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Assessing the State and Livelihood Opportunities Towards Sustainable and Ecosystem-Based Approaches: Insight from Keter Beel Area of Southern Bangladesh

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Abstract

Keter Beel is a natural wetland that contributes to the local economy and food availability, specifically, as a centre point of biodiversity protection, ecosystem firmness, fisheries, and watershed management. Conversely, the present state and livelihood opportunities of this wetland are unrevealed. Therefore, this study emphasizes the water quality, ecosystem services, socio-economic and ecotourism well-being to assess the state and livelihood opportunities. The study showed that the water quality of this wetland is still in good condition. Notably, the local people provide their labor in this Beel in different activities of pisciculture for monthly payment. Thus, this wetland supports the villagers living in surrounding areas by contributing to their monthly income and it also has become a good source of fish consumption and grass collection for their cattle. At present, this wetland attracts a significant number of tourists nationally and has created substantial ecotourism potential. People select this spot as a beautiful nature-based refreshing destination. Every tourist spends a positive amount of cash on transportation to visit here, and their cost contributes to the local economy. However, despite these blessings, this tourism is informal in type, and there is no proper system to deal with tourists who create a disturbance in this environment. Hence, this study proposed a sustainable livelihood and management strategy framework integrating ecosystem values and functions with conservation and development processes for the welfare and benefits of wetland ecosystems.

Keywords: Livelihood, Sustainability, Ecosystem, Keter Beel, Bangladesh

1. Introduction

Wetland ecosystems have a great contribution in supporting fauna and floral diversity, exploring livelihood options and reinstating eco-hydrological functions like water and wastewater treatment, restoring groundwater, controlling flood, and supporting a wide variety of fish and plants (Lupi et al., 1991; Brander et al., 2006; Fisher & Acreman, 2004). Wetlands are termed "the kidneys of the landscape" from the beginning of human settlement on earth and wetlands supply valuable resources for the human population and economic well-being (Davis et al., 1997; Roy et al., 2012; Verma and

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Negandhi, 2011). Wetlands are capable of providing high-valued ecosystem service as recipients, conduits, and sinks of biotic and abiotic resources (Hall et al., 2008; Sunny et al., 2020). Ecosystem, resource, and livelihood are interlinked with each other and govern the function and livelihood of community people (Verma and Negandhi, 2011; Sunny et al., 2020). Though wetland covers only 1.5% of the earth's surface they contribute to 40% of the world's ecosystem services (Zedler & Kercher, 2005). Among different sectors of the world, ecotourism industry is growing very fast and its estimated growth rate is about 10-15%, expressing one of the largest industries in the world (Scheyvens, 1999).

Bangladesh is a riverine floodplain reservoir including streams, haors, baors, lakes, channels, canals and beels where the livelihood of the surrounding community depends on the services from wetland resources, food web, and biodiversity (Barbier et al., 1997; Kostori, 2012). Additionally, the country is blessed with numerous natural floodplains and wetlands for its variety of ecological services and biodiversity richness (Sultana et al., 2019; Khan et al., 2022). For example, Chalan Beel, located in the Natore district of Bangladesh serves as a representative wetland and is crucial for biodiversity status, and demands concerted efforts to safeguard its rich biodiversity and maintain its ecological balance (Mou et al., 2023). Hence, regulating services are very important for minimizing pollution, disaster management and ensuring fresh water safety and security (Greeson et al., 1979; Zedler & Kercher, 2005). These services differ from other types of ecosystem services based on their environmental and socioeconomic impact (Russi et al., 2013; Gaworek-Michalczenia et al., 2022). The quantity of carbon density in wetlands is the highest among different terrestrial ecosystems and it is about 20-25% of the world's organic soil carbon (Gorham, 1991; Barbier, 2011). They are the dominant natural source of methane emission but can also sequester carbon as anaerobic conditions prevent decomposition of organic matter (Kayranli et al., 2010). Moreover, wetlands afford religious and cultural support while their aesthetic beauty gives mental relaxation and appeals the tourists (Clarkson et al., 2013).

Wetlands also attract different recreational and ecotourism activities that assist income for local people and also contribute to the local as well as national economy (Davis et al., 1997; Eagles, 2001). The development and promotion of ecotourism are supportive of sustainable management and utilization of wetland resources for poverty elevation and socioeconomic development (Baker, 2008; Islam, 2020). Nature-based sustainable tourism incorporates a desire to mitigate the environmental and social impact of our environment (Herath, 2002).

In Bangladesh, many places have developed such types of wetland-based livelihood opportunities (Hossain et al., 2009; Kafy et al., 2018). Besides livelihood support many of these *Beel*s are providing recreational support to the people living in surrounding areas. Wetland-based ecotourism is not widely practiced in its truest scene, although some measures have been taken after a couple of years (Reid & Shafiqul Alam, 2017). But there is a huge possibility to boost its natural heritage and reach its ecotourism destination. However, in 1999 the tourism sector of Bangladesh got recognition as a separate industry earning from tourist activity to the country's GDP which is less than 1% (Hassan et al., 2013). Simultaneously, these wetlands are taken as informal tourism spots, particularly in Bangladesh (Borre et al., 2001).

