a) Restrictions on the use of nets

According to Assam Fish Seed Act, 2005, (Assam Act No. XIV of 2005)[27] there are certain restrictions on the use of nets and restriction on fishing during breeding season on catching and selling of under sized fish are instructed under different rules. These are highlighted below.

Rule no 23.

(1) The use of Berjal/Mahajal or Fasijal or any type of net with meshes less that 7 cm. bar/ 14 cm mesh is prohibited during breeding season beginning from the first day of the month of April and ending on the fifteen day of the month of July, both days inclusive, in any proclaimed fishery.

(2) The use of net with less than 1 cm Bar/ 2 cm. mesh. Mosaijal in size is prohibited in any fishery throughout the year.

(3) The department of Fisheries, Government of Assam instructed to Officers of the Fishery Department (not below rank of Fishery Extension Officer) shall have access to any records, register, document, or any other materials including craft and gear of the lessee and have the power to seize them if any breach of rules is detected during the course of inspection and can impose a penalty to the extent of Rs. 500/- or as fixed by the Government from time to time.

[27] Department of Fisheries, Government of Assam. Retrieved from http://fishassam.gov.in/doc/prohibitedgears.pdf

Bana with less than 7 cm. sq. gaps fixed at the mouth of Beels or Dobas or at the boundaries of River Fisheries by which water is drained out it permissible to be used only during fishing season excepting the period between the first day of the month of May and the fifteen day of the month of July of the year, both days inclusive."

(b) Restriction on Fishing during Breeding Season on Catch and Sale of Under Sized Fish

Rule no 23 A.

(1) Catching of brood fish (fish carrying eggs and sperm) of the following species, namely-Rohu, Catla, (Bahu), Mrigal, Mali (Calbasu), Chital, Kharia, Pithia (Mahasol), Gharia and Kuri (Gonius) is prohibited during season beginning from the first day of the month of May and ending on the fifteen day of the month of July, both days inclusive, in any proclaimed fishery.

(2) Catching and killing, by any method, of fish for any purpose whatsoever including consumption and selling of under size fish of the following species, namely- Rohu, Catla, Bahu, Mrigal, Chital, Kharia, Pithia (Mahasul) Gharia below 23 cm in length and Mali (Calbasu), Gonius, Kurhi/ Bhagan below 10 cm in length is prohibited between the first day of August and 31st of October[28]: Provided that the above restriction may be relaxed by the order of the Directed of Fineries in writing, for piscicultural purposes only.

(3) All under sized fish specified in sub-rule (2) above caught in the nets shall either be let off into the fishery or supplied to the Fisheries Department by the lessee in live conditions at the rate to be fixed by Government from time to time.

[28] Department of Fisheries, Government of Assam. Retrieved from http://fishassam.gov.in/doc/rESTRICTED_FISHING_SEASON.pdf

Rule No 24

No movable Bana with gap less than 7 cm sq. shall be used for fishing between the first day of the month of May and the fifteen day of the month of July, both days inclusive, in any rivers, Dobas or Bees or Fisheries." Bana with less than 7 cm. sq. gaps fixed at the mouth of Beels or Dobas or at the boundaries of River Fisheries by which water is drained out it permissible to be used only during fishing season excepting the period between the first day of the month of May and the fifteen day of the month of July of the year, both days inclusive.

1.6.10 Marketing of Fish in Sone Beel

In Sone Beel marketing of fresh fish is done in two ways, fishermen sell fish caught as soon as the catch is brought to the fish landing sight and sorted out in different sizes. Fishermen sort out the salable fish and other big fishes in the fish containers. A new set up for the management of market transactions related to fish catch that includes auctioning and bidding (called *Machher Arath*, i.e., the whole sale trading and transactions place) was formed in July 2012. Under this newly formed institution, fish catchers and sellers sell their daily catch indirectly through a formal bidding system. The number of fish auctions observed in the landing sites are 3 to 4 and this number fluctuates depending on the season. However, only 2 – 3 auctions are found to be active and functional on a regular basis. It was further observed that this system of fish bidding helps fishermen to get better prices for their daily catch. However, catchers are charged with five percent of the value of their daily catch as fee on account of participation in the organized bidding under the *Machher Arath*. There are local fishing entrepreneur and fish sale commission agent. In return fishermen provide their catch to the commission agent. The commission agent sells the fish in an open auction and takes 5 percent of commission from the fish value. In the same time,

commission agents also became beneficiary by their trade. Then the total revenue are distributed equally among the team catchers except those cases where owner of the boat team who take 60 percent of the total shares. In this study it is found that there are 65 team catchers where boat owners (also skipper) in the team get the larger share of total fish value. The other sections of the fish sellers of Sone Beel who purchase fresh fish from the fish sellers through fish auctioned are proceed to their respective places for sale. Sone Beel can be approached from either the district of Karimganj or Hailakandi, the nearest major urban location being the district Head Quarter town of Hailakandi. Hailakandi town is located approximately 20 km to the east of the Sone Beel and is road-way connected. Due to the proximity of Hailakandi town, majority of fish caught in the Sone Beel is marketed in Hailakandi and Silchar district.

