



International Journal of Fisheries and Aquatic Studies

E-ISSN: 2347-5129

P-ISSN: 2394-0506

(ICV-Poland) Impact Value: 5.62

(GIF) Impact Factor: 0.549

IJFAS 2019; 7(5): 382-393

© 2019 IJFAS

www.fisheriesjournal.com

Received: 16-07-2019

Accepted: 18-08-2019

Md. Abul Kashem

Department of Oceanography,
Dhaka University & Junior
Consultant, National Land
Zoning Project, Ministry of
Land, Bangladesh

Abdullah Al Mamun Siddiqui

Junior Consultant, National
Land Zoning Project, Ministry of
Land, Bangladesh & Institute of
Marine Sciences & Fisheries,
University of Chittagong,
Chittagong-4331, Bangladesh

Md. Atiqul Islam Mondal

Institute of Marine Sciences &
Fisheries, University of
Chittagong, Chittagong-4331,
Bangladesh

Coastal fisheries land use zoning and its potentials of Maheshkhali Upazila, Cox's Bazar, Bangladesh

Md. Abul Kashem, Abdullah Al Mamun Siddiqui and Md. Atiqul Islam Mondal

Abstract

Maheshkhali Upazila under Cox's Bazar District is located between 21°28' and 21°46' north latitudes and between 91°51' and 91°59' east longitudes. Total area of this upazila is 36,234 ha. Land use in coastal Bangladesh is diverse, competitive and conflicting. Agriculture, shrimp farming, salt production, forestry, ship-breaking yards, ports, industry, settlements and wetlands are some of the uses. Land uses have gone through major changes. Land use in the 1950s had been mainly for paddy cultivation, but salinity intrusion and tidal flooding prevented further intensification. The detailed fisheries study has been carried out up to union level to collect all kinds of relevant data, maps, reports and information from field survey using proper tools and techniques. The relevant secondary data on fisheries land uses, satellite image classification and information pertinent to present status of fisheries had also been collected from Department of Fisheries (DoF), BBS and SPARSO suitability and assign it to one or a few specific uses for which the land will technically most suitable and economically viable. To determine present fisheries land use situation detailed experiment study has been conducted through PRA tools like Key Informant Interview (KII) with the related fish farmer, local people.

Keywords: Land use, aquaculture, blue economy, wetland and land zoning

Introduction

Agriculture & Aquaculture is a major sector of Bangladesh's economy and the coastal area of Bangladesh is suitable for growing rice. More than 30% of the cultivable land in Bangladesh is in the coastal area. Out of 2.86 million hectares of coastal and off-shore lands about 1.056 million ha of arable lands are affected by varying degrees of salinity. Farmers mostly cultivate low yielding, traditional rice varieties during wet season. Most of the land remains fallow in the dry season (January- May) because of soil salinity, lack of good quality irrigation water and late draining condition (Karim et al., 1990; Mondal, 1997 and SRDI, 2001) ^[1, 2, 3].

The state of world fisheries and aquaculture 2015, Bangladesh is ranked on 4th in the world in inland fish production by capture and also is ranked 5th in world aquaculture production. Fisheries play an important role in the social and economic life of Bangladesh. It contributes 4.7% to the GDP of the country while providing full-time employment to approximately 1.2 million people. In addition, a very large number of people are engaged in subsistence fishing and in activities related to the fisheries sector. Fish provides 80% of the animal protein intake of the people of Bangladesh. It is also a major earner of foreign exchange, contributing about 10% of the total export earnings and ranking 3rd in terms of importance after the garment and leather sectors. The role of fisheries in Bangladesh in supplying animal protein, in providing employment, in earning foreign exchange and in supporting multifarious ancillary industries at the rural levels is well-known. The fishery-based economy will, no doubt, gain even greater importance in the future. Because of the limitations of capture fisheries and the vast potential for the development of culture fisheries, most of the additional fish production, necessary for domestic consumption or for export will have to come from aquaculture. It is also felt that a large part of the surplus labour could be productively absorbed through the development of aquaculture.

The fisheries of Maheshkhali Upazila consist of inland open water fisheries and fresh water aquaculture. Like other parts fisheries sector of the country, particularly fisheries of Maheshkhali Upazila is a major source of nutrition, income, employment and livelihood support of the local people. Wetlands are among the most fertile and productive ecosystem that

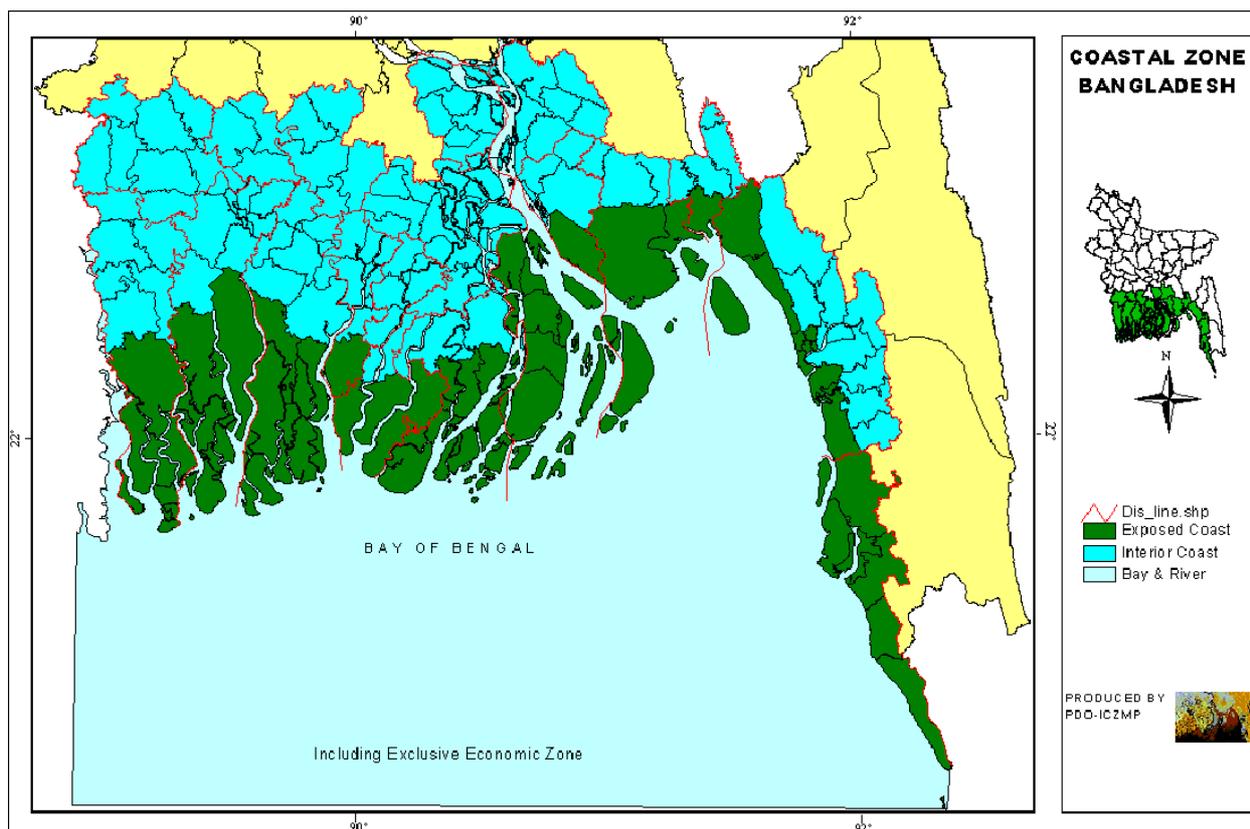
Corresponding Author:

Md. Abul Kashem

Department of Oceanography,
Dhaka University & Junior
Consultant, National Land
Zoning Project, Ministry of
Land, Bangladesh

Support the life cycle of different fauna and flora resources of this upazila area. Land uses in coastal Bangladesh (Map: 1) have gone through major changes over the last half century. The land is intensively used for agriculture, settlements, forests, shrimp ponds (known locally as ghers), water bodies and fisheries, salt production, industrial and infrastructure developments, tourism and preservation and management of environmentally important and special areas. With the continually increasing population, the following features emerge. The prime uses of wetlands are fisheries, aquatic vegetation and navigation. The Maheshkhali Upazila is enriched with open water fisheries which are available in the rivers, khals and floodplain. In Bangladesh, both freshwater

and brackish water aquaculture are practiced. Culture of marine organisms in the marine environment is, however, yet to be introduced. The Bay of Bengal and the associated river mouths are characterized by strong waves, wide tidal and salinity fluctuations, frequent cyclones and tidal bores. The open beaches are strongly surf-bitten. The lack of lagoons, backwaters or other sheltered marine environments is apparently why mariculture has not taken off. The culture practices, capture fisheries management have important implications for food and nutrition in this upazila. Land zoning application is necessary for a sustainable development of fisheries resources to ensure fish production and nutrition security of Maheshkhali Upazila.