Keter Beel is one of the natural wetlands of Chuadanga district, Bangladesh; which was brought under a management approach for getting the expected economic benefit. At present, this *Beel* provides different types of valuable ecosystem services and thus plays a great role in improving the economic condition of the surrounding villagers. This *Beel* is meeting the demand for protein by supplying a huge amount of fish every day to the nearby markets. The natural beauty of this *Beel* is also very attractive for its aesthetical value to the people. People from different distances come to visit this *Beel* to relax and refresh their minds and enjoy its natural beauty. This kind of tourist activity is snowballing familiarity very rapidly over time.

However, no studies have been conducted to access the state and livelihood opportunities towards sustainable and ecosystem-based approaches of Keter Beel. Moreover, as far as we know, no inclusive study to assess the ecosystem service approach has yet been undertaken. But the fact is that the services of these wetlands are uncounted and still unrecognized in terms of ecosystem services. Therefore, to determine the present status, an ecosystem-based approach is needed to indicate the status of the state the Beel ecosystem and livelihood opportunities of the stakeholders focusing on the following definite objectives: (i) To quantify the water quality of the Keter Beel wetland (ii) To assess the perception of ecosystem services (iii) To analyze ecosystem activities and livelihood aspects in the study areas. (iv) To recognize major causes of ecological change and environmental degradation.

2. Materials and Methods

2.1 Study Sites: Keter Beel Wetland

Keter Beel is situated in the Southwestern part of Bangladesh which is a naturally developed wetland. The total area of this *Beel* is 120 acres and extends into the villages named Vultia, Nabinagar and Jibnagar (Population and housing census, 2011). This micro watershed Beel area supports various

occupational practices and around 70% of its land is covered by farmland. The wetland is characterized by monsoon to subtropical moderate rainfall and supports miscellaneous occupation and eco-hydrological agriculture that has a significant influence on the local economy and livelihood. On the North, it is enclosed by Alamdanga upazila, in the South bounded by Jibannagar upazila, while on the East there are three upazilas named Jhenaidah sadar, Kotchandpur, and Harinakunda upazilas. And to the West there is Damurhuda upazila and West Bengal state of India. The main rivers are Mathavanga, Nabaganga, Chitra and Bhairab (Figure 1). Before the management approach was introduced, this wetland was unproductive for any type of cultivation. In the subsequent stage, the land owner group of this Beel leased the land to a person or group of individuals on a contract basis.

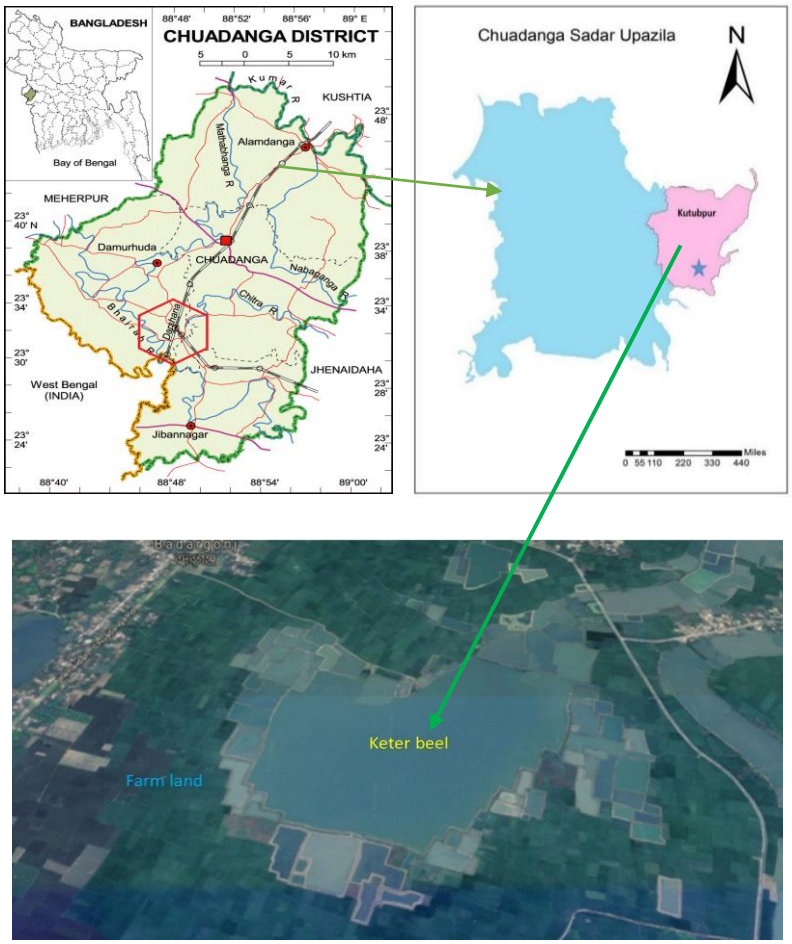


Figure 1: Location of Keter Beel in southern Bangladesh (Source: Google Earth, 2021 and GIS Digitalization)

The number of owners of the land of this Beel is more than 300. Different types of fish species are cultivated in this Beel. Among those are Rui (*Labeo Rohita*), Catla (*Catla catla*), Kalibaus, Sor puti (*Pentius goniomotus*). Pangas (*Pangasius pangasius*) etc. There are also different types of trees which have grown along the bank of this Beel. Among these are coconut (*Cocos nicifera*), Java palm (*Syzgium cumini*) and different types of small herbs and shrubs.

