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Biodiversity of the Medir Haor wetland ecosystems of Bangladesh

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Abstract
Complex nexus between aquatic and terrestrial ecosystems, namely wetland has a significant environmental impact on the survival, breeding, nesting, and feeding of numerous floral and faunal species. A study was carried out in the Medir haor (MH) wetland ecosystems of Bangladesh to enumerate its vegetation coverage, faunal resources, and evaluate the impacts of biodiversity on the ecosystems as well as surrounding communities. A total of 76 plant species belonging to 66 genera, and 135 faunal species (12 invertebrates and 123 vertebrate species) were enumerated from the study area through extensive fieldwork following vegetation survey, faunal survey, interview, and Focus Group Discussion (FGD). Among the plant resources, herb was the dominant category (32 species, 29 genera) followed by tree (22 species, 18 genera), shrub (11 species, 9 genera), climber (3 species, 3 genera), and fern (2 species, 2 genera). Bird species were found to be higher (46%) in comparison to other faunal species in the study area. The study divulged that residents were dependent enormously on the natural resources of the MH wetlands. Though biological diversity has significant ecological and socio-economic importance on haor-dependent residents, natural resources seemed to diminish continuously from the haor area due to over-exploitation. This research recommended sustainable wetland management, awareness-raising among the residents, and policy implications to manage the biodiversity of the MH wetlands on a sustainable way.

Keywords: Bangladesh, biological diversity, environmental sustainability, Medir Haor, wetland ecosystems

1. Introduction
Wetlands, a combination of different aquatic and terrestrial conditions, are considered the most complex ecosystems of the world that harbor a huge variety of floral and faunal species and are of great ecological significance [1]. Wetlands are probably envisaged as the most important zone for inland freshwater fisheries because they support a large invertebrate fauna, act as a feeding ground for young and growing fishes, crustaceans, vertebrates, microbes, etc., and also provide a large variety of refuges against predators [1, 2]. Gradually, high varieties of major groups of animals and plants have greatly adapted to these mosaic ecological landscapes [3]. Wetland ecosystems can provide a huge ecological contribution to biodiversity, even demonstrating high levels of alpha and beta diversity, i.e., species diversity and turnover between habitats [4].

Wetlands are not only the habitats of several animals, but also the important sources of drinking water, sources of edible food, and often used by the migratory birds for breeding and resting [1, 3]. Meanwhile, wetland landscapes are the most feasible ecosystems for nesting, breeding, and survival of various fauna, i.e., amphibians, fishes, reptiles, invertebrates, microbes, etc. [1]. But, due to human influences and anthropogenic disturbances, wetlands are the most threatened and deteriorated ecosystems of the world nowadays [1, 3, 4]. Researchers reported that more than 50% of wetland ecosystems were disturbed and lost globally during the last century due to human interferences, specifically drainage, conversion, and collection of natural resources [5, 6]. Hence, the abundance of freshwater species is reducing tremendously from the biodiversity-rich wetland ecosystems [5, 7].

In a broader sense, wetlands are categorized as the interface between terrestrial and aquatic ecosystems, and sometimes one or more wetland types are combined to form a floodplain [8,9]. Bangladesh, located in the northeastern part of South Asia, possesses a rich biological heritage

of flowering plants, algae, fungi, ferns, mammals, birds, reptiles, amphibians, insects, microbes, fishes, invertebrates, etc. and the floodplains of Bangladesh are amongst the world's most important wetlands [10, 11]. Research findings showed that about a million hectares of floodplain lands are inundated every year in Bangladesh during the monsoon period (rainy season), and over half of the country is underwater in an exceptional flood year [12].

In Bangladesh, wetlands play a significant role and provide several ecosystem services, e.g., groundwater recharge/discharge, storage of floodwater, shoreline stabilization and reduction of erosion, sediment trapping, nutrient retention/removal, support for food chains, fisheries production, habitat for wildlife, recreation, natural heritage values, biomass production, water transport, biodiversity presentation, micro-climate stabilization, etc. Simultaneously, wetlands of this biological diversity-rich tropical country provide the habitat for over 260 fish species, construct the nest for hundreds of thousands of migrating birds, and serve the nutrition for millions of rural households [13, 14].

Wetland ecosystems, distributed in a scatter form all over the country, are of great importance to Bangladesh due to their extent. Wetlands of Bangladesh are locally known as haors, due to their 'bowl-shaped' depression between the natural levees of a river that are flooded every year by monsoon floods [15, 16]. Haors of Bangladesh are also the most significant wetlands of South Asia. Tanguar haor, Hakaluki haor, Medir haor, etc. are some remarkable haors of Bangladesh [16, 17]. In this study, an attempt has been made to enumerate the flora and fauna of the MH wetland ecosystems. Assessment of the nature of resources and their impacts on the surrounding ecosystems of the MH is another objective of this exploratory study.

2. Related work

Haors are the most important wetlands in Bangladesh because of their ecological significance, environmental vitality, and diversified flora and fauna [14, 16]. According to the researchers [18], nearly 141 fish species are living in the Tanguar haor of Bangladesh. Another study [16] on fish resources enlisted a total of 134 fish species from the Tanguar haor. Hasan and co-researchers [19] recorded a total of 26 aquatic weed species under 20 families from the Tanguar hoar areas at Taherpur upazila under Sunamganj district, Bangladesh [19].

Like most, Medir haor (MH) is another most important freshwater wetland located in the Brahmanbaria district of Bangladesh, and supports plentiful flora, wildlife, and aquatic resources. However, in recent times this haor has become a fast-degraded landscape and facing increased pressures and threats from different sources including over-exploitation of its resources by the residents. Though the Medir haor is rich in natural resources, inventory on natural resources has so far been not found for this haor.

3. Materials and Methods

3.1. Physiographic condition of the study area

The Medir haor (MH), also known as Medinir haor, is situated in Nasirnagar upazila (*Upazila: an administrative unit of Bangladesh*) of Brahmanbaria district (Figure 1) under the division of Chattogram, Bangladesh with an area of about 3628 hectares [20]. It is about 28 km north of the Brahmanbaria Sadar city. The Nasirnagar upazila is bounded by six other upazilas (i.e., Austogram, Bajitpur, Sarail, Brahmanbaria Sadar, Madhabpur, and Lakhai) [20]. In general, three/four haors (i.e., Akashi-Shapla haor, Medinir haor, Shelnir haor etc.) are distributed in the Nasirnagar upazila. Medir haor is the coalescence of two or more scatter small haor-basins. Specifically, MH starts from the north side of Nasirnagar Sadar and ends at Lakhai Upazila. Further, Balyajuri, Shingjuri, North Balyajuri, etc. are distributed in the MH. The land uses of the Medir haor can be divided into three major categories: a) Agri-lands (land for agriculture, cultivation, and crop-production), b) Beels (the deepest part of the haor), and c) Kandas (the outer portion of the haor adjacent to the surrounding communities) [20]. The general description of the MH wetland ecosystems was presented in Table 1.