Map 1: The Coastal Zone of Bangladesh. (Source: Islam *et al.*, 2006)

Approach and Methodology

The study was conducted in 8 selected unions Bara Maheshkhali, Chhota Mohes Khali, Dhalghata, Hoanak, Kalarmarchhara, Kutubjom, Matarbari, Saflapur and Paurashava of Maheshkhali upazila of Cox'sbazar.

Maheshkhali consists of 36234.01 hectare (Table 1) of land and is located in the center of the northern region of the coastal zone. It is situated on the Bay of Bengal and connected to the Bay Kouheliya River. The most area of Maheshkhali upazila close to the bay of Bengal and mangrove forest which covers of 3775.29 and 4364.90 hectare land (Study of Detailed Coastal Land Zoning with Two Pilot Districts of Plain Land Project under Government of the People's Republic of Bangladesh, Ministry of Land, field survey 2006-2012 and BBS 11, SPARRSO 2013, Table 1). The study area was selected on the basis of the following criteria: (i) the area should have extensive shrimp and fish culture; (ii) the change in the physical environment should be homogeneous and representative of the situation in the coastal areas; (iii) Proper utilization of Blue economic resource (iv) Present status of agriculture and urban land.

The detailed fisheries study has been carried out up to union level to collect all kinds of relevant data, maps, reports and information from field survey using proper tools and techniques. The relevant secondary data on fisheries land uses, satellite image classification and information pertinent to present status of fisheries had also been collected from Department of Fisheries (DoF 2013 and CEGEIS 2013) respectively to develop a data bank for classifying land and water bodies on the basis of fisheries land suitability and assign it to one or a few specific uses for which the land will technically most suitable and economically viable. To determine present fisheries land use situation detailed study has been conducted through PRA tools like Key Informant Interview (KII) with the related fish farmer, local people and government officials.

Information was collected from all unions and paurashava of upazila different government office and respondents belonging to five landowner categories using land-use survey and questionnaire survey techniques. Field observation based on the perception of local people was carried out and recorded documents of relevant studies were examined. Information

relating to the landscape ecology in the past was collected with Retrospective Inquiry System (RIS) techniques and ground truthing was performed with the help of aerial photography and satellite images.

Objectives of the study

- The broad spectrum objectives of the study are:
- To demarcate the suitable areas for both capture and culture fisheries.
- To proper utilization of Blue economic resource
- To analyze fisheries land use change in the past and future.

Review of Literature

History of fisheries land use in Maheshkhali Upazila of Cox's Bazar district zone (Map 1.1) is a significant maritime habitat of ecologically rich and economically important natural resources. Maheshkhali Upazila under Cox's Bazar district lies within the Bio-ecological Zone 8a: Coastal Plains (IUCN, 2002) ^[24] and is unique in its natural vegetation e.g. homestead/community forest and mangrove forest, Jaw forest, Hill forest etc. Moreover, there are huge accreted lands /tidal flats potential for mangrove forestry, grazing and other uses. Maheshkhali is a small island (268 square kilometres) of the Cox's Bazar coast. The island offers panoramic scenic beauty and is covered by low hills and mangrove forests. Adinath, a temple of Shiva, and a Buddhist pagoda are also located in the island which reveals that the upazilla is a suitable place for ecotourism development.

The coastal region, especially the southwestern portion Cox's Bazar district is one of the most promising areas for shrimp cultivation for two major reasons (MOFL, 1997; Karim and Shah, 2001) ^[11, 12]: First, its fresh- and saltwater resources are abundant in almost all seasons; second, the world's largest continuous mangrove forest, the Sundarbans, provides a food source and nursery for the offshore fishery. It is estimated that about 250,000 ha of land has good potential for coastal aquaculture (Ahmed, 1995) ^[13]. About 180,000 ha is suitable for shrimp culture (Khan and Hossain, 1996) ^[14]. Coastal aquaculture increased from 20,000 ha in 1994/1995 to 135,000 ha in 1996/1997, and production from 4000 to 35,000 metric tons in the same period (MOFL, 1997) ^[11]. The rapid expansion of shrimp farm development during the last decade, along with the adoption of extensive and improved extensive culture techniques, has caused growing concern as to its adverse effect on the coastal environment and damage to the traditional agricultural systems. The socioeconomic scenarios have changed rapidly. This chapter aims to assess the effects of the past and current situation as regards shrimp cultivation methods in relation to the coastal environment. In particular, the research aims to identify the inherent potentials and problems, as well as the emerging trends in the causes and extent of land-use changes over a period of time, with a view to understanding the implications for land-use planning and the development of more environmentally acceptable shrimp cultivation methods. Exclusion of these lands from an aquaculture zone could prevent appropriate development,

subject it to inappropriate regulation or restrict access of poor people to opportunities for aquaculture development. Furthermore, zoning may actually be undesirable for encouraging a concentration of aquaculture because of the associated environmental and social impacts. Environmental capacity measures the resilience of the natural environment in the face of impact from human activities. Some assessment of environmental capacity is desirable and is of particular relevance to the problem of cumulative effects. It has been argued (GESAMP, 2001) ^[15] that environmental capacity must be assessed, even if only at the most elementary level, if sustainable development is to have any practical meaning. Environmental capacity (otherwise referred to as assimilative capacity) is 'a property of the environment and its ability to accommodate a particular activity or rate of an activity without unacceptable impact' and must be measured against some established standard of environmental quality. A set of planning interventions in the form of incentives and constraints (planning regulations) will be required to implement the strategy and ensure that objectives are met, standards are not breached and environmental capacity is not exceeded. These might apply to location of aquaculture development, waste emissions and the quantity or quality of inputs used (e.g. food, chemicals).

The shifting rate of agricultural land to non-agricultural use is said to be about 1.0% per year (South Asian Human Resources Development Report, 2003 by UNDP) or over 80 thousand hectare per year (Planning Commission, 2009) ^[21]. BIDS conducted a study to estimate annual conversion of agricultural land to non-agriculture and consequent loss of crop production during the eight year period of 2001 to 2008. Land uses are classified as net cropped area, current fallow, current waste, forest and area not available for cultivation. Along this line, SRDI (Soil Resources Development Institute) produces agricultural land-use maps for the country identifying many different types of agricultural land use.

In the coastal zone also, the population is expected to increase from 36.8 million in 2001 to 43.9 in 2015, and to 60.8 million by 2050 (PDO-ICZMP, 2005a) ^[16]. Present per capita agricultural land of 0.056 ha will decrease to 0.025 ha by 2050. On top of this, about 54% of the people of coastal Bangladesh are functionally landless and more than 30% are absolutely landless. Among the landholders, 80% are small farmers, 18% are medium farmers and only 2% are large farmers (PDO ICZMP, 2004b) ^[17]. These have decisive impacts on major economic and livelihood activities, on land use and subsequently on the quality of land. In 2010- 2011, an estimate was made (Table 1) capturing a broader perception of land use and recognizing seasonal variations (CEGIS & SPARRSO 2013, Field survey 2013). Two complications were identified: areas under river and water bodies increased greatly in the wet season and estuarine/riverine wetlands (known locally as chars) cultivated during the dry season went under water in the wet season. Land use Maheshkhali Upazila of Cox's Bazar district in the coastal zone is diverse, competitive and conflicting.