2.2 Data Collection

2.2.1 Sample size determination and analysis technique

In this study, laboratory analysis was performed for the measurement of the water quality of this wetland. For water quality analysis water sample was collected from three spots of this wetland. The first spot was the Eastern ghat of the *Beel*, the second spot was the Northern ghat of the *Beel* and the third spot was the Northeastern site of this *Beel* (Table 1).

Table 1: Sample size determination with sampling locations

SS No.	Location	Physical feature of Keter BBeel	Coordinate	
			Longitude (N)	Longitude (N)
SS-01	Eastern ghat of the Beel	Area:120 acres	23^0 55'75"	88^0 96'81"
SS-02	Northern ghat of the Beel	Average Depth: 1.68m	23^0 56'08"	89^0 96'77"
SS-03	North-eastern ghat of the Beel	Surrounding villages: 05	23^0 56'40"	88^0 96'77"

Note: SS = Sampling Spot

Different analytical methods were adopted for the determination of major cations and anions of the water samples. The analytical methods used to conduct the present study are enlisted in Table 2.

2.2.2 Survey data distribution: methods and techniques

After a preliminary survey, a questionnaire was finalized, and based on it a final questionnaire survey was conducted for the collection of data from the dependent people on this wetland and from the tourists of this area. In this survey, the simple random sampling technique was followed to collect data. In our survey a total of 80 respondents participated where 40 individuals were from the dependent people on this wetland and 40 were individuals who came to this place for recreational purposes and these visitors are considered as tourists. Four Focus Group Discussions (FGD) and Key Informant Interviews

(KII) were conducted to get a proper idea about the livelihood dependency, opportunities, threats and management approaches (Table 3).

Table 2: Analytical methods used for the investigation of the collected water samples

Types of Parameters	**Analysis Remark**	**Parameter**	**Methods /Instruments**	**References**
Physical	Analysis conducted on the study field	Water Temperature	Portable Multirange conductivity meter (HI-9635)	Instrumental and APHA, 1992
		Salinity	Turbidmetric method (Thermo spectronic, UV-visible Spectrophotometers)	
		Electrical conductivity (EC)	Portable Multirange conductivity meter (HANNA instruments, HI-9635)	
		Total Dissolved Solid (TDS)		
		pH	Microprocessor pH meter (HANNA instruments, Hi 8424)	
Chemical	Analytical measurement conducted in laboratory	Ca^{2+}	Titrimetric method	Ramesh and Anbu, 1996 And APHA, 1992
		Mg^{2+}	Titrimetric method	
		HCO_3^-	Titrimetric method	
		PO_4^{3-}	Ascorbic acid method (Heλ10Sγ, Thermo-spectronic meter, UK)	
		BOD	5-Day BOD Test method	

Table 3: Survey distribution and adapted methodological procedures for data collection

Name of the methods	Data Distribution	Procedure	Purpose
Questionnaire survey	Total 80 (40 from wetland-dependent people and 40 from visitors and business persons)	Both closed-ended and open-ended questions	▪ Age distribution; Educational status ▪ Income and working hours ▪ Fish consumption ▪ Nature of time spending and level of satisfaction ▪ Occupational variation and tourist activity ▪ Travel distance and transport cost
FGD	Total 4 FGD (2 FGD: Local inhabitants; 2 FGD: Business and tourist community)	State and livelihood opportunities (Discussion and conceptualization) Risk, vulnerability, and management (Discussion and scoring)	▪ Livelihood opportunities vs vulnerability ▪ Key ecosystem services ▪ Major impacts due to climate change and human interruptions ▪ Livelihood risks, susceptibility and management strategies
KII	Total 10 KII: 5KII: Local Knowledgeable Person; 5KII: Expert among tourist and business community	Open discussion and Conceptualization of the information	▪ Prospects and problems in study sites ▪ Major ecosystem services ▪ Opportunities and threats
Social Mapping	Random visits and conversation	Transect walking and community visioning	▪ Changes in land use and occupational pattern ▪ Changes in production, economy and transport system ▪ Future viewpoint and expectations

3. Results and Discussion

3.1 Water quality of the wetland

At present, people come to visit this *Beel* to enjoy the natural beauty of this wetland. As access to this wetland area is open for all and there is no proper management system for tourist activity, there is a possibility of water pollution. In this perspective, the water quality of this wetland was tested to inform about the present state of this wetland. Water temperature is very important for wetland species and the resulting range of temperature among the spots was revealed within 30.5 ºC - 31.8 ºC where the noticed TDS of the water sample was within 160 -177 ppm in different spots.