Table 1: Background information of the MH wetland ecosystems

SL. No.	Parameter	Data	Source
01.	Distribution	Bhramanbaria Sadar and Nasirnagar	Data from Upazila Land Office of Nasirnagar, Brahmanbaria, Bangladesh [20]
02.	Latitude	24° 05' 914" North	
03.	Longitude	91° 06' 643" East	
04.	MAT* (Maximum)	34.3 °C	
05.	MAT* (Minimum)	12.7 °C	
06.	Annual rainfall (average)	2551 mm	
07.	Soil type	Silty clay loam	
08.	Soil color	Dark grey	
09.	Topography	Not uniform	
10.	Inundation (month)	April/May to October	
11.	Surrounding communities	About 22 villages	
12.	Land-use categories	3 distinct classes: Agri, Beel, Kanda	

*MAT: Mean Annual Temperature

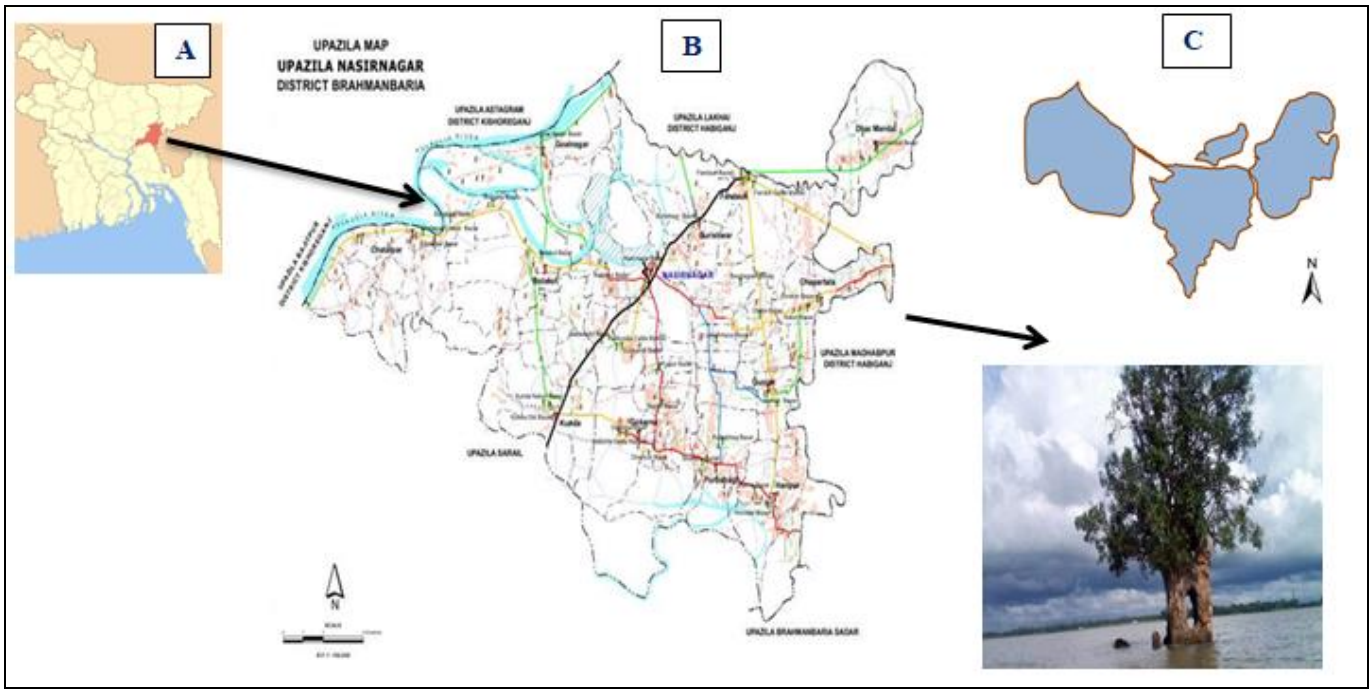

Fig 1: The study area

[Here, A: Map of Bangladesh with the location of Brahmanbaria district (Photo: Wikipedia); B: Map of Nasirnagar Upazila; C: Medir haor wetland ecosystems/ the study area (Map: Shourav Dutta, Photo: Sohrab Shanto, 2016)]

3.2. Experimental design

3.2.1. Reconnaissance survey

A reconnaissance survey (field observation) was conducted in the study area before the fieldwork [11] to gain a general idea regarding physiographic and overall conditions of the study site with particular attention to species composition, nature of species occurrence, and habitat of the floral and faunal species.

3.2.2. Vegetation survey

The transect method of systematic sampling type was adopted. To assess for individual species occurrence, representative species were chosen and recorded. The quadrate method was also applied to assess the occurrence of plant species. The quadrate method is the most applied method for the collection of quantitative data for vegetation analysis [16]. The quadrate method was used for the analysis because it covered most of the species. Four quadrates of 1m × 1m ($1m^2$) were selected randomly, collected all the data, and recorded. Recorded plant species were categorized into eight dominant habitat classes, prescribed by the researchers [16, 21].

3.2.3. Faunal survey

During the survey of mammals, a transect line (1 km) has been used, as strip transect sampling [22] is the most suitable to estimate the population status and relative abundance of wildlife. Observation of all individuals at the line and estimation of the proportion has been conducted. For birds, data was collected by strip transect sampling, opportunistic survey, and visual observation. Any important or interesting observation/information was recorded at any time while in the field during the practice of opportunistic survey [16]. Observed birds were identified with the help of key characteristics and illustrations guide-*Birds of Indian Subcontinent* [23]. Amphibians and reptiles were surveyed using Transect lines (1 km long). For amphibians and reptiles, opportunistic searches were also carried out over a wider area. Researchers also searched in bushy habitats, holes, and hollows for frogs, geckos, and snakes. Common invertebrate species were also identified and recorded during the fieldwork through observation. Fish resources were surveyed through field observation, market survey, interview, and Focus Group Discussion (FGD). Further, various sites of the study area were considered for samplings and data collection.

