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Dhonagoda River: Threats Investigation of River and Biodiversity for Policy Implementation

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Abstract

The River Dhonagoda is one of the important Rivers of Chandpur district with diverse fish biodiversity and supports livelihood for fisher's community. The present study was conducted from January 2016 to September 2017 to determine the threats on the River Dhonagoda and fish biodiversity and to document fish species with their present conservation status both in the context of Bangladesh and global aspects. The major threats to Dhonagoda River and its fish biodiversity were found to be the illegal River encroachments, use of River bank soil, indiscriminate killing and overexploitation of fish fry and fingerling, habitat destruction, use of destructive fishing gear and methods, silt bed, water pollution and lack of proper management initiatives. A total of 56 fish species were documented belonging to 9 orders and 23 families. The most dominant order was found to be Siluriformes consisting 32% of the total fish population. Cyprinidae was found to be the richest family (21.4%). In the studied areas 15 common groups were recorded where Catfish contributes the highest percentages (32%). River-Estuary was found to be the biggest habitat for the maximum number of fishes (50%). Among the total identified fish species from the River Dhonagoda, 13 threatened fish species (19%) were recorded in which 6 species (46%) were found as Vulnerable (VU), 5 species (38%) as Endangered (EN) and 2 species (16%) as Critically Endangered (CR). To save the River and to conserve its fish biodiversity best management practices have to be adopted and strictly implemented by the proper authority.

Introduction

Bangladesh is a great delta formed by the alluvial deposits of the three mighty Himalayan Rivers: the Ganges, the Brahmaputra and the Meghna. There are about 405 Rivers in Bangladesh [1]. The life and livelihood of the millions of people of Bangladesh have been revolving around waters of these Rivers over the ages. Dhonagoda is one of the important Rivers of Chandpur district with diverse fish biodiversity. But due to the multiple reasons, the River and its fish biodiversity is under serious threat.

Origin

Dhonagoda is a River in Sadar and Matlab upazila of Chandpur district of South-eastern Bangladesh. Being formed from the River Meghna upstream, River Dhonagoda has entered Chandpur district through Kalirbazar of Baganbari union of North Matlab upazila. Then it flows up to Amirabad bazar of Forayeji union of the same upazila and meets again in the upstream of the River Meghna [2].

Length

The length of the River is 41 km.

Width

The average width of the River is 299 meter.

Depth

The average depth of the River is 10 meter.

Area

The area of the River in the River basin is 38.78 square kilometre.

Water flow

There is water flow in the Dhonagoda River all the year round. But the lowest and highest (6370 cubic meter) water flow are found during the month of February-March and July-August respectively [3].

Vulnerability

It's a flood prone River.

Special case

Meghna Dhonagoda Irrigation Project (MDIP) is located at Northern part of Chandpur district and 40 km South-East of Dhaka near the confluence of the Padma and the Meghna River. MDIP comprises the gross area of 17584 ha in Matlab upazila of Chandpur district and is bounded on the North and the West by the mighty Meghna and on the East and the South by the Dhonagoda River. The Project is encircled by a 60.7 km of flood embankment completed in 1987. It has also a drainage canal of 125.50 km and an irrigation canal of 218 km [4].

In Bangladesh, research has been conducted on the diversity of fishes of many Rivers but study on the condition of River and its biodiversity has not been shown in brief. The aim of the study is to

investigate the threats and the impact of threats on the River Dhonagoda and fish biodiversity with the evaluation of their present conservation status both in the context of Bangladesh and Global aspects.

Figure 1: Map of the River Dhonagoda (Chandpur, Bangladesh).

Materials and Methods

Study sites

A total of 11 sampling sites of Matlab upazila were selected for the present study (Figure 1). The corresponding GPS reading of those sites were taken by the GPS meter given as below:

Study period

The study period was from January 2016 to September 2017 (Twenty months).

Data collection framework

Data were collected by using a semi-structured questionnaire through following methods:

FGD: Focus Group Discussion is one of the most popular qualitative research methods in which people from similar backgrounds or experience are interviewed to discuss a specific topic of interest. FGD was conducted in fish landing centers, fish bazar adjacent to the River and fishers village of the selected sampling sites.

Key informant interviews: Key informants interviews are qualitative in-depth interviews to collect information from a wide range of people-including community leaders, professionals or residents-who have first-hand knowledge about a topic of interest. Information regarding River and fish were collected through face to face interview of boat owners of commercial fishing vessels, fish retailer, fish traders, fisherman, Riverside settlers and local community leaders from and around the sampling sites (Table 1).

Direct observation: The River condition such as River flow, River water pollution, River dams and submersible char were assessed through personal field observation. Fish catch by different fishing nets and traps were also observed with the help of fisherman.