EC was found between 320-353 µS/cm. Dissolved Oxygen (DO) was within 6.8-7.5 mg/L in different sampling spots. BOD5 is also a crucial parameter to understand the organic content of the water body. After measuring BOD5, the maximum level was found in Spot 1 and that amount was 2.8 mg/L. On the other hand, this level was found in the minimum level in spot 3 and that amount was 1.3 mg/L. As the wetland lies in a saline-free region and the same level of salinity was found in all three spots of this wetland and the salinity level was 0.16 ppm. Potential hydrogen expressed in terms of pH depends upon the amount of bicarbonates and free carbonates in the water. After measuring the pH of the water, it was revealed that the pH range of all three spots was within 7.03-7.06. The bicarbonate range was found within 54.9-73.2 mg/L in three sampling spots.

Table 4: Descriptive statistical measurement of Physicochemical Parameters

Water quality parameters	**SS-01**	**SS-02**	**SS-03**	**Minimum**	**Maximum**	**Mean ± Std.**	**BD standards (SW)**
Temperature (^{0}C)	30.50	30.50	30.50	30.50	31.20	30.73 ±0.40	20-30
pH	7.04	7.06	7.04	7.03	7.06	7.04 ±0.02	6.5-8.5
EC (µs/cm)	330	320	330	320.00	353.00	334.33 ±16.92	500-1500
TDS (ppm)	165	160	165	160.00	177.00	167.33 ± 8.74	<1000
Salinity (ppt)	0.16	0.16	0.16	0.16	0.16	0.16 ±0.00	-
BOD (mg/L)	2.20	1.30	2.20	1.30	2.80	2.10 ±0.75	3-6

Calcium (mg/L)	31.08	34.01	31.08	28.06	34.01	31.05 ±2.98	<75
Magnesium (mg/L)	15.80	13.37	15.80	13.37	15.80	14.58 ±1.22	30-35
Bicarbonate (mg/L)	67.10	54.90	67.10	54.90	73.20	65.07 ±9.32	-
Phosphate (mg/L)	0.68	0.96	0.68	0.68	1.14	0.93 ±0.23	<6

Note: SS = Sampling Spot; TDS = Total dissolved solids, EC = Electrical conductivity, BOD= Biological Oxygen Demand, *Std. = Standard Deviation; SW = Surface Water; BD = Bangladesh*

The presence of Calcium (Ca^{2+}) and magnesium (Mg^{2+}) ion determine the hardness level of the water body. The concentration of calcium ion was found within 28.05–34.0068 mg/L and the concentration of magnesium was within 13.367–15.798 mg/L, and the concentration of phosphate was found 0.682 – 1.142 mg/L. From Table 4, it is observed that almost all of the measured parameters lie within the standard level. Only the temperature was found above the standard limit which might have happened because of the time of sampling. This sampling took place on a hot summer day of August month. Most of the measured parameters were found within the standard level that demonstrates the wetland ecosystem in terms of analytical parameters. But without proper tourist management in a systematic way, there is a possibility of pollution in the water body and environment of this wetland.

3.2 Ecosystem Services: Livelihood and ecosystem resilience

This wetland have provided diverse ecosystem services continuously over the time. Fish is one of the most significant services here as huge number of fish is harvested from this wetland every day. With the introduction of commercialization and business exposure this wetland has now turned into a private water body. Now aquaculture has become a dominant livelihood practice that supports variety of tasty fish and income opportunities for many people. Besides fish production, this wetland now has become a tourist and recreation spot for many people. Every day, many people come here for recreational purposes with their families, friends and others. This market-based economy provides working opportunities that govern the livelihood of many people in different sector like transport, aquaculture, crop cultivation, security guard and accountant. We incorporate and summarize the services and response percentages of involved people under four major arenas: 1. Provisioning services (e.g., food, wood, water, livestock etc.); 2. Regulating services (e.g., climate regulation, watershed management, water and waste water treatment etc.); 3. Cultural Services (e.g., ecotourism, recreation,

aesthetic beauty, religious and cultural services) and 4. Supporting services (e.g., nutrient balance, soil formation, ecosystem restoration etc.). These are incorporated in Table 5.

Table 5: Perception on ecosystem services in Keter Beel wetland

Provisioning services	**Response Rate**	**Regulating services**	**Response Rate**	**Cultural services**	**Response Rate**	**Supporting services**	**Response Rate**
Fish food	90%	Climatic regulation	70%	Ecotourism	80%	Nutrient dynamic	50%
Aquaculture	80%	Micro watershed management	30%	Recreation and relaxation	90%	Productivity	70%
Livestock and grazing	60%	Water treatment	70%	Aesthetic and natural beauty	70%	Soil formation	30%
Crops and vegetation	50%	Wastewater purification	50%	Religious and cultural	40%	Ecosystem restoration	50%
Wood and timber	50%	Flora and faunal diversity	40%				
Water services	60%	Clean air	60%				
Medicinal Plants	30%						

Sources: Questionnaire survey, social mapping, FGD, and KII (Adapted from Reid and Shafiqul Alam, 2017)

3.3 Socio-economic and livelihood attributes of surrounding wetland community

A significant number of local villagers provide their services in this *Beel* for a certain level of salary. People of different ages are involved in these jobs. It was observed that the age limit of the respondents was from 15 to 55 years. Some of them are involved in the caring of fish hatching activity, some of them are involved in catching fish for selling in the markets and some of them are involved in the coordination among different activities of this fish cultivation. Majority of them are under SSC in terms of their educational qualification. Other major numbers have an educational background of the primary level. A certain number of respondents haven't received any institutional education. About 43% of the respondents render their service for

6-7 hours, and, another major portion (37%) of the respondents provide their services for 8-9 hours.