3.2.4. Interview and Focus Group Discussion (FGD)

The interview schedule was designed diligently to attain the maximum information about the floral and faunal composition from the study site. The respondents were selected randomly based on age (old stakeholder), profession (fisherman and housewife), social status (member of administrative unit), etc. [21]. The respondents were residents as they have been living in the wetland area for more than 20 years. Meanwhile, information about the natural resources and their impacts was gathered through Focus Group Discussion (FGD) involving residents living around the surrounding areas of the MH wetlands. Bringing out the current and previous status of natural resources of the MH wetlands as residents' observation and perception was the principal intention of this group discussion. FGD was also used in the clarification of information obtained. Each FGD consists of 7-8 (min.) persons, including local community leader, member of the administrative unit, fisherman, local villagers, resource collectors, and resource-dependent persons. Personal communication and informal interview with personnel (i.e., researchers, foresters, conservators, local key informers, biologists, environmentalists, bird watchers, etc.) were also conducted to collect precise information about the floral and faunal composition of the MH wetland ecosystems.

3.2.5. Secondary data collection and species identification

Before the fieldwork, several literatures, published articles, publications, project reports, and institutional data were

gathered and reviewed to gain an idea, and determine the species composition (flora and fauna) of the MH wetlands. During the fieldwork, several possible instruments like binocular with high resolution, visual documentary, and comments/suggestions from biologists, conservators, environmentalists, and taxonomists were used for identifying the resources [21]. The recorded species were identified through the field observations as well as with the help of knowledgeable residents. Consultations were also made with several reliable literatures, i.e., Birds of Indian Subcontinent [23], Encyclopedia of Flora and Fauna of Bangladesh [24], Bangladesh Wetland Ecosystem Information and Knowledge Base by BCAS [25], Red List of Threatened Animals of Bangladesh [26], Freshwater Fishes of Bangladesh [27], Wildlife of Bangladesh [28], etc. to identify the vascular plants, amphibians, birds, fishes, mammals, and reptiles of the MH wetland ecosystems.

3.3. Data analysis
All information were collected and sorted (qualitative and quantitative) carefully using a spreadsheet software (Microsoft Excel, version MS 2010). The sorted data were compiled, processed, and analyzed to gain the exact findings. Finally, the key results of this research were disclosed scientifically in the form of tables and figures.

4. Results
4.1. Floral composition
The study revealed a total of 76 plant species belonging to 66 genera from the Medir haor wetland ecosystems. All the recorded plant species were categorized based on habit and classified under the genus. Herbs constitute the major category (32 species under 29 genera) followed by trees (22 species under 18 genera), shrubs (11 species under 9 genera), climbers (3 species under 3 genera), and ferns (2 species under 2 genera). Some moving/ free-floating plant species (specifically herbs and weeds) were classified as hydrophytes, and a total of 6 naturally occurring hydrophytes (under 5 genera) were recorded from the study area. Among the 76 plant species, herbs were occupying 42% of all the recorded plant species followed by trees (29%), shrubs (14%), hydrophytes (8%), climbers (4%), and ferns (3%) (Figure 2). The scientific name, vernacular name, habit, and habitat class for each plant species are presented in Table 2.

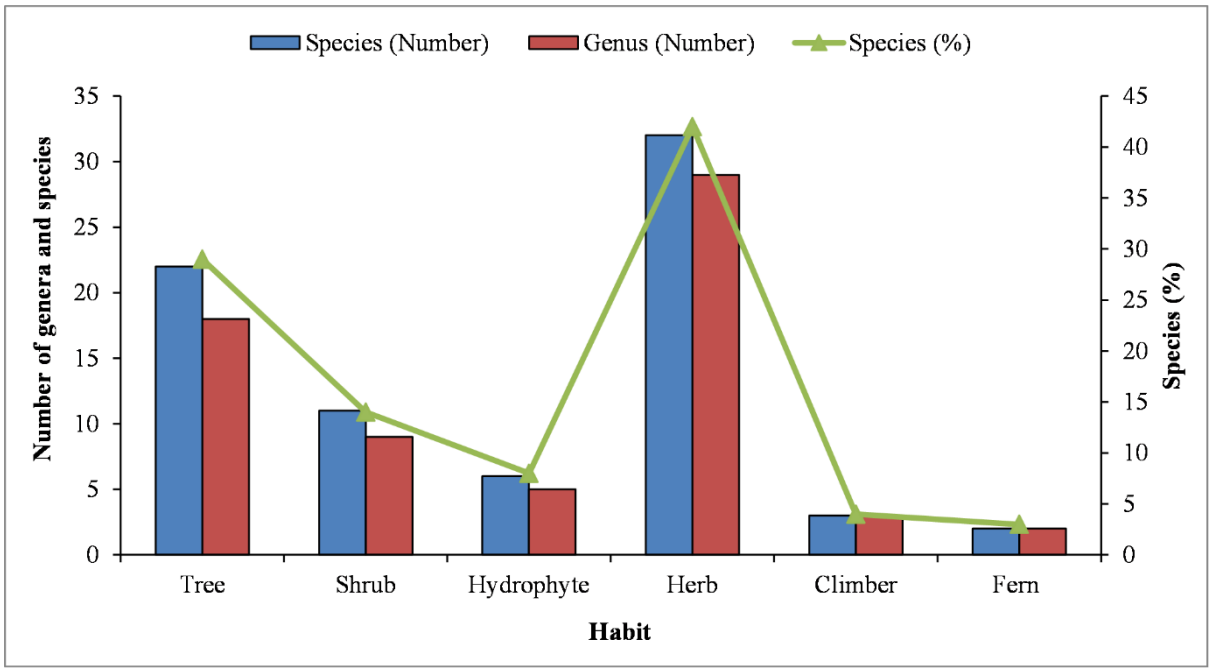

Fig 2: Species number, genus number, and species (%) of the recorded plant species under various habit

The most common tree species of the MH wetlands are *Barringtonia acutangula* (Hijol), *Diospyros cordifolia* (Tamal), *Erythrina variegata* (Mandar), *Lagerstroemia speciosa* (Jarul), *Ficus religiosa* (Ashwathwa), *Pongamia pinnata* (koroch), etc. The most commonly occurred shrub species are *Datura stramonium* (Dhutura), *Ipomoea carnea* (Dholkalmi), *Phragmites karka* (Nal), *Saccharum spontaneum* (Kash), *Schumannianthus dichotomus* (Pati-pata) etc.