Map 1.1: (Source: www.banglapedia.org)

Land Use of Maheshkhali Upazila

Land use in Bangladesh is generally determined by physiography, climate and land height in relation to water level (Brammer, 2002) [18]. These together make a highly complex environment characterized by five main land types related to depth of seasonal flooding: 30 or more agro-ecological zones encompassing differences in soils, climate and hydrology; and areas with varying degrees of risk of disastrous floods, drought and cyclones. About 60% of the lands are inundated to a depth of 30 cm or more. The Bangladesh Bureau of Statistics publishes land-use statistics regularly. Along this line, SRDI (Soil Resources Development Institute) produces agricultural land-use maps for the country identifying many different types of agricultural land use.

Land is the basic natural resource that provides habitat and sustenance for living organisms, as well as being a major focus of economic and livelihood activities. Bangladesh has a population of 123 million living on a land area of 147,000 km² (PDOICZMP, 2004b) [17]. The population is increasing and the land is being converted from directly productive purposes, such as crop cultivation, to other uses such as housing, roads and urban development, and this trend is expected to continue. Some of the statistics provide an alarming picture:

- Some 220 ha of arable land is being lost daily to uses such as road construction, industry, houses, etc. (Islam *et al.*, 2004) [19].
- Some 70% of the land of Barisal and Khulna divisions is affected by different degrees of salinity, which reduces agricultural productivity (Rahman and Ahsan, 2001) [22].
- Some 50% of the coastal lands face different degrees of inundation, thus limiting their effective use. This situation is expected to worsen further because of the effects of climate change.

In the coastal zone also, the population is expected to increase from 36.8 million in 2001 to 43.9 in 2015, and to 60.8 million by 2050 (PDO-ICZMP, 2005a) [16]. Present per capita agricultural land of 0.056 ha will decrease to 0.025 ha by

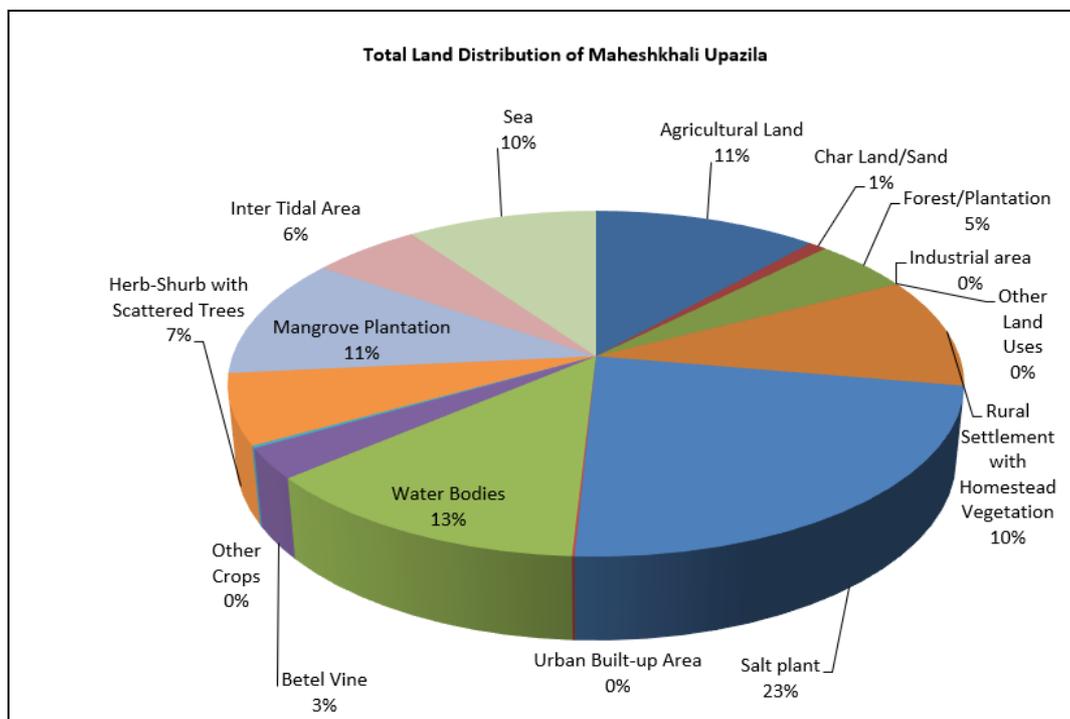
2050. On top of this, about 54% of the people of coastal Bangladesh are functionally landless and more than 30% are absolutely landless. Among the landholders, 80% are small farmers, 18% are medium farmers and only 2% are large farmers (PDO-ICZMP, 2004b) [17]. These have decisive impacts on major economic and livelihood activities, on land use and subsequently on the quality of land.

In 2013- 2014, an estimate was made (Table 1) capturing a broader perception of land use and recognizing seasonal variations (Source: CEGIS& SPARRSO 2013, Field survey 2013). Two complications were identified: areas under sea and water bodies increased greatly in the wet season and estuarine/riverine wetlands (known locally as chars) cultivated during the dry season went under water in the wet season.

In Maheshkhali Upazila agriculture, shrimp farming, salt production, forestry, human habitation and wetlands are some of the uses in an area of only 36234.01 hectare (Table 1) inhabited by 2,56546 people. Land use in the coastal zone is diverse, competitive and conflicting.

Table 1: Total Upazila Summary of Land Distribution

Maheshkhali Upazila (Cox's Bazar District)		
Land Use (Summarized)	Area (Hectare)	%
Agricultural Land	4453.68	11.48
Char Land/Sand	356.12	0.92
Forest/Plantation	1936.30	4.99
Industrial area	2.54	0.01
Other Land Uses	2.42	0.01
Rural Settlement with Homestead Vegetation	4009.52	10.33
Salt plant	8946.38	23.05
Urban Built-up Area	39.52	0.10
Water Bodies	4987.02	12.85
Betel Vine	1118.02	2.88
Other Crops	85.01	0.22
Herb-Shurb with Scattered Trees	2559.06	6.59
Mangrove Plantation	4364.90	11.25
Inter Tidal Area	2170.86	5.59
Sea	3775.29	9.73
Total	38806.65	100.00



(Source: Field Survey 2013, GIS Data from CEGIS & SPARRSO 2013, BBS 2011)

Fig 1: Total Land Distribution of Maheshkhali Upazila

Land Capability Classification

The land capability classification indicates the relative suitability of land for sustained production of common agricultural crops and other uses adapted to the existing physical and environmental condition. Any physical development of the land or physio-chemical changes of the soil may likely to change land capability classes. In that respect land capability classification is an economic evaluation of land. The physical suitability of an area or the suitability of land has a great influence on its multiple uses. It expresses the degree to which the sustained implementation of a land use on a certain land unit is feasible without risk to the

human or natural environment. The physical suitability of land emphasizes on the relatively permanent aspects such as soil conditions, land type and topography, hazards like erosion, drought and socio-economic interventions etc. Different types of spatial and attribute data were used to conduct the land suitability analysis. The land and soil parameters used for this purpose are: Land type, relief, surface water recession, drainage condition, soil texture, soil moisture, topsoil P^H and soil salinity. The different attributes used for the assessment of physical suitability of crops are shown in (Table 2)

Table 2: Bio-physical Attributes for Suitability of Agricultural Crops

	Boro (HYV)	T. aman	T. aus (HYV)	Rabi Crops
1. Land type	High land (HL) to Medium Low land (MLL)	HL to MHL	HL-MLL	HL to MLL
2. Relief	Level	Level	Level	Level
3. Recession of surface ater	Very early to very late	Very early to late	Very early to late	Very early to late
4. Drainage	Moderately Well to poor	Moderately Well to poor	Moderately well to poor	Well to poor
5. Soil texture	Sicl to clay	Sicl to clay	Sicl to clay	SiL-Sicl
6. Topsoil consistency	Firm to friable	Firm to friable	Firm to friable	Friable
7. Soil moisture	Moderate to High	Moderate to High	Moderate to High	Moderate to High
8. Soil P ^H	4.5-8.4	4.5-8.4	4.5-8.4	4.5-8.4
9. Soil salinity (ds/m)	<3	<3	<3	<2

(Source: Coastal Land Use Zoning in the South-West, CEGIS 2005)

Note:

- High Land (HL)
- Medium High Land (MHL)
- Medium Low Land (MLL)
- Low Land (LL)
- Silt loam (Sil)
- Silty clay loam (Sicl)
- Silty clay (Sic)
- Clay (c)