The economic status has improved after commercial aquaculture and tourism business of this *Beel*. Many of them are now engaging in this sector besides their other traditional occupation. It was seen that about 65% of the total respondents usually get 7000-8000 BDT per month whereas 35% respondents received a payment of 5000-6000 BDT per month based on their labor and time spent. Besides earning money, these people also collect large amount of fish. It was observed that about 52% of respondents get 6-7 kg of fish per month and another highest percentage of respondents get 7-8 kg of fish per month. The respondents also collect some grass from the grassland of the *Beel* for their cattle. It was found that about 48% of the respondents collect about 11-15 kg grass per month and 33% of the respondents collect about 5-10 kg of grass per month for their domestic cattle.

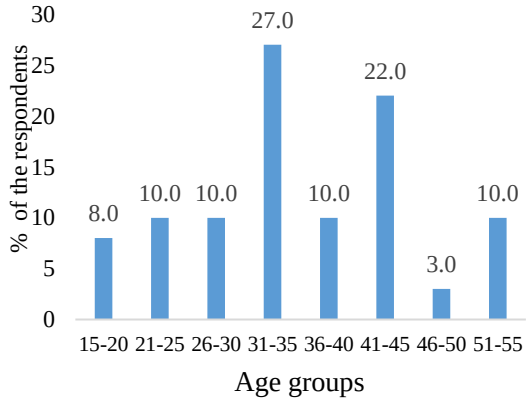
This *Beel* is also playing an important role by supplying water for the irrigation in the nearby croplands during the dry seasons. About 300 farmers partially depend on this *Beel* for this irrigation water in the dry seasons. Before creating the working opportunity in this *Beel*, there was a very limited working field for these local people. This study shows that, 20% of the respondents who work in this *Beel* has reached an excellent satisfaction level, while 44% of the respondents have mentioned a very good satisfaction level and 36% of the respondents have mentioned good satisfaction level.

After undertaking a management approach for the purpose of fish cultivation, keter Beel is supporting the livelihood for many of the villagers nearby. They are involved in different types of activities. Some of them work here as part time workers and some are engaged in full time work. Before getting involved here, they had very limited opportunities of providing labor on proper wages basis. Now they have got a chance to provide their labor in diverse occupational activities like protection of fish hatchling from different fish eater birds, working as security guards, drivers, local retailers etc. The socio-economic and livelihood attributes of surrounding wetland community are delineated in Figure 2.

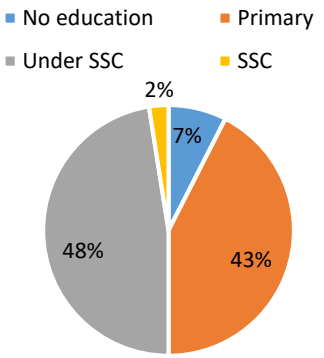
3.4 Ecotourism activities and livelihood prospects

At present, *Keter Beel* has become a very popular tourist spot. Though the number of tourists is not remarkable compared to the other established and well-managed tourist places on daily basis, it is a very positive sign that, people have chosen this place for their mental refreshment. These visitors come to visit this *Beel* from nearby areas. Ecotourism activities and livelihood prospects of Keter Beel area are delineated in Figure 3. It was revealed that

about 85% males and 15% female tourists came here and these respondents were in different age groups. The age group of the maximum number of respondents was 21-25 whereas the second maximum group was under 26-30 age range. The respondents' occupation was diverse in type and the majority were students (45%). The second highest number of the respondents were small local businessmen.



(a)



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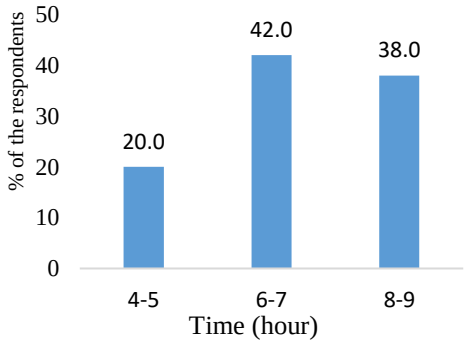