Herb species that commonly occurred in the haor area are *Asparagus racemosus* (Satamuli), *Centella asiatica* (Thankuni), *Colocassia esculenta* (Kochu), *Cynodon dactylon* (Durba), *Enhydra flactuans* (Helenca), *Marsilea quadrifolia* (Sushnishak), *Nymphaea nouchali* (Shapla), etc. Common climber species of the MH are *Aponogeton natans* (Vasaghas), *Calamus tenuis* (Bet), etc. *Azolla pinnata* (Kutipana) and *Sylvania natans* (Tilokpana) are two fern species commonly occurred in the MH wetlands. The study also divulged some noxious weeds that have luxuriant growth and suppressed the growth of other native plant species, e.g., *Heliotropium indicum* (Hatisur), *Mikania cordata* (Assamlata), etc.

This study categorized the plant community (habitats) of the MH wetlands into eight major habitat classes (i.e., Crop-field vegetation, Free-floating plant, Freshwater swamp plant, Homestead vegetation, Rooted floating plant, Reed swamp plant, Sedges and meadows vegetation, Submerged vegetation) based on the plant occurrence (Table 1). The maximum number of plant species was recorded from the homestead as homestead vegetation (29) and occupying 34% of all the recorded plant species, followed by rooted floating (11 species), sedges and meadows (10 species), and free-floating (8 species) plant categories. Crop-field vegetation, freshwater swamp plant, reed swamp plant, and submerged

vegetation categories had 7 plant species each (Figure 3). *Barringtonia acutangula*, *Diospyros cordifolia*, *Diospyros peregrine*, *Erythrina variegata*, etc. were the common tree species recorded from both the freshwater swamp and homesteads. *Colocassia esculenta* was recorded as both crop-field vegetation and sedges & meadows vegetation. *Vetiveria zizanioides* was identified as both reed swamp plant and sedges & meadows vegetation. *Schumannianthus dichotomus* was the only plant species found in three major habitats, i.e., crop-field, homestead, and sedges & meadows (Table 2).

Table 2: Recorded plant species with their habit and habitat

SL. No.	Scientific name	Local name	Habit	Habitat
01.	*Acacia catechu* (L. f.) Willd.	Supari	t*	HV**
02.	*Aegle marmelos* (L.) Corr.	Bel	t	HV
03.	*Albizia procera* (Roxb.) Benth.	Silkoroi	t	HV
04.	*Albizia saman* (Jacq.) F. Muell.	Raintree koroi	t	HV
05.	*Aponogeton natans*	Vasaghas	c	SV
06.	*Artocarpus heterophyllus* Lamk.	Kanthal	t	HV
07.	*Asparagus racemosus*	Satamuli	h	RSP
08.	*Azolla pinnata*	Kutipana	f	FFP
09.	*Bambusa vulgaris* Schard ex Wendle.	Bansh	h	HV
10.	*Barringtonia acutangula* (L.) Gaertn.	Hijol	t	FWSP, HV
11.	*Bombax ceiba* L.	Simul	t	HV
12.	*Calamus tenuis* Roxb.	Bet	c	HV
13.	*Centella asiatica* (L.) Urban.	Thankuni	h	HV, RFP
14.	*Cocos nucifera* L.	Narikel	t	HV
15.	*Colocassia esculenta* (L.) Schott.	Kochu	h	CFV, SMV
16.	*Croton bonplandianum*	Bon-tulshi	h	CFV
17.	*Cucurbita maxima* Duch. ex Lamk	Kumra	t	HV
18.	*Cynodon dactylon* (L.) Pers	Durba	h	CFV
19.	*Cyperus iria*	Murta-pata	s	RFP
20.	*Datura stramonium* L.	Dhutura	s	HV
21.	*Diospyros cordifolia*	Tamal	t	FWSP, HV
22.	*Diospyros peregrine*	Gab	t	FWSP, HV
23.	*Echinocholoa colonum*	Parua	h	RFP
24.	*Echinocholoa crus-galli*	Barashama	h	RFP
25.	*Eclipta alba* (L.) Hassk.	Kesuriya	h	SMV
26.	*Eichhornia crassipes*	Kocuripana	hy	FFP
27.	*Enhydra flactuans*	Helenca	h	RFP, SMV
28.	*Eranthus ravannae*	Ekra	h	FWSP
29.	*Erythrina variegata* L.	Mandar	t	FWSP, HV
30	*Euryale ferox*	Makna	s	RSP
31.	*Ficus benghalensis* L.	Bot	t	HV
32.	*Ficus hispida* L.	Dumur	t	HV
33.	*Ficus religiosa* L.	Ashwathwa	t	HV
34.	*Heliotropium indicum* L.	Hatisur, Bhurundi	h	CFV
35.	*Hydrilla verticillata*	Seola, Kureli	h	SV
36.	*Hygroryza aristata*	Phutki	h	SV
37.	*Imperata cylindrica* (L.) P. Beauv.	Chhon	h	RSP
38.	*Ipomoea aquatica*	Kalmishak	s	SMV
39.	*Ipomoea carnea* Jacq. subsp. *fistulosa* (Mart ex Choisy) D. Austin.	Dholkalmi	s	SMV
40	*Lagarosiphon roxburghii*	Hornwort	h	SV
41.	*Lagerstroemia speciosa* (L.) Pers.	Jarul	t	HV
42.	*Lemna perpusilla*	Khudipana	hy	FFP
43.	*Limnophila indica*	Angulighash	h	RFP
44.	*Mangifera indica* L.	Aam	t	HV
45.	*Marsilea quadrifolia*	Sushnishak	h	RFP
46.	*Melocanna baccifera* (Roxb.) Kurz	Muli	h	HV
47.	*Mikania cordata* (Burm. f.) Robinson	Assamlata	c	HV
48	*Musa paradisiaca* L.	Kola	h	HV
49.	*Nymphaea nouchali*	Shapla	h	RFP
50.	*Nymphaea pubescens*	Sada-shapla	h	SV
51.	*Nymphoides hydrophylla*	Panchuli	h	RFP
52.	*Ocimum sanctum* L.	Tulshi	s	HV
53.	*Ottelia alismoides*	Panikola-phul	h	SV
54.	*Phragmites karka*	Nal-khagra	s	RSP
55.	*Pistia stratiotes*	Jolkumbhi	hy	FFP
56.	*Polygonum glabrum*	Kukra	h	SMV
57.	*Polygonum stagninum*	Bishkanthali	h	SMV
58.	*Pongamia pinnata* (L.) Pierre.	Koroch, Kerung	t	FWSP
59.	*Saccharum spontaneum* L.	Kash	s	RSP