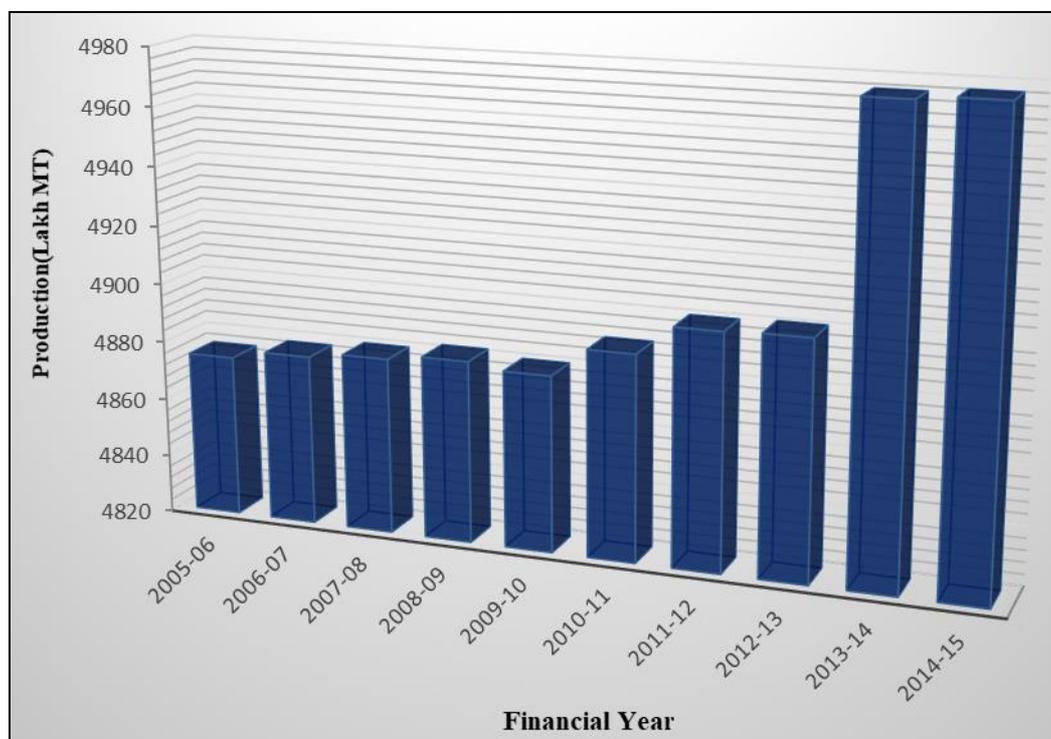
Present Fisheries Status of Maheshkhali Upazila

Bangladesh is among the countries with large number of people vulnerable to the potential impacts of climate change. The extensive coastal floodplains in the lower Ganges-Brahmaputra delta are important for natural fisheries, shrimp farming, agriculture, and other natural resources including the Sundarbans mangrove forest. However, the inhabitants are

already prone to floods, cyclones, salinity intrusion, and seasonal drought, and the incidence of these hazards is rising. Fresh water culture fisheries of Maheshkhali Upazila are present the mainstay of pond aquaculture, gher, canal, etc. Total areas of capture and culture fisheries in Maheshkhali Upazila are 5825.28 hectare and 8615.68 hectare respectively (Table 3). The average fish production of Maheshkhali

Upazila capture fisheries is 320kg/ha and culture fisheries (pond aquaculture) is 3705kg/ha. The fisheries production of Maheshkhali Upazila showed an increasing trend. It was 4875MT in 2005-2006 that was gradually increased to 4976.89MT in 2014-2015 (Figure 1.1). On the other hand, the national fisheries production in 2005-2006 was 22.84 lakh

MT that was gradually increased to 36.84 lakh MT in 2014-2015. Fisheries production in Maheshkhali Upazila increased by 2.09% in last 10 years (2005-2014), where national production increased to 61.30% (2005-2014) only (Source: DoF-2015,*GIS Data from CEGIS 2013 and Field Survey 2013).



(Source: DoF-2015,*GIS Data from CEGIS 2013 and Field Survey 2013)

Fig 1.1: Fisheries Production of Last 10 Years in Maheshkhali Upazila

Productivity status of Maheshkhali Upazila is prospective due to application of scientific technical knowledge about stock enhancement, seed production, and old culture technology, pond management system. Basic inputs like fish seeds, fish feeds and other on-farm inputs are available to most ponds, gher owners. More especially availability of quality seeds is single largest limitation in expansion of aquaculture. But due to two cyclones (known as Aila and Sidr) seriously affected in fishery sector 2007-2010 in Maheshkhali upazila. These natural calamities have been stressful to the already vulnerable livelihood strategies of many poor people: fish catches are declining, and demand for labour has fallen resulting in rural to urban migration. Climate change will exacerbate many current problems and natural hazards due to increasingly frequent and severe tropical cyclones leading to more damage, heavier and more erratic rainfall, resulting in higher river flows, river bank erosion, and sedimentation, melting of the Himalayan glaciers, lower and more erratic rainfall, and sea level rises

(The International Climate Change Strategy and Action Plan 2008,). So should be need demonstration of aquaculture technologies in the farmer's field at the upazila and union level to carry on present productivity status. In conclusion, the present survey has identified that the pond, shrimp farmers, hatchery owners and nursery owners in all, Maheshkhali Upazila are severely affected by climate change. Maximum shrimp farmer said that they are fully unknown to severity of climate change, they cannot market their crops in proper time, they face late PL availability, high price of PL etc. and they

become economically looser. Climate change is inevitably a challenge for fisheries and aquaculture in the region. The aquaculture production has been greatly reduced due to uncertain climate change in the southwest region of Bangladesh.

Fisheries Land Use Distribution of Maheshkhali Upazila

Maheshkhali Upazila is regularly flooded by flash floods from the Bay of Bengal and Kauheliya River. The affected areas remain water logged for a few days after every flood and thus sustain severe damage. The areas are often lashed by cyclones. Landslides are a common occurrence during the monsoon. People blamed increasing siltation of the rivers due to soil erosion, deforestation, faulty agricultural practices, etc., for the land – slides. Riverbank erosion results in substantial losses of people's farming and homestead lands, livelihoods and assets. Besides causing destruction of the physical infrastructure like roads, bridges and market centers, river erosion uproots people from their communities and social networks. Maheshkhali Upazila has a total wetland area of 14440.96 hectare of which 5825.28 hectares are under open water capture fisheries and 8615.68 hectares are under culture fisheries. Land distribution including wetland, wetland distribution of capture and culture fisheries under different union's and Paurashava has been shown below (Table 3).

Kutubjom, Hoanak and Kalarmarchhara unions shows good potential for fisheries production of Maheshkhali Upazila which covers 94.43%, 85.45% and 68.67% of total wetland respectively.

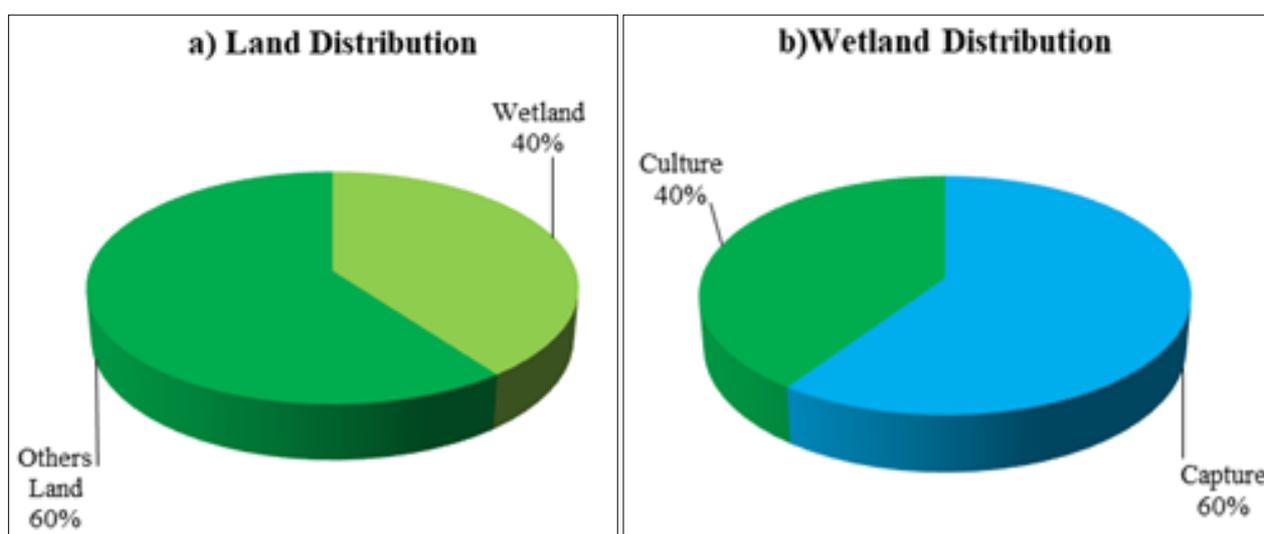
Table 3: Wetland Distribution of Maheshkhali Upazila (Area in Hectare)