1.7 Theoretical and Conceptual Framework

To begin with let us consider a production function of the form $Y = F(x_1, x_2)$ where a single output is being produced with the help of two endogenous inputs. Specifying the exact form of the production function we proceed to collect data on the inputs and output measured in suitable units. We may use ordinary least squares technique to estimate the parameters of the production function and can get the estimated output $\hat{Y}$. The regression residuals or the error *e* is simply the difference between observed and estimated output. That is, $e = Y - \hat{Y}$ and these errors have zero means. In other words some of the residuals are positive, some are zero and others are negative such that they sum up to zero. This is simply because a least squares regression is intuitively an averaging technique in the sense that the OLS estimated regression line on an average represents the scatter (from our actual observations) such that the residuals *e* average out to zero. This directly follows from the first order condition for minimizing the sum of squares of errors.

But does the estimated regression equation satisfy the most fundamental property of a production function? Or else, does the estimated regression equation technically represent a production function? The answer to both questions is 'no'. In an attempt to estimate the production function by the traditional least squares technique, the very definition of a production function is contradicted. The estimated regression line does not give us the maximum output obtainable from a given quantity of inputs. This is because OLS gives us a sort of average such that the least squares regression residuals sum up to zero. Least squares regression does not give us the best practice production function which indicates the ideal situation.

The short fall from the maximum output represents inefficiency on the part of the production unit. Conventional econometric practice attributes departures from the OLS estimated production function to random statistical noise only. This issue is related to the measurement of productive efficiency. Since OLS cannot achieve this, it is necessary to develop a modified econometric approach to the measurement of productive efficiency or inefficiency. Thus instead of estimating the 'function' we must attempt to estimate the 'frontier'. The frontier sets a 'limit' or a boundary to some specific set of observations. The 'limit' may refer to either a maximum or a minimum. More specifically, actual output may fall short of frontier output, actual cost may exceed 'frontier cost' and actual profit may fall short of 'frontier profit'. These are indications of inefficiencies on the part of the production unit. The econometric task is to search for a frontier that envelopes data rather than with functions which intersect data.' In other words OLS estimated regression line passes through the scatter and does not envelop it. It violates the precise concept of a production function which deals with an ideal situation (maximum output given inputs and technology) and not with the average. Evidently, since OLS does not

estimate the frontier or the best practice production function it cannot give the shortfall from the best situation, which is a measure of inefficiency on the part of the firm or the production unit. That is, by how much are firms' output, profit and cost deviating from the desired or the ideal state? The study intends to estimate the deviation of catch from each fishing team's position from the desired (maximum) state.

Econometricians are of the view that the frontier represents the "best practice" technology whereas non-frontier estimation techniques estimate the "average" technology. This view is sufficient if returns to scale, elasticity of substitution etc, which are the important aspects of technology, are different on the frontier than off the frontier. Since, the difference from the frontiers is assumed to be the consequence of the random error (not white random noise) and which is called *inefficiency*, according to Schmidt (1985-86) the frontier function is a "neutral transformation" of the average function. If the features of the technology varying with distances from the frontier can be determined, this will provide sufficient justification for applying frontier approach to measure *efficiencies.* However, the frontier approach is the best approach and updated to become a method of measuring based on microeconomic approach. The non-frontier approach mistakenly interprets the white random noise as the *inefficiency*, the shortcoming which is well overcome in the frontier approach.

The presence of inefficiency leads to four major consequences in the production process. First, it reduces the quantity of output for a given set of inputs. Second, some of the inputs will be either under-utilised or over-utilised. Third, it raises the cost of production. Finally, there will be a loss in profit due to the presence of inefficiency. We classify efficiency into three categories, technical, allocative and scale. Technical efficiency refers to producer's behaviour relating to the production of actual output

relative to maximum possible output with the help of given quantity of inputs. Allocative efficiency is related to producer's choice of optimal input combination. And finally, scale efficiency is a situation of choice of right quantity of output, where price and marginal cost of production are assumed to be equal. For the present study allocative and scale efficiencies are not measured so that measurement of technical efficiency and its non-input and exogenous determinants remain the central theme. The reason for this is the lack of reliable data on factor prices and output prices.