60.	*Sagittaria spp.*	Pani-kochu	h	RFP
61.	*Schumannianthus dichotomus* (Roxb.)	Patipata	s	CFV, HV, SMV
62.	*Scirpus juncoides*	Phul-ghash	h	SMV
63.	*Solanum melongena* L.	Begun	s	CFV
64.	*Solanum nigrum* L.	Tit-begun	s	CFV
65.	*Sylvania natans* L.	Tilokpana	f	FFP
66.	*Syzygium fruticosum* (Wall.) Masamune.	Putijam	t	HV
67.	*Terminalia catappa* L.	Kathbadam	t	HV
68.	*Trapa maximowiczii*	Singrah	h	RFP
69.	*Trewia nudiflora* L.	Pitali, Pitagula	t	FWSP
70.	*Typha elephantine*	Hogla	h	RSP
71.	*Utricularia aurea* Lour.	Pani-saibol	hy	FFP
72.	*Utricularia exoleata*	Bladderworts	hy	FFP
73.	*Vallisnaria spiralis*	Eelgrass	h	SV
74.	*Vetiveria zizanioides*	Binna	h	RSP, SMV
75.	*Wolffia arrhiza*	Khudipana	hy	FFP
76.	*Ziziphus mauritiana* Lamk.	Boroi	t	HV

*Habit of the plant: t = tree, s = shrub, h = herb, c = climber, f = fern, hy= moving hydrophyte.
**Habitat: HV = Homestead Vegetation, CFV = Crop Field Vegetation, FFP = Free Floating Plant, FWSP = Fresh Water Swamp Plant, RFP = Rooted Floating Plant, RSP = Reed Swamp Plant, SMV = Sedges and Meadows Vegetation, SV = Submerged Vegetation.

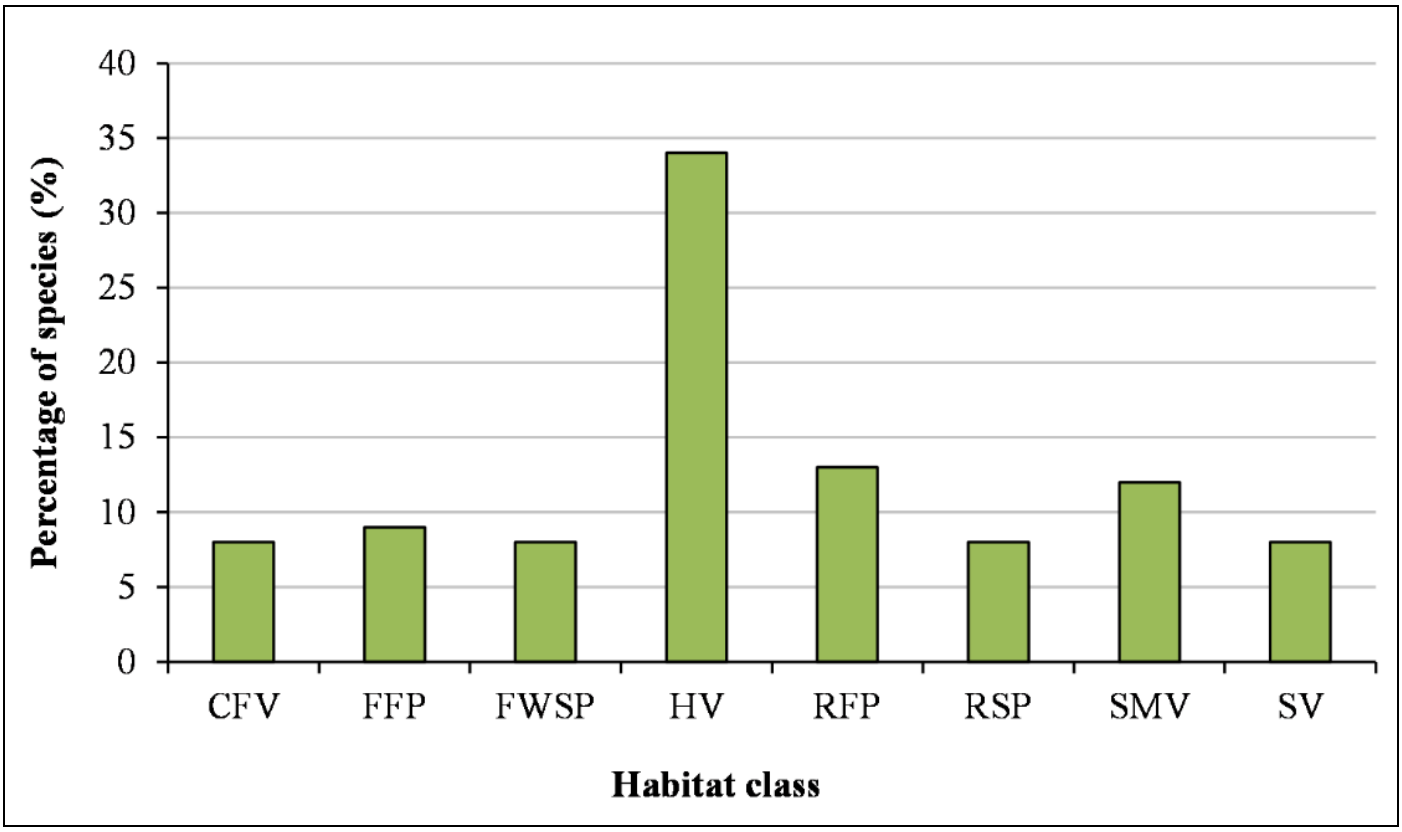

Fig 3: Percentage distribution of plant species in major habitat classes (Here, CFV = Crop Field Vegetation, FFP = Free Floating Plant, FWSP = Fresh Water Swamp Plant, HV = Homestead Vegetation, RFP = Rooted Floating Plant, RSP = Reed Swamp plant, SMV = Sedges and Meadows Vegetation, SV = Submerged Vegetation)

4.2. Faunal composition

The study revealed a total of 12 invertebrates and 123 vertebrate species from the study area (Table 3). A total of 12 amphibian species belonging to 10 genera were recorded. *Bufo melanostictus, Kaloula pulchra, Polypedates maculatus*, etc. were some common frogs and *Xenophrys parva* was the common toad species of the study area. A total of 57 bird species (belong to 49 genera) were enumerated from the wetlands. *Alcedo atthis, Ardea alba, Bubo bubo, Haliaeetus leucoryphus, Podiceps cristatus, Phalacrocorax fuscicollis*, etc. were some very common bird species that build their nest in the study area and have a tremendous influence on the maintenance of food-web and ecosystems. This research divulged a total of 31 fish species from the MH wetland, whereas 6 species were estimated as catfish. The study also enumerated 11 mammal species belonging to 10 genera, and 12 reptile species belonging to 9 genera from the MH wetland ecosystems (Figure 4).