Union Name	Union Area	Culture Fisheries		Total Culture	*Total capture (In dry season)	Total Wetland
		Pond culture	Other Fish culture			
Bara Mahesh khali	1500.405	4.92	16.33	21.25	73.61	94.86 (6.32%)
Chhota Mohes Khali	1102.024	30.39	00	30.39	8.27	38.66 (3.50%)
Dhalghata	200	2.46	00	2.46	98.15	100.61 (50.30%)
Hoanak	3722.672	2893.94	00	2893.94	287.21	3181.15 (85.45%)
Kalarmarchhara	2904.453	1827.40	00	1827.4	167.33	1994.73 (68.67%)
Kutubjom	3047.368	2166.74	3.64	2170.38	687.48	2857.86 (93.78%)
Matarbari	2705.263	1305.69	19.42	1325.11	1229.71	2554.82 (94.43%)
Saflapur	13796.36	156.03	00	156.03	3266.01	3422.04 (24.80%)
Paurashava	7255.466	188.72	00	188.72	7.51	196.23 (2.70%)
Total	36234.01	11989.22	39.39	8615.68	5825.28	14440.96 (39.85%)

Source: BBS 2011,*GIS Data from CEGIS 2013 and Field Survey 2013

Out of total area of 36234.01 hectare 40% represents wetland which covers 60% capture and 40% culture fisheries respectively (Figure 1.2 a, b). Generally it varies in dry and wet season. During dry season, situation of water level becomes alarming. As the progressive river siltation occurs,

this reduces the water holding capacity of the water bodies. On the other hand, these water bodies are also dried up quickly in the dry season as they are located at a higher elevation.



(Source: BBS 2011,*GIS Data from CEGIS 2013 and Field Survey 2013)

Fig 1.2 a): Distribution of Land b) Distribution of Capture & Culture Fisheries (1.2 b) Wetland of Maheshkhali Upazila.

Coastal Wetland Status of Capture & Culture Fisheries in Maheshkhali Upazila

Progressive river siltation is causing frequent floods in the rainy season due to reduction of water holding capacity. On the other hand, these water bodies are also dried up quickly in the dry season, which prevents growing of fish throughout the full season. Blockade of rivers and canals by flood protection embankments has seriously affected natural abundance of fisheries. As a result of combined effects of the ecological changes to the wetland, present average production from these water bodies is very low.

Wetland status of capture fisheries area and culture fisheries area also shows comparatively different trend. The capture fisheries were 16143 hectares area in 2005-2006 has been minimum change 16147 hectares during last 10 years but area under culture fisheries area has not been any recorded in 2014-2015 (Fig 1.1). Increasing trend of capture fisheries have been noticed from FGD, KII and general information of fisheries resources of Maheshkhali Upazila due to excellent co-ordination and communication between DoF, BFRI, BFDC, Ministry of Land and NGO's.

Availability of Open Water Capture Fisheries

Maheshkhali Upazila has potential of inland open water fisheries resources that consist of the seasonal water bodies, rivers, natural depressions or beels and reservoir. There are about 11,823 fisheries beneficiaries (Field Survey 2013, DoF 2013) involved in fisheries activities of the upazila. Present field survey shows that, 410 numbers of fish/shrimp farm and annual flooding in the rainy season has inundation area 25% of the total land surface of this upazila. Despite the existence of huge resources the inland capture fisheries have been replaced as top fish producing sources over the years by aquaculture due to decline and degradation of resources. But over a few years aquatic biodiversity especially fish species and other aquatic organism in inland open water have been declined due to natural and anthropological causes. The priority is given to improved biological management that will restrict the degradation of resources and production.

Major native capture species are: Landing centers of this union are also enriched with brackish and marine water fisheries species which have high commercial values in the market (Table 4).

Table 4: Major Native Capture Species Local and Scientific Name

No	Fish Local Name	Fish Scientific Name
1	Taki	<i>Channa punctatus</i>
2	Kholisha	<i>Colisa sp</i>
3	Shoal	<i>Channa striatus</i>
4	Chanda	<i>Chanda ranga</i>
5	Koi	<i>Anabas testudineus</i>
6	Magur	<i>Clarias batrachus</i>
7	Tengra	<i>Mystus tengra</i>
8	Foli	<i>Notopterus notopterus</i>
9	Baim	<i>Mastacembelus spp.</i>
10	Mola	<i>Amblypharyngodon</i>
11	Sarputi	<i>Puntius sarana</i>
12	Pabda	<i>Ompok pabda</i>
13	Gulsha	<i>Mystus bleekeri</i>
14	Bashpata	<i>Ailia coila</i>
15	Etki	<i>Lates calcarifer</i>
16	Bagdachingri	<i>P. japonicus</i>
17	Chagachingri	<i>P. indicus</i>
18	Rakha	<i>Datniodespolota</i>
19	Balay	<i>Awaous grammepomus</i>
20	Datina	<i>Acanthopagruslatus</i>

The commonly found Fish species are: These species are commonly available all the area of Maheshkhali Upazila (Table 5). They are given below:

Table 5: Commonly Found Fish Species Local & Scientific Name

No	Fish Local Name	Fish Scientific Name
1	Ilish	<i>Hilsa ilisha</i>
2	Koral	<i>Lates calcarifer</i>
3	Loittya	<i>Harpadon nehereus</i>
4	Rangachokya	<i>Lutianusjohnii</i>
5	Chhuri	<i>Trichiurus haumela</i>
6	Lakhua	<i>Polynemus indicus</i>
7	Rita	<i>Aurius platytomus</i>
8	Rup chanda	<i>Stromateus sinensis</i>
9	Hangor	<i>Scoliodon sorrakowah</i>
10	Bagdachingri	<i>Penaeus monodon</i>
11	Chagachingri	<i>Penaeus. indicus</i>

Availability of Fish Species

They are *Liza tade*, *Mugil corsula*, *Pomadasys hasta*, *Lutjanus johnii*, *Mene maculata*, *Arius spp.* *Lepturacanthus savala*, *Johnius belangerii*, *Otolithoides argenteus*, *Muraenesoxtelabonoide*, *Polynemus Paradiseus*, *Metapenaeus monoceros*, *Parapenaeopsissculptilis*, *Parapenaeopsis stylifera*, *S. domina*, *S. taty*, *Carangids sp*, *H. neherius*, *C. lingua*, *C. bilineatus*, *S. phasa*, *E. tetradactylum*, *Trichanthu ssp*, *Scomberomorus guttatus*, *S. commerson*, *Rastrellige sp*, *Sphyaena barracuda*, *Nemipterus japonicus*, *Upeneus sulphureus*, *Saurida tumbil* etc. and shrimp species like (*P. japonicus*), etc. In this Upazila Datina (*Acanthopagrus latus*) fish species has been categorized as endangered. The biodiversity of this species could be improved through habitat restoration and establishment of sanctuaries.