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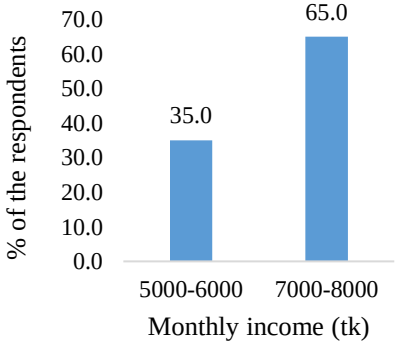
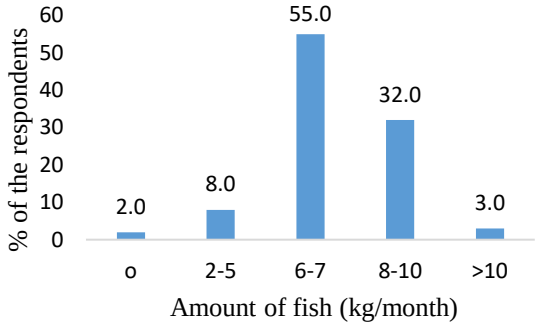
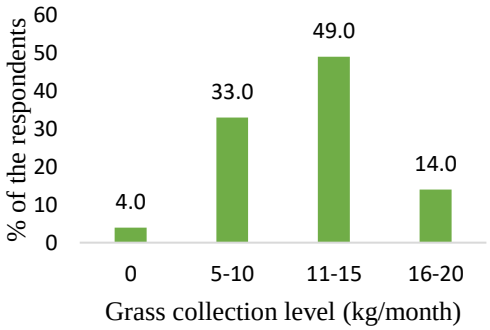


(d)

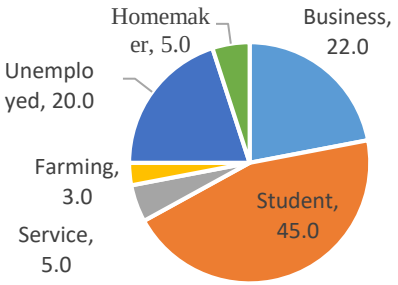


(e)



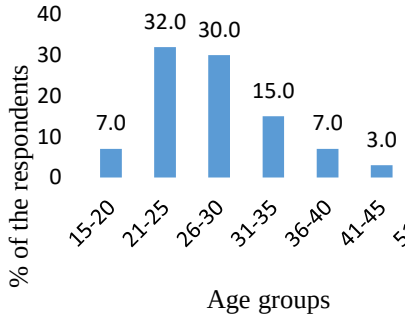
(f)

(g)

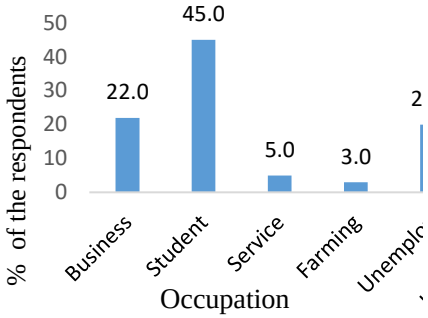


(h)

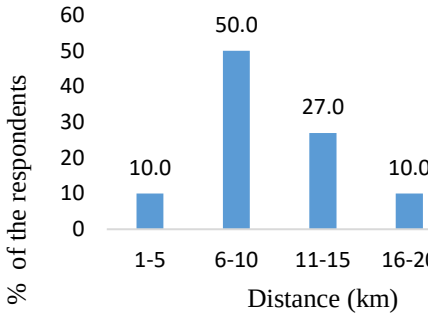
Figure 2**:** a) age distribution; b) education status c) working hours; d) distribution of income level; e) amount of fish consumption f) grass collection; g) satisfaction level; h) occupational diversity of the respondents


40
30
20
10
0
% of the respondents
32.0
30.0
15.0
7.0
7.0
3.0
15-20
21-25
26-30
31-35
36-40
41-45
Age groups

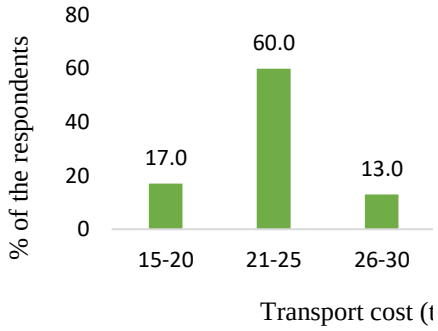
(a)


50
40
30
20
10
0
% of the respondents
45.0
22.0
5.0
3.0
Business
Student
Service
Farming
Occupation

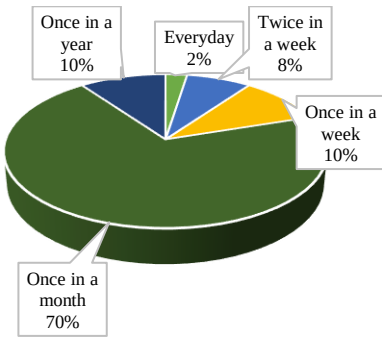
(b)


60
50
40
30
20
10
0
% of the respondents
50.0
27.0
10.0
10.0
1-5
6-10
11-15
Distance (km)

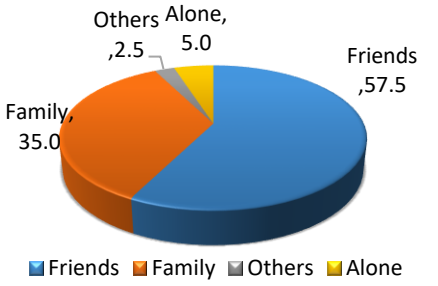
(c)