Table 3: Recorded faunal species with their habit

SL. No.	Scientific Name	Vernacular Name	Habit
	Invertebrate		
01.	*Apis dorsata*	Moumachi, Bee	Flying insect
02.	*Formica rufa* L.	Piprah, Wood-ant	Eusocial insect
03.	*Helix pomatia*	Shamuk, Snail	Mollusk
04.	*Hirudo medicinalis*	Jonk	Parasitic leech
05.	*Lumbricus terrestris* L.	Earthworm	Worm
06.	*Macrobrachium rosenbergii*	Chingri/Prawn	Crustacean
07.	*Margaritifera margaritifera*	Jhinuk	Freshwater Mollusk
08.	*Nephila pilipes*	Makorsha, Spider	Insect
09.	*Odontotermes obesus*	Uoi, Termites	Eusocial insect
10.	*Sartoriana spinigera*	Kankra	Crustacean
11.	*Sympetrum flaveolum*	Dragonfly	Insect
12.	*Titanus giganteus*	Kath-poka, Beetle	Insect
	Vertebrate		
	Amphibian		
13.	*Bufo melanostictus*	Bengal frog	Frog
14.	*Euphlyctis hexadactylus*	Indian frog	Frog
15.	*Fejervarya limnocharis*	Alpine frog	Frog
16.	*Hoplobatrachus crassus*	Bull-frog	Frog
17.	*Hylarana garoensis*	Garo hill frog	Frog
18.	*Hylarana taipehensis*	Taipei bang	Frog
19.	*Kaloula pulchra*	Asian frog	Frog
20.	*Kaloula taprobanica*	Common Bull-frog	Frog
21.	*Microhyla ornate*	Ornamental frog	Frog
22.	*Occidozyga lima*	Green frog	Frog
23.	*Polypedates maculatus*	Common frog	Frog
24.	*Xenophrys parva*	Crowned toad	Toad
	Bird		
25.	*Accipiter virgatus*	Besra	Kite
26.	*Aegypius monachus*	Shokun	Vulture
27.	*Alcedo atthis*	Machranga	Kingfisher
28.	*Anas acuta*	Hansa, Duck	Water fowl
29.	*Anas crecca*	Teal	Water fowl
30.	*Apus affinis*	Chotopakhi	Swift
31.	*Aquila rapax*	Tawny-eagle	Eagle
32.	*Ardea alba*	Sada-bok	Bittern
33.	*Ardea cinera*	Gray heron	Heron
34.	*Aythya fuligula*	Duck	Water fowl
35.	*Batrachostomus hodgsoni*	---	Nocturnal frogmouth
36.	*Bubo bengalensis*	Eagle-owl	Owl
37.	*Bubo bubo*	Pencha	Owl
38.	*Burhinus indicus*	---	Thick-knee
39.	*Caprimulgus asiaticus*	Indian nightjar	Nightjar
40.	*Centropus sinensis*	Coucal	Cuckoo
41.	*Charadrius dubius*	---	Plover
42.	*Chrysococcyx maculatus*	Asian cuckoo	Cuckoo
43.	*Ciconia boyciana*	Bahari-sharosh	Stork
44.	*Ciconia ciconia*	Sada-sharosh, Heron	Stork
45.	*Ciconia nigra*	Kalo-sharosh	Stork
46.	*Clanga hastate*	Spotted eagle	Eagle
47.	*Columba livia*	Kobutor, Pigeon	Pigeon
48.	*Copsychus saularis*	Doyel	Flycatcher
49.	*Corvus macrorhynchos*	Dar-kak	Crow
50.	*Corvus splendens*	Pati-kak	Crow
51.	*Cuculus canorus*	Common cuckoo	Cuckoo
52.	*Ducula aenea*	Dolu-kobutor	Pigeon
53.	*Francolinus gularis*	Francolin	Allies
54.	*Fulica atra*	---	Gallinule
55.	*Grus grus*	Common crane	Crane
56.	*Gyps indicus*	Indian-shokun	Vulture
57.	*Haliaeetus leucoryphus*	Chil	Hawk
58.	*Heliopais personata*	Masked finfoot	Fin-foot
59.	*Hemicircus canente*	Kath-thokra	Woodpecker
60.	*Hemiprocone coronata*	Gachopakhi	Tree-swift
61.	*Hirundapus giganteus*	Needle-tail	Swift
62.	*Houbaropsis bengalensis*	Bengal florican	Bustard