Closed Water Culture Fisheries in Maheshkhali Upazila

Fresh water aquaculture is an important component of Maheshkhali Upazila fisheries. The culture fisheries of Maheshkhali Upazila include ponds, nursery, gher and canals and are also gradually coming under culture-based capture fisheries practice. The seasonal water bodies, aquaculture pond and the gher offering tremendous scope and potential for

augmenting fish production by adopting aquaculture based enhancement techniques in Maheshkhali Upazila. It is expected that with the introduction of scientific method of fish culture, the present production will be increased substantially. Currently aquaculture has been practicing in a total area of about 8615.68 ha which cover about 40% of total inland water of Maheshkhali Upazila (Table 6). Culture fisheries comprise pond aquaculture, fish culture in homestead pond and paddy field etc.

Table 6: Major native culture Fisheries Species Local and Scientific Name

No	Fish Local Name	Fish Scientific Name
1	Bata	<i>Labeo bata</i>
2	Grass carp	<i>Ctenopharyngodon idella</i>
3	Mrigal	<i>Cirrhina mrigala</i>
4	Tilapia	<i>Oreochromis Nilotica</i>
5	Silver carp	<i>Hypophthalmichthys Iblis</i>
6	Pungus	<i>Pungassius suchi</i>
7	Rui	<i>Labeorohita</i>
8	Catla	<i>Catlacatla</i>
9	Gonia	<i>Labeo boggut</i>
10	Bagdachingri	<i>Penaeus monodon</i>
11	Chagachingri	<i>Penaeus indicus</i>

Problems of Capture & Culture Fisheries in Maheshkhali Upazila

- Indiscriminate use of destructive fishing gears like currentjal (mono filament twin net).
- The fish species diversity and stocks were under threats of depletion due to indiscriminate and uncontrolled harvesting.
- Indiscriminate harvesting of brood/mother fish during breeding season.
- Deposition of silt in river mouths limits migration of fish to upstream.
- Extensive use of pesticides and agro-chemicals ultimately hamper spawning and damage fish habitats.
- The demand for agricultural production, particularly cereals, encourage attempts to dry out the wetland with a reduction in the capture area particularly beel and its fisheries resources.
- Erratic rainfall, prolong flooding, six month dry season and sandy soil is a major problems for full time aquaculture practices.

Sustainable Development measures for Capture & Culture Fisheries of Maheshkhali Upazila

- Use of destructive gears must be prohibited and current net must be stopped by creating public awareness
- Formulation of coastal land zoning for fisheries areas and its implementation is an immediate necessity.
- Deposition of silt from the river mouths should be removed to facilitate fish migration.
- Reduction of perennial water bodies is due to falling of existing ground water level and land conversion.
- Provision for fish passes should be kept at vital points during construction of roads, sluice gate, cross dam and embankments etc.
- Prohibition law on fish fry collection should be implemented properly.
- Lack of training and on-farm demonstration of improved fish farming practices
- Harvesting of brood/mother fish should be strictly

prohibited during breeding season and provide alternative livelihood.

- Fishermen must be trained on open water resource management for sustainable management.
- Transfer of wetland for other purposes/uses is to be strictly prohibited.

Fisheries Land Suitability of Maheshkhali Upazila

Land soil characteristics of Maheshkhali Upazila are mainly loamy and clay which is better for pond preparation of good aquaculture practices. This type of soil has high water holding

capacity. The soil pH reference value above 5.0 is suitable for fish culture system. According to soil nutrition status and pH, soil can be divided into three categories as high, medium and low productivity rate that shows below (Table 7). Average 2 meter water depth of a pond is suitable for fish culture and 6.5-8.5 pH level is good for optimum fish production. The soil p Hvalue, water quality and land type of medium low land (MLL) of different unions of Maheshkhali Upazila are mostly suitable for both capture and culture fisheries.

Table 7: Land Suitability Matrix for Fresh Water Fish Culture (According to soil nutrition status and pH)

Productivity Rating	pH Level	Nutrition Component Level (mg/kg Soil)		
		Nitrogen	Phosphorous	Carbon
High	7.5-6.5	> 50	6-12	> 1.5
Medium	6.5-5.5	25-49	3-5	0.5-1.4
Low	< 5.5 & > 8.5	< 25	< 3	< 0.5

Socio-Economic Conditions of Maheshkhali Upazila

Socio-Economic conditions depend on income status, alternative income, occupational status, educational status, family size, family type, housing condition, food consumption, nutrition, drinking water facility, sanitation facility of a particular place. Socio-economic issues have to be addressed for the overall development of Maheshkhali Upazila. Over the last 10 years, the socio-economic condition of the upazila is gradually rising. The growing of small & medium industries, business associated with *pointed gourd*, sugarcane, paddy, fish, fertilizer, different types of fruits and vegetables are the key element of socio-economic growth of Maheshkhali. The financial activities are mainly operated through the Sonali Bank, Pubali Bank, Krisi Bank, Islamic Bank, Grameen Bank and Rupali Bank. Nevertheless, there are 13 NGOs are working here for socio-economic boost up by introducing implementing micro-credit, education, nutrition, livelihoods, social awareness health and family planning, water & sanitation, women empowerment program.

Proshikha, ASA, World Vision, RIC, Grameen Bank, Grameen Solti, Buro Bangladesh, CCDB, and BRAC are notable NGOs of this upazila (Field Survey-2013) which are working for the socio-economic development of people of Maheshkhali Upazila. The sources of drinking water are tube well 91.84%, tap 0.46%, pond 01.09% and others 06.61%. About 25.55% of dwelling households of the upazila use sanitary latrines and 56.21% of dwelling houses use non-sanitary latrines; 18.24% of households do not have latrine facilities. Moreover, about 13.34% of the dwelling households have access to electricity. Overall housing condition of this upazila is not so good; maximum houses are made of Tin and Bamboo which is 27.5%, Chun and Mud 17.63%, Semi Building house 17.63%, Tin and wood products 12.5%, Bamboo and Chun 10%, Building house 6.13%, Tin house 5.63%, Machang house.50% and others 2.5% (Field survey 2013).

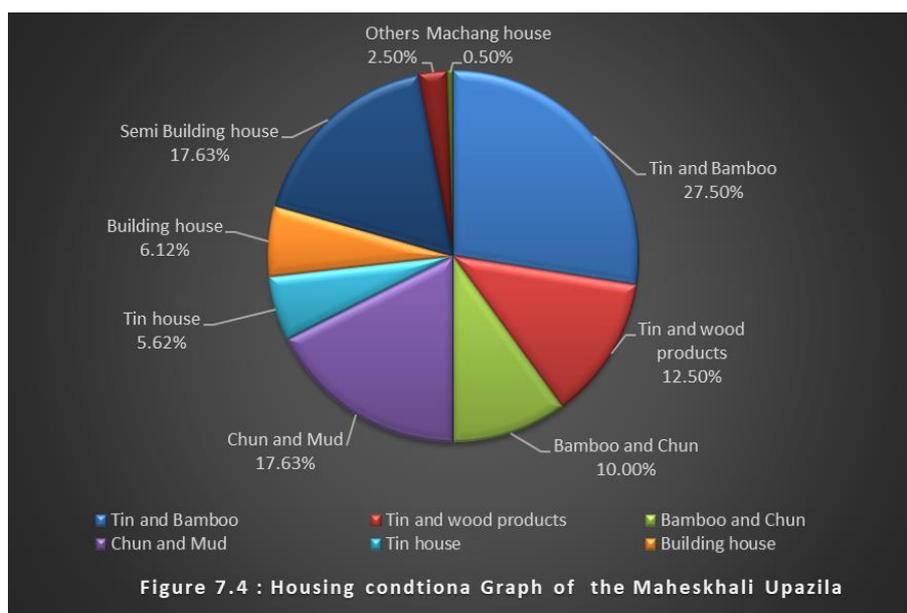


Figure 7.4 : Housing conditiona Graph of the Maheshkhali Upazila

Fig 1.3: The Housing Condition Chart of Maheshkhali Upazila

Although, at present about 34% of the population of this upazila directly or indirectly lives on agriculture, however ownership of agricultural land Landowner 33.23%, landless

66.77% and agricultural landowner in urban is 20.93% and rural is 33.94%. Due to the unplanned industrialization, land degradation, the numbers of landless people is increasing