The study prefers the stochastic production frontier approach. According to Timmer (1971, 788) "technical inefficiency is the Holy Grail in this quest". Schmidt (1985-86) pointed that if we remove the effects of differences in certain measured inputs, some firms still produce more or less than others; and this is *inefficiency*, which is inherently a residual concept. However, the accuracy of the measurement of efficiency strongly depends on completeness and correct specification of the model so that the omitted variables become uncorrelated with the included variables. The advantage of the stochastic production frontier is that it includes a white random noise along with a one sided inefficiency random variable in the composed error term and allows statistical testing for the absence of technical inefficiency.

This study applies the above method to measure the level of technical efficiency of a sample of fishing teams in Karimganj district of Assam. More importantly, the influences of a host of non-input (socio-economic) factors on the level of team level technical efficiency are examined in the present study. The objectives and hypotheses along with their economic rationale are explained in detail in the following section.

1.8 Objectives

The objectives of the present study are outlined below. The focal point or focal theme of the study is worth mentioning here. The issues of over fishing or over concentration of catchers in the area due to rapid population growth among fishing households are deliberately kept outside the purview of the present study. The study focuses on the measurement of technical efficiency of fish catch of traditional fishermen across fishing teams with multiple catchers and single or individual catchers and also on how various non-input (socio-economic) factors that are exogenous to the production process, affect the technical efficiency levels in the fishing teams. The studies also examine the economic viability of fishing as a sustainable occupation. The objectives are logically arranged for sake of convenience of the research.

Firstly, to measure the technical efficiency of fish catch of traditional fishermen fishing in the Sone Beel of Karimganj district.

Secondly, to identify selected non-input factors and socioeconomic that influences the technical efficiency of fish catch.

Thirdly, to examine the economic viability of fishing as a sustainable occupation.

Fourthly, to outline policy prescriptions aimed at raising technical efficiency of fish catch and improving overall quality of life of fishing households dependent on the Sone Beel.

The objectives of this research need clarification and discussion. The first objective is most basic. The relative performance, attainment or achievement of fish catch among fishing teams in a cross section (sample) of observations may be appropriately captured by estimating technical efficiency of each sample fishing team with the help

of a suitably constructed production frontier (stochastic in this study). Study area mainly comprise in the district of Karimganj is chosen for this purpose. In this study technical efficiency is measured between multiple catchers team and single catcher team separately. The distribution of team level technical efficiency is then analysed across the different catcher teams. Naturally whether large team sizes are more efficient compared to small teams can be tested once the farm level technical efficiency levels are determined. In other words, whether any association exists between the number of crew members and the level of technical efficiency, may be easily verified.

The second objective addresses an altogether different issue. Technical efficiency varies or fluctuates across teams but this variation in technical efficiency across teams is the manifestation of a host of factors that may be exogenous to the process of production. Factors other than inputs may influence the relative performance of production units (in this case the socio economic variables has been chosen to captures their impact on the fishing teams). For team level efficiency such factors may include the average experience of the fishing teams, average number of years of formal schooling, average non-fishing income at the fishing team level from agriculture and allied activities during slack season, socio-economic conditions prevailing in the fishing household (such as sanitation facilities and housing condition). The aim here is to identify the causes of efficiency variations across teams.

The third objective of the present study is need to be justified in the sense that whether fishing can be considered as a sustainable source of livelihood and can provide a decent standard of living. This is important from the view point of policy analysis. Finally, outline policy prescriptions aimed at raising technical efficiency of

fish catch and improving overall quality of life of fishing households dependent on the Sone Beel.

The study adopts a Cobb-Douglas stochastic production frontier model with inefficiency effects (Battese and Coelli, 1995) the details of which are presented the chapter on methodological issues (chapter 3). The all important hypotheses are presented next.

Hypotheses

The hypotheses considered in the present study are a direct outcome of the objectives and are presented in a logical sequence.

1. Socioeconomic factors do not influence the technical efficiency of fish catch.
2. Income sources other than fishing do not influence the technical efficiency of fish catch.
3. Fishing can be considered as a sustainable source of livelihood and can provide a decent standard of living.

Appropriate statistical and econometric tools are used to test the hypotheses. These are discussed in detail in the methodology chapter.