63.	*Merops orientalis*	Pokavuk-pakhi	Bee-eater
64.	*Ocyceros birostris*	Dhanush	Hornbill
65.	*Pavo cristatus*	Peafowl	Grouse
66.	*Pavo muticus*	Green-peafowl	Grouse
67.	*Pelacanus philippensis*	Sarosh	Pelican
68.	*Phalacrocorax carbo*	Boro-pankure	Cormorant
69.	*Phalacrocorax fuscicollis*	Pankouri	Cormorant
70.	*Pitta brachyuran*	Indian-pitta	Pitta
71.	*Platalea leucorodia*	---	Spoonbill
72.	*Plegadis falcinellus*	Glossy-ibis	Ibis
73.	*Podiceps cristatus*	Cokha	Grebes
74.	*Pterocles indicus*	---	Sand-grouse
75.	*Rhipidura aureola*	---	Fantail
76.	*Strix ocellata*	Kath-pencha	Owl
77.	*Surniculus lugubris*	---	Cuckoo
78.	*Treron bicincta*	Sobuj kobutor	Pigeon
79.	*Upupa epops*	Hoopoe	Hoopoe
80.	*Vanellus indicus*	---	Lapwing
81.	*Zapornia akool*	Brown crake	Gallinule
	Fish		
82.	*Ailiichthys punctate*	Kajuli	Fish
83.	*Amblypharyngodon mola*	Mola	Fish
84.	*Batasio batasio*	Tengra	Fish
85.	*Catla catla*	Katol	Fish
86.	*Channa marulius*	Gozar	Fish
87.	*Channa punctate*	Taki	Fish
88.	*Channa striata*	Shoul	Fish
89.	*Chitala chitala*	Chital	Fish
90.	*Cirrhinus cirrhosis*	Mrigel	Fish
91.	*Clarias batrachus*	Koi	Catfish
92.	*Clarias gariepinus*	Magur	Catfish
93.	*Corica soborna*	Kechhki	Fish
94.	*Gagata youssoufi*	Shing	Fish
95.	*Glossogobius giuris*	Bele	Fish
96.	*Gudusia chapra*	Chapila	Fish
97.	*Labeo bata*	Bata	Fish
98.	*Labeo boggut*	Ghonia	Fish
99.	*Labeo calbasu*	Kalibaus	Fish
100.	*Labeo dyocheilus*	Ghora mach	Fish
101.	*Labeo rohita*	Ruhi	Fish
102.	*Lepidocephalichthys annandalei*	Gutum	Fish
103.	*Mastacembelus armatus*	Baim	Fish
104	*Mystus vittatus*	Tengra	Catfish
105.	*Neotropius atherinoides*	Batasi	Fish
106.	*Ompok pabo*	Pabda	Catfish
107.	*Pangasius pangasius*	Pangash	Catfish
108.	*Plotosus canius*	Gang-magur	Catfish
109.	*Puntius puntio*	Punti	Fish
110.	*Puntius sarana*	Shorpunti	Fish
111.	*Wallago attu*	Boal	Fish
112.	*Xenentodon cancila*	Kakila	Fish
	Mammal		
113.	*Bandicota bengalensis*	Indur, Rat	Rodent
114.	*Canis aureus*	Shiyal, Fox	Omnivorous mammal
115.	*Cynopterus sphinx*	Baduhr, Bat	Flying mammal
116.	*Felis chaus*	Ban-biral	Mammal
117.	*Lutra lutra*	Udh-biral	Mammal
118.	*Lutra perspicillata*	Otters, Bhodor	Mammal
119.	*Manis javanica*	Pangolin	Mammal
120.	*Prionailurus viverrinus*	Mecho-biral	Mammal
121.	*Ratufa bicolor*	Kath-birali, Squirrel	Tree-dwelling rodent
122.	*Viverra indica*	Baghdhash, Civet	Mammal
123.	*Vulpes benghalensis*	Bengal-fox	Omnivorous mammal
	Reptile		
124.	*Asperderetes hurum*	Monitor	Lizard
125.	*Enhydris gyii*	Kando-sap	Snake
126.	*Enhydris plumbea*	Dhankhet-sap	Snake
127.	*Geochlemys hamiltoni*	Common monitor	Lizard

128.	*Kachuga tecta*	Choto-girgiti	Lizard
129.	*Lissemys punctate*	Lizard	Lizard
130.	*Naja naja*	Gokra	Snake
131.	*Python molurus*	Monitor lizard	Lizard
132.	*Rhabdophis barbouri*	Barbor-sap	Snake
133.	*Rhabdophis lineata*	Zigzag-sap	Snake
134.	*Rhabdophis tigrinus*	Baghmara-sap	Snake
135.	*Varanus bitatawa*	Guishap	Lizard

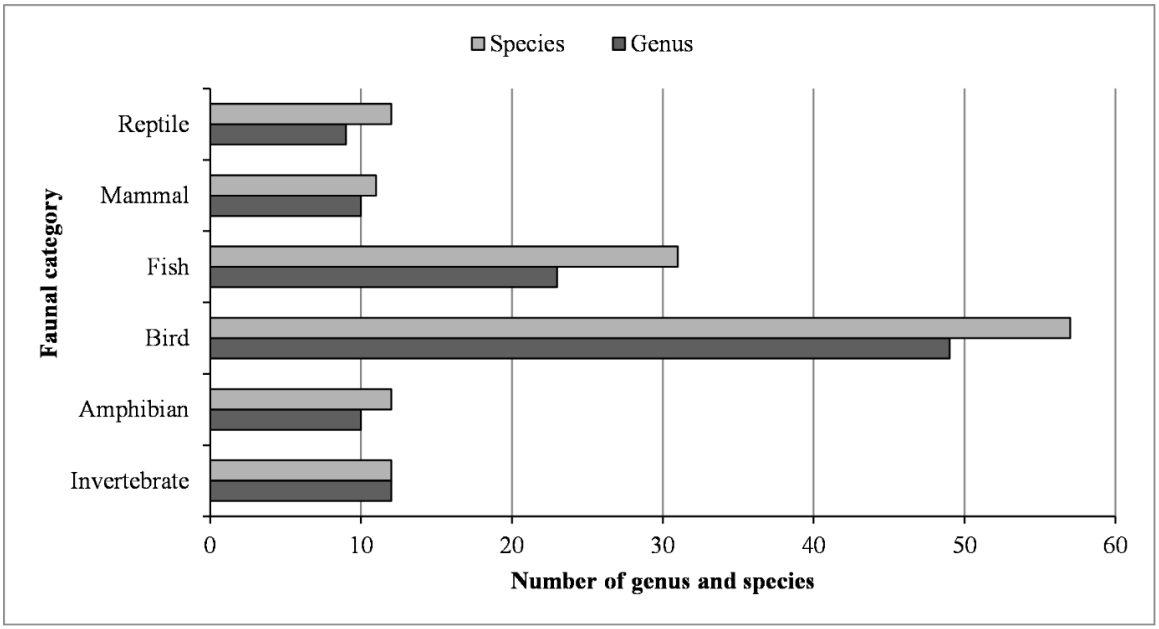

Fig 4: Number of genus and species of faunal composition in the MH wetlands

The present study indicated that bird species (46%) were higher than the other faunal species followed by fish species (25%) in the study area. Mammals in the study area possessed the lowest occurrence (9%). The population of amphibians and reptiles also seemed lower in the study area (Figure 5). It might be due to the severe anthropogenic disturbances, climate change, pollution, and lack of sustainable nature management. Fishermen are catching several native fish species, and residents are exploiting a variety of natural resources from the study area regularly.