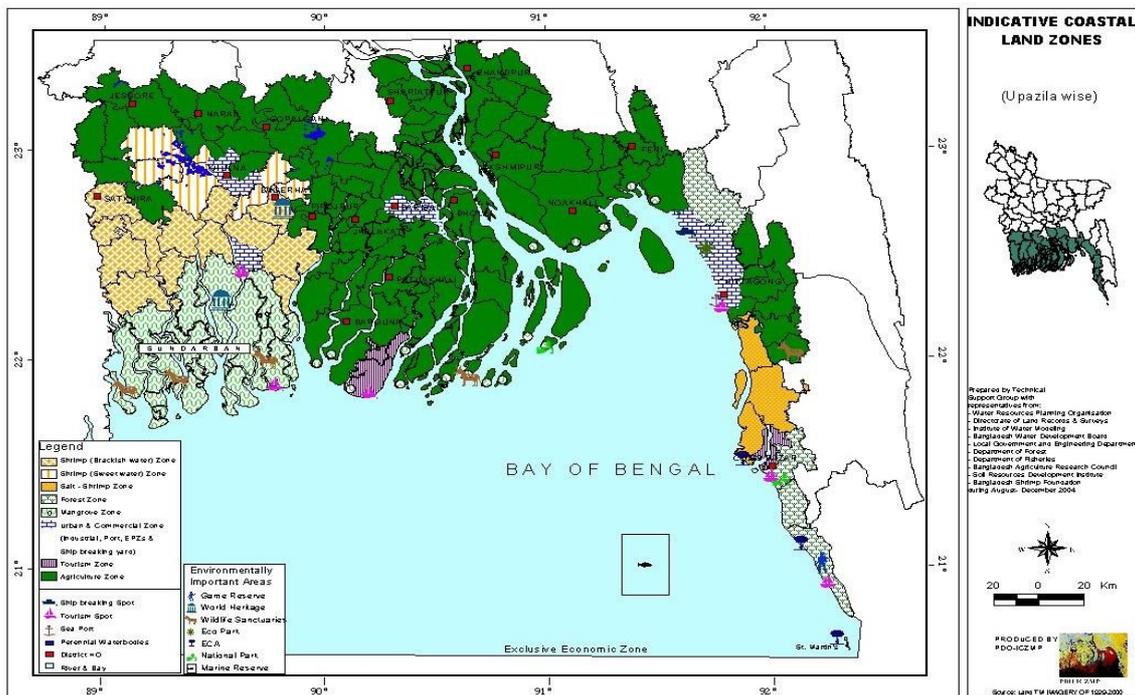
which creates the most adverse pressure on the rural livelihood and economy.

Indicative Land Zones and Fisheries Land use map in Maheshkhali Upazila

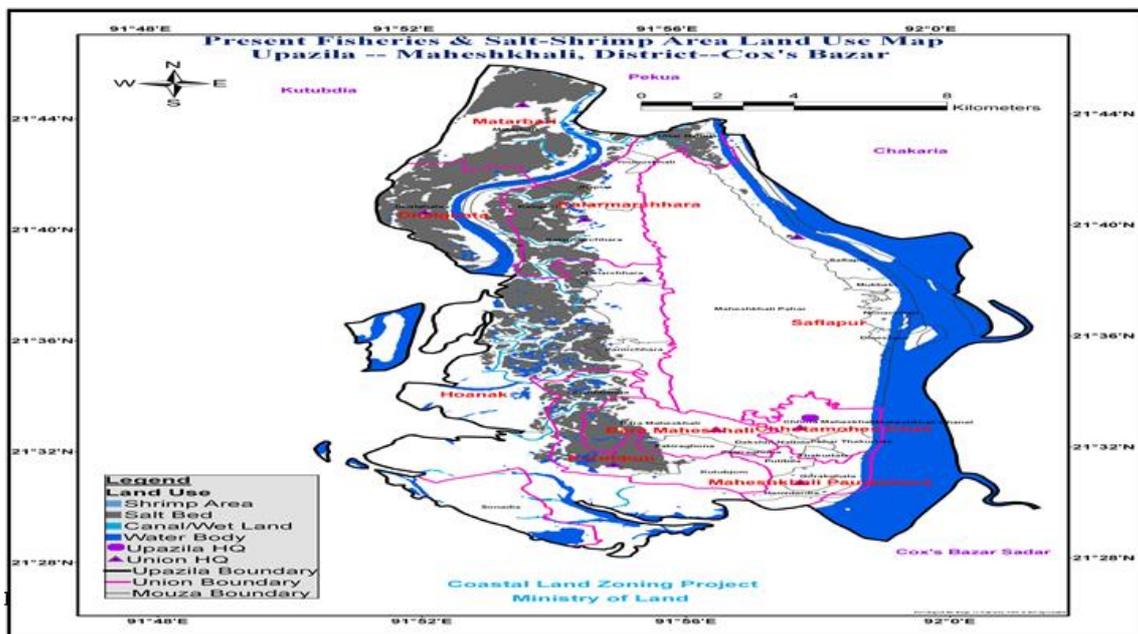
Land is the basic natural resource that provides habitat and sustenance for living organisms, as well as being a major focus of economic and livelihood activities. In Bangladesh, agriculture shares nearly 20% of the gross domestic product (GDP) and 65% of the labor force (World Bank, 2009 as described by Planning Commission, 2009) [21]. It has been reported that because of food demand of the over growing population, a remarkable change in land and water use has been observed after green revolution (Rahman, 2010) [23]. It is estimated that it would be quite difficult to feed the projected increasing population without appropriate management of

natural resources. With the increasing population, the agricultural land is being converted to other uses such as housing, roads and urban development, and this trend is expected to continue. An indicative land zoning has emerged (Map.1.2, PDOICZMP, 2005b), identifying the following eight zones:

- (i) Shrimp (brackish-water) zone
 - (ii) Shrimp(sweet-water) zone
 - (iii) Salt–shrimp zone
 - (iv) Forest zone
 - (v) Mangrove
 - (vi) Urban and commercial zone (industrial, port, export processing zones and ship-breaking yards)
 - (vii) Tourism zone, zone (Including Sundarban) zone and
 - (viii) Agricultural zone
- Results of the indicative land zones have been presented to field-level stakeholders at regional workshops and to policy planners at national workshops. There is now a national consensus on indicative land zoning.



Map 1.2: Indicative Coastal Land Zones of Bangladesh. Source: Islam et al., 2006



Map 1.3: Fisheries Land use map of Maheshkhali Upazila (GIS Data from CEGIS & SPARRSO (2013) BBS (2011)