80
60
40
20
0
% of the respondents
60.0
17.0
13.0
15-20
21-25
26-30
Transport cost (

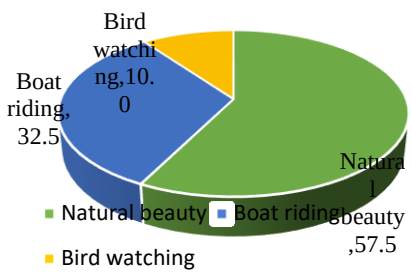
(d)


Once in a year 10%
Everyday 2%
Twice in a week 8%
Once in a week 10%
Once in a month 70%

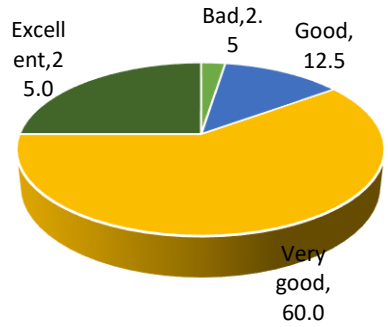
(e)


Others ,2.5
Alone, 5.0
Friends ,57.5
Family, 35.0
Friends
Family
Others
Alone

(f)



(g)



(h)

Figure 3: a) age distribution; b) occupational multiplicity c) travel distance; d) transport cost; e) frequency of visiting; f) travel partner; g) satisfaction level; h) occupational diversity of the respondents

It was noticed that the highest number of respondents came here from a distance of 6-10 kilometers. Few respondents came to this spot from a distance level more than 20 kilometers. Every day these tourists come to this spot by spending a certain amount of cash on transportation and they also spend money to purchase different goods and local foods from the local vendors. This transportation cost contributes the local economy. A large number of these respondents visit this place almost once a month and their number is about 70% of the total respondents. Most of them came here with their friends, and 55% of the total respondents spent about 1-2 hours. The most attractive site for most respondents (57%) was the natural beauty of the *Beel* whereas boat riding is enjoyed most by 33% of tourists. 10% of respondents most like to watch the roaming of different types of birds.

As this *Beel* is open for all, there is no sufficient and well-planned management facilities for the tourist. Regarding the ticket system, most of the respondents expressed a positive opinion. It was seen that the expected range of ticket price for maximum respondents was 5-10 BDT and the second highest was between 11-15 BDT. All of the respondents are satisfied with having such a nice natural tourist spot in their locality and among them, 10% of the respondents expressed their interest in being involved with such kind of wetland-based fish cultivation from where a huge number of fish will be harvested. The overall expectation was to build up a well-mechanized ecotourism and livelihood facilities that can be sustained in the long run.

3.5 Vulnerability context of wetland ecosystem

This study area is located at the right side of Padma River. A small river named Nabaganga is situated along the Eastern side of this Beel. This wetland ecosystem is the reservoir of diversified plant varieties, microorganisms, fish,

birds and other species. At the same time, they are very sensitive to human interruptions, the influence of outsiders, development pressure, and environmental degradation. People get fresh water from a depth of 70-90 ft underground. Due to the over-extraction of groundwater for agricultural purposes recently, people are now facing a freshwater crisis mostly in the dry season.

Natural disasters such as cyclones, storm surges, floods and waterlogging are prominent features that impact on the livelihood and agricultural practices that demand suitable management and future planning. Along with commercial aquaculture, privatization of this Beel generates some ecological threats though it also creates more income opportunities for the local inhabitants. The following table 5 is the conceptual summarization of the views of stakeholder communities on livelihood and environmental issues over time.

Table 6: Ecological change and environmental degradation in Keter Beel area

Dimensions	**Components**	**Present state of vulnerability**	**Change remarks**	**Possible Reasons**
Biological	Biodiversity	High	Depleting	Lack of conservation
Physical	Land use	Moderate	Increasing	Crop cultivation shifted to aquaculture
Environmental	Water quality	Moderate	Deteriorating	Lack of management and drainage facilities
	Natural vegetation	Moderate	Decreasing	Lack of good planning and ecosystem-based approach
Climatic	Water logging	High	Increasing	Narrow escape to discharge due to improper sluice gate and polder
	Cyclone and flood	High	Increasing	Climate change and human interruptions

Economic	Aquaculture	High	Increasing	Fish production and economic gain
	Crop production	Poor	Decreasing	Low production and lack of water facilities all year round
	Homestead gardening	Moderate	Neutral	Environmental condition and homestead agriculture.
	Income	Moderate	Increasing but uncertain	Limited income source opportunities
Infrastructural	Roads and institution	Moderate	Increasing	Numerous development initiatives

Source: FGD, KII and social mapping (Adapted from: Huq *et al.*, 2012)

4. Proposed Sustainable Livelihood and Management strategy framework

Wetland ecosystem of *Keter beel* is a vital part of ecological, economical and socio-cultural dignity of the local community. Ecosystem structures and processes regulate the ecosystem functions like production, climatic regulation and habitat formation. Thus, the wetland supports the livelihood in both economic and environmental point of view. It has very high possibility of ecotourism and employment opportunities but needs to maintain the environmental quality, biodiversity and natural aesthetic beauty as a tourist and economic hub. Our proposed wetland scenario (e.g., ecosystem structures, processes and functions) inclined with vulnerability context (e.g., livelihood assets, activities and strategies) can ensure the socio-eco-hydrological values like food availability, accessibility and affordability (Figure 4). Some measures can be suggested for this conservation:

- **Integrated conservation and development:** Livelihood adaptive support system, capacity building up, reducing imbalance competition over resources, improving governance and involve them in bottom-up decision-making approach can prevent environmental degradation,

maintain ecological balance and support socio-economic means of sustainability in the long run.