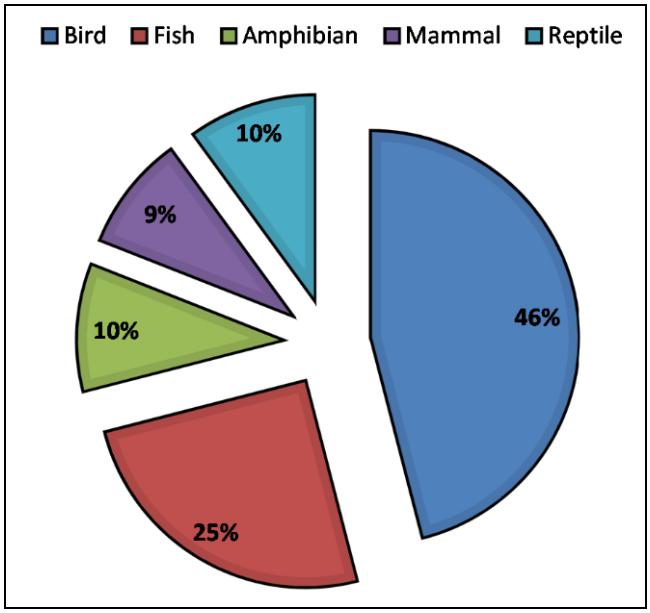

Fig 5: Percentage distribution of faunal species in the MH wetland ecosystems.

5. Discussion

This study divulged a total of 76 plant species from the MH wetlands ecosystem which was lower than of Hossain and co-researchers [21], but higher than of Das and co-researchers [29]. Hossain and co-researchers [21] enumerated a total of 164 plant species from the Tanguar haor wetlands, and Das and co-researchers [29] recorded 13 plant species from the Ratargul freshwater swamp forest of Bangladesh. On the other hand, a floral survey of IUCN at Tanguar haor wetlands of Bangladesh has estimated a total of 104 plant species under 88 genera and 51 families [30], which is comparatively higher than that of the floral composition (76 plant species belonging to 66 genera) of the MH wetlands enumerated by the present study.

During the fieldwork, it was observed that a huge number of residents are involving in catching fishes; hunting wild animals, specifically mammals, reptiles, etc.; shooting birds; and collecting non-wood resources from the wetlands to continue their livelihoods. Hence, catching, shooting and hunting of indigenous fishes and wildlife by the local hunters are a great threat to wildlife conservation in the MH wetlands, which are common scenarios in other wetlands and freshwater swamps of Bangladesh. The report of Das and co-researchers [29] showed that the floral and faunal diversity of the Ratargul freshwater swamp of Bangladesh is enormously disturbed by the rural communities.

The richness of fish (31 species) resources of the MH wetland was comparatively lower than Alam and co-researchers [16] recorded from the Tanguar haor wetland ecosystems. A total of 134 fish species was reported from the Tanguar haor wetland ecosystems [16]. The present research recorded some mollusk and crustaceans (i.e., *Helix pomatia*, *Sartoriana spinigera*, etc.) from the study area which are also common in

the Ratargul Freshwater swamp, reported by the other researchers [29].

Apparently, a considerable number of residents are fully or partially dependent on the floral resources, specifically non-wood forest products of the MH wetland ecosystems for firewood, fuel, thatching materials, and fodder. Such dependencies and resource exploitation hampered the biological diversity severely, disturbed the species breeding, and diminish the environmental vitality of MH wetlands. Both direct and indirect exploitation of resources, continuous fishing, fragmentation of animals' breeding ground, etc. were observed during the fieldwork. In that regard, habitats of wildlife and fishes in the MH wetlands are being vulnerable. Floral resources of the study area are more exploited gradually than others due to their availability and accessibility. Similar results were also excerpted from the tropical mixed evergreen forests of the Ratargul Freshwater swamp [29], Sitakunda Botanical Garden and Eco-park [31], Chunati Wildlife Sanctuary [32], etc. of Bangladesh.

Wetland ecosystems are the most vital habitats and breeding zones for aquatic organisms [21]. In this regard, MH ecosystems provide important habitat for several faunal species. But, due to several anthropogenic disturbances (i.e., over-exploiting, hunting, shooting, or catching resources) conducted by the residents and natural calamities (i.e., severe floods, climate change), natural resources (flora and fauna) of the MH ecosystems are depleting faster. Severe human interferences are disturbing the biological functioning, hampering the natural environment, and deteriorating the vegetation and fauna drastically. Hence, it is the right time to conserve and protect natural resources, optimize ecological functioning, and minimize the unsustainable resource uses of the MH wetland ecosystems.

As a haor-basin, there are several scopes to develop nature-based tourism (eco-tourism) in the MH wetlands. The eco-tourism sector could be a great source of income for local communities; mean of local economic improvement as well as useful to reduce environmental deterioration. On the other hand, the uses of heavy motors, trawlers, and engine boats in the name of tourism should be controlled and strictly forbidden during the breeding seasons of fishes, reptiles, and bird species. To conserve the existing natural resources of the MH wetlands, biodiversity-abundant areas should be protected and declared as core zones, and excessive fishing, hunting or any other activities that directly disturbed the species survival must be prohibited.

Moreover, residents of surrounding communities are not conscious of the conservation issues. They should aware of the conservation and prevention of this ecologically significant ecosystem. Afforestation programs with indigenous plant species, alternative income generations, participation of residents for biodiversity conservation, participatory forestry, etc. should be initiated in the study area. Adequate implications of forest law and policy, capacity building among the local communities, etc. also should take into account for the environmental amelioration of the MH wetlands.

6. Conclusion

The study enumerated the floral and faunal composition and revealed a wide range of diversity in the wetland ecosystems of the Medir haor in Bangladesh. The biological diversity of the Medir haor has a tremendous impact on ecological amelioration as well as environmental sustainability. Faunal species of the MH have a positive role in the ecosystem functioning as they dispense a significant contribution to maintain the integrality of the food chain, and sustain the ecological balance of the haor. They also deliver a significant benefit in the socio-economic upliftment of the adjacent residents. But, several floras, specifically non-timber species, and fish species are deteriorated faster due to over-exploitation. Hence, sustainable conservation measures are urgently needed to preserve them in their natural habitats. Creating natural nests and resting places for migratory birds are needed to increase the bird populations in the wetlands. This study also highly recommended sustainable wetland management approach, long-term planning, awareness-raising at all levels, policy implications, etc. to manage the MH wetland and its biological resources properly. The findings of this research would help in the management planning and also help in developing chronological baseline information of the Medir haor wetland ecosystems. Further study is also suggested for ascertaining the effective influences of biodiversity on the ecosystems of the Medir haor and vice-versa.

7. Consent

Authors have collected and preserved the written consent of respondents cautiously as per university standard or international standard.

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