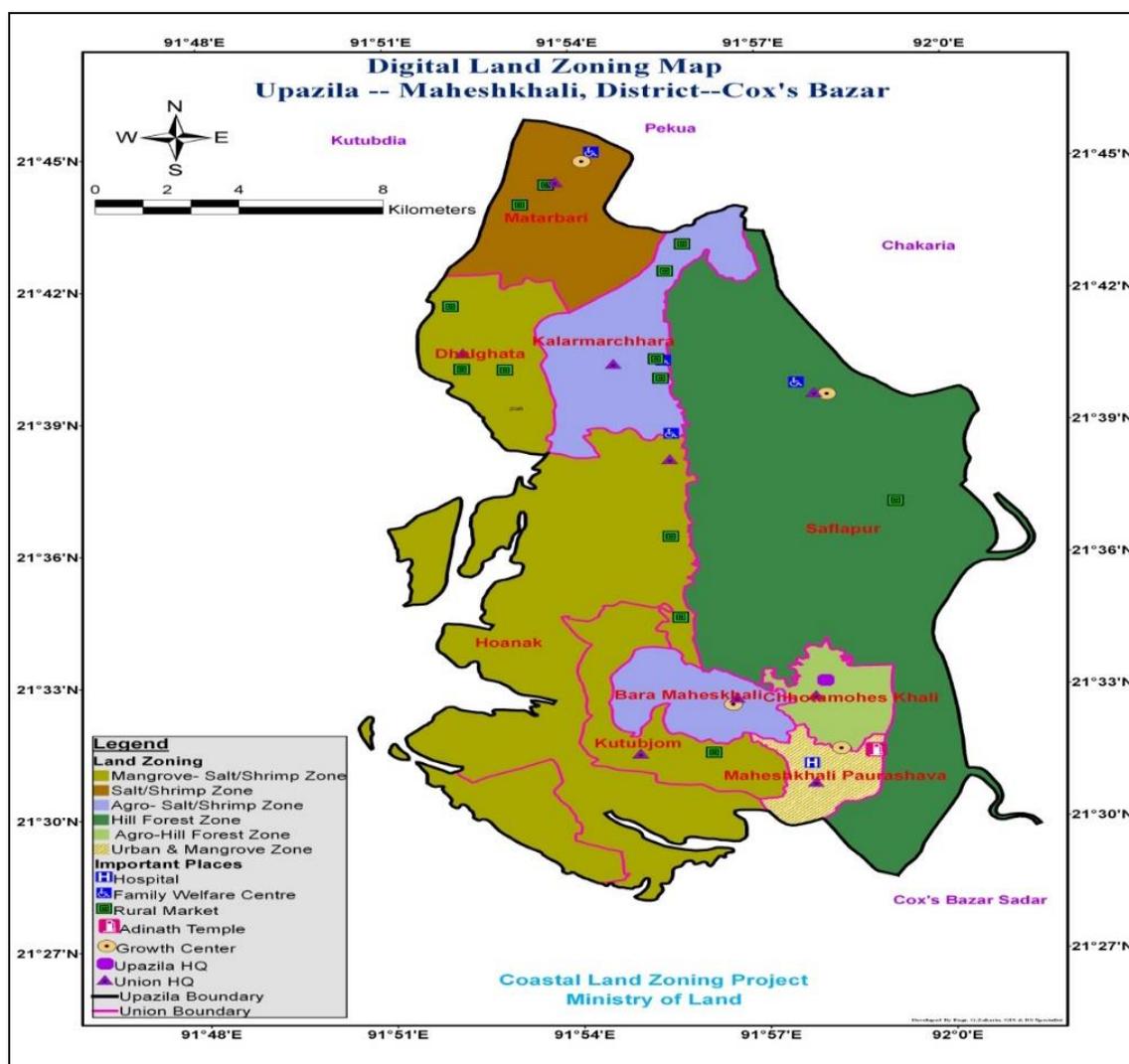
Conclusion

Maheshkhali Upazila has great potential for enhancing fisheries production. The water bodies of the upazila are habitats of valuable fish and other aquatic organisms. Culture of high value fish species can be a source of hard cash earnings for the people of the upazila. For a sustainable fisheries development, protection of wetland is a pre-requisite. This land zoning report has identified wetland habitat suitable for fisheries production of the upazila. Adequate administrative measures and management attention are needed to protect this wetland habitat. Wetland protection, improvement of fisheries habitat, controlling over exploitation and destructive fishing practices, open water fish stocking and other favorable supports will facilitate an increased fisheries production of the Upazila.

This study has identified potential causes for this decline including habitat degradation due to siltation and conversion

of wetland to agriculture, increasing fishing pressure, destructive fishing practices and an acute shortage of dry-season wetland habitats. Optimization of fish productivity of the upazila, fisheries land zoning is an important approach.

The present study suggests that the land should be divided into different zones such as Agro-Salt/Shrimp Zone, Agro-Hill-Forest Zone, Mangrove Salt and Shrimp Zone-Mangrove- Forest, Urban and Commercial Zone, Hill Forest Zone on the basis of suitability (Map 1.4), i.e. most suitable, moderately suitable and unsuitable, for multiple uses. Zoning can be time-shared, i.e. shrimp farming during monsoon months (May to October), and salt production during summer months (November to April). The zoning and land use approach provides important information for potential developers/investors to identify suitable zones for the optimal allocation of resources and minimization of conflicts among users.



Map 1.4: Land Zoning Map of Maheshkhali Upazila

References

1. Karim Z, Husain SG, Ahmed M. Salinity problems and crop intensification in the coastal regions of Bangladesh. Soils publication No. 33. BARC, 1990, 17.
2. Mondal M K. Management of soil and water resources for higher productivity of the coastal saline rice lands of Bangladesh. PhD thesis. University of the Philippines, Los Banos, Philippines, 1997.
3. SRDI. Soil Resources in Bangladesh: Assessment and Utilization, Soil Resources Development Institute, Dhaka, 2001.
4. Islam MR, Ahmad M, Huq H, Osman M. "State of the coast 2006", Program Development Office for Integrated Coastal Zone Management Plan Project, Water Resources Planning Organization, Dhaka, 2006a.
5. Study of Detailed Coastal Land Zoning with Two Pilot Districts of Plain Land Project under Government of the People's Republic of Bangladesh, Ministry of Land, field

- survey, 2006-2012.
6. BBS. (Bangladesh Bureau of Statistics) Statistical Yearbook of Bangladesh. Statistical Division, Ministry of Planning, Dhaka, Bangladesh, 2011.
 7. Bangladesh Space Research and Remote Sensing Organization (SPARRSO) data from 2012- 2013.
 8. CEGIS. National Land Zoning Project (NLZP), Ministry of Land, Government of the Peoples Republic of Bangladesh: Center for Environmental and Geographic Information S Programme, 2013.
 9. DoF. Fishery Statistical Yearbook of Bangladesh, 2013-2014.
 10. Fishery statistical yearbook of Bangladesh Fisheries Resources Survey System, Department of Fisheries (DoF). Dhaka. 2013, 2014.
 11. MOFL (Ministry of Fisheries and Livestock) Fisheries resources development and management. Paper presented at the National Workshop, 29 October to 1 November 1997, MOFL, Dhaka, Bangladesh, 1997.
 12. Karim MR, Shah MS. Brackish Water Shrimp Cultivation Restricts Coastal Agriculture. *Khulna University Studies*, Khulna, Bangladesh. 2001; 2(1):123-134.
 13. Ahmed ATA. Impacts of shrimp culture on the coastal environment of Bangladesh. In: Proceedings of the National Workshop on Coastal Aquaculture and Environmental Management. Institute of Marine Sciences, 25–28 April 1995. Nuruddin Mahmood, University of Chittagong/UNESCO, Bangladesh, 1995, 77-84.
 14. Khan YSA, Hossain MS. Impact of shrimp culture on the coastal environment of Bangladesh. *International Journal of Ecology and Environmental Sciences*. 1996; 22(2):145-158.
 15. GESAMP. Planning and Management for Sustainable Coastal Aquaculture Development. IMO/FAO/Enesco/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution, Rome, 2001.
 16. PDO-ICZMP (Program Development Office for Integrated Coastal Zone Management Plan) Living in the Coast: Urbanization. PDO-ICZMP, Water Resources Planning Organization, Dhaka, Bangladesh, 2005a, 36.
 17. PDO-ICZMP (Program Development Office for Integrated Coastal Zone Management Plan) Where Land Meets the Sea: A Profile of the Coastal Zone of Bangladesh. The University Press Limited, Dhaka, Bangladesh, 2004b, 317.
 18. Brammer H. Land Use and Land Use Planning in Bangladesh. The University Press Limited, Dhaka, Bangladesh, 2002, 554.
 19. Islam MR. Where land meets the sea: a profile of the coastal zone of Bangladesh (Ed). The University Press Limited, Dhaka, 2004, 317.
 20. NLZP, National Land Zoning Report Field Survey 2013-2016, National Land Zoning Project (NLZP), Ministry of Land, Government of the Peoples Republic of Bangladesh. [Study Team Member, 2015.
 21. Planning Commission Steps Towards Change-National Strategy for Accelerated Poverty Reduction II (Revised). FY 2009-11. Government Peoples Republic of Bangladesh, Dhaka, 2009.
 22. Rahman M, Ahsan M. Salinity constraints and agricultural productivity in coastal saline area of Bangladesh. In: Soil Resources in Bangladesh-Assessment and Utilization. Proceedings of the Annual Workshop on Soil Resources, 14-15 February, 2001. Dhaka: Soil Resources Development Institute. 2001, 1-14.
 23. Rahman S. Six decades of agricultural land use change in Bangladesh: effects on crop diversity, productivity, food availability and the environment, 1948-2006. *Singapore Journal of Tropical Geography*. 2010; 31:245-269.
 24. Nishat A, Huq SM, Enamul, Barua SP, Reza AHMA, Khan ASM. Bio-ecological Zones of Bangladesh. Dhaka: IUCN Bangladesh Country office. 2002, 141