- **Education and awareness:** All the stakeholders especially the farmers should be given proper education and hands on training for preparing organic fertilizer, pesticides, sustainable crop cultivation and well-planned aquaculture. Biodiversity of flora, fauna and medicinal plant should be maintained through creating natural barrier and introducing homestead gardening.
- **Welfare and profit by ecotourism:** The local inhabitants should be more conscious of both environmental and economic factors compared to outsiders. Community initiated resource management and consumption pattern help them to build up sustainable ecotourism from which they can be benefitted by economic and ecological services.

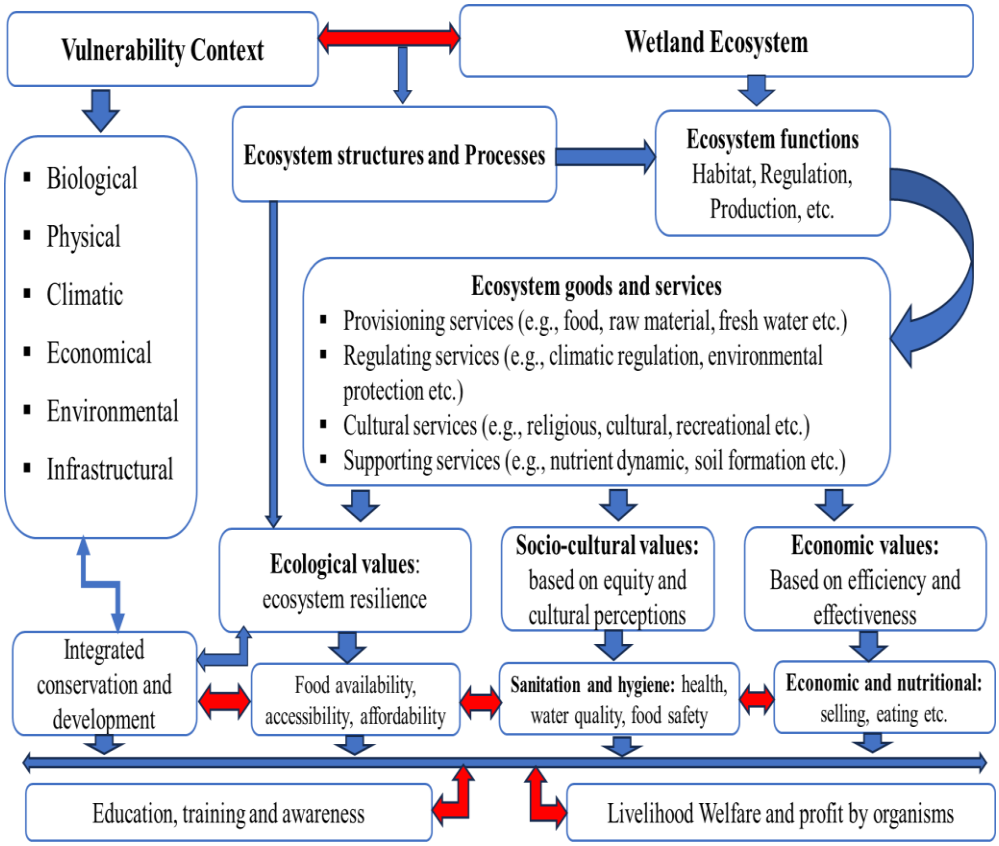


Figure 4: Conceptual sustainable livelihood and management strategy framework

5. Conclusion

Keter Beel has created a very good working opportunity for the local people. The people who are involved with the wetland ecosystem are benefited in many ways. Besides earning monthly wages these people are now promoted by the consumption of fish and grass collection for their cattle. Some respondents who were jobless before commercialization, have now started some part-time jobs in this *Beel*. At present, they are drawing a handsome amount of salary depending on the service basis and invested time. Most of the beneficiary respondents are satisfied with working here. Besides fish production, this wetland serves as a place of ecotourism. Every tourist spends a certain amount of money for their transportation and pursuing different goods from the local vendors which contributes to developing the local economy. Though this tourism is informal in type, the activities of these tourists have not created any disturbance to the water body as revealed from the water quality analysis. However, due to the lack of proper tourist management activity, there is a possibility of future environmental pollution and livelihood threats. So, it can be suggested that if this wetland eco-tourism can be brought under a formal management approach by integrating conservation and tourist-friendly development scheme, it will generate supplementary livelihood support for the local people.

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