Information crosscheck: Information collected through FGD, Key informants interview were crosschecked by the different literature and books related to River and fish.
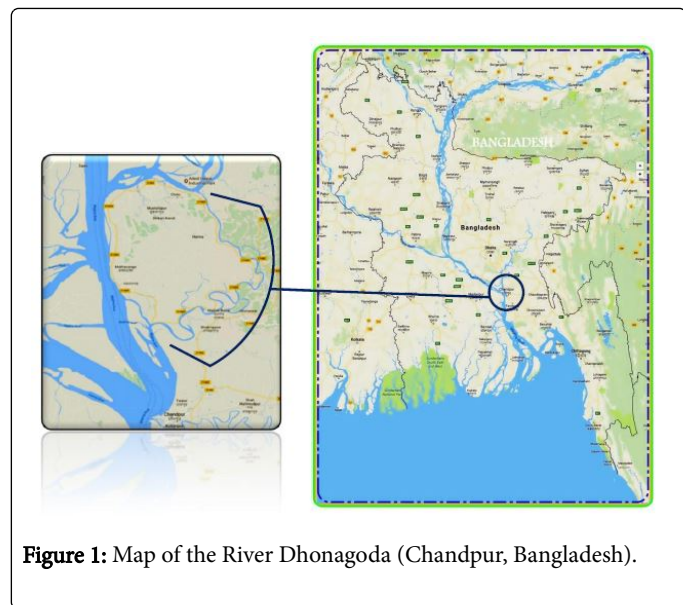
Sampling Station No.	Name of the Sampling Stations	Latitude (N)	Longitude (E)
1	Matlab Ferighat Area	230 20' 57.547"	900 42' 18.288"
2	Shaheb Bazar, Enayetnagar	230 22' 26.220"	900 42' 30.764"
3	Machua khal	230 23' 19.230"	900 45' 00.746"
4	Char Shibpur	230 24' 37.466"	900 44' 18.602"
5	Nandapur Bazar	230 25' 06.910"	900 43' 38.687"
6	Durgapur Bazar	230 26' 06.528"	900 42' 23.633"
7	Srirayer char launch terminal	230 27' 17.083"	900 42' 19.290"
8	Dhanagoda Bazar	230 28' 02.489'	900 41' 49.766"
9	Kalir Bazar	230 29' 03.377"	900 41' 24.507"
10	Janata Bazar	230 20' 20.780"	900 39' 02.429"
11	Gazipur Bazar	230 21' 22.564"	900 41' 04.691"

Table 1: Sampling stations with corresponding GPS values.

Fish specimen identification

From the fisherman's catch landed at different fish landing centers of the selected sampling sites and from fish bazars adjacent to those

sites, fish specimens were collected. To capture photos of different fish specimens, a digital camera was used. The collected fish samples were then identified by analyzing their morphometric and meristic

characteristic following [5]. The valid scientific names of the identified species were ensured by checking Catalogue of Fishes [6].

Threat identification

River threat: Trends of present and future threats of the River were identified on the basis of FGD, Key informants interview and personal observation.

Fish biodiversity threat: Present and future threats on fish species composition, fish biodiversity and availability were identified from the evaluation of data collected through FGD, Key informants interview and personal observation.

Determination of conservation status

Local conservation status: Local conservation status was determined by following the database IUCN Bangladesh [7].

Global conservation status: Global conservation status was determined by following database of IUCN 2017 [8].

Data analysis

Computer software Microsoft Excel 2010 was used for data analysis and graphical presentation.

Determination of recommendations

Recommendations were made after analyzing and evaluating data such as the nature of threats on River and fish biodiversity, given by the key informants and others with their particular knowledge and understanding. Some recommendations were also made from the authors' personal observations and experience.

Results

Status of physical trends

The River Dhonagoda is very important in the context of navigation, fishing, business and irrigation. The River condition is not as same as it was in the past. The changes recorded during the study period are shown in the Table 2:

Past	Present
Torrential	Less current
Wide	Less especially in bazar or factory area
Well navigation route (Steamer, Launch, Big boats, Trawler)	Navigation route is almost close
Well business route	Business route is almost nonetheless
Neat and clean environment	Dirty environment
Plenty of fish abundance	Less fish abundance
Less use of illegal nets	High use of illegal nets

Table 2: Status of physical trends of Dhonagoda River.

Trends of threat

River threats:

Illegal River encroachment: Many illegal establishments were developed through encroachments and recorded during the study period.

River water pollution: River water was found to be polluted either Indirectly: Pesticides, insecticides used in agricultural land are washed out during the monsoon rain and polluting the River water indirectly.

Directly: Garbage, Plastics thrown directly to the River and rice mills sewage are polluting the River directly.

Construction of dam: Dams built for irrigation might create threats to the River.

Use of River bank soil: River bank soil was found to be taken and used for making bricks which creates immense threats to the River.

Unplanned and massive withdrawal of sand from the River: Unplanned and massive withdrawal of sand from the River were recorded which seemed to be very harmful.

Increase of water hyacinth: Water hyacinth was recorded in plenty in the River.

Fish biodiversity threats

Illegal fish farming:

Jakh system: Jakh fishing is a traditional fishing system in Matlab upazila of Chandpur district. It's a one kind of attracting fish shelter which is made of Bamboo, brunches of trees, net, rope, feed etc. Almost 500-600 Jakh were recorded during the study period.

Ber/Bamboo fence system: In two sides and mid landscape of the River, a total of 20-30 bamboo fences were recorded in 41 kilometers of the River starting from Matlab South to Matlab North.

Use of harmful nets: Different harmful nets such as gill net (current jal), mosquito net with very small mesh size had been found to be used enormously to harvest fish. Gravid Punti, Tengra, Koi, Pabda, Dhela, Bele, Kuchia were found to be harvested by mosquito net and juveniles of Pangas, Rui, Katla, Ayre were found to harvested by current net. Indiscriminate killing of jatka (Hilsa juvenile) was found to be most destructive use of current nets as Hilsa is national fish species in Bangladesh.

Construction of dam: Construction of dam which might create threats to fish biodiversity.

River water pollution: Water polluted by wastage of rice mills and other garbage were creating huge threats to fish biodiversity.

Rise of submersible char: Submersible char (silt bed) were recorded which creates immense threat to fish species composition.

From the 11 sampling stations a total 56 species were recorded including 9 orders and 23 families. List of existing fish species with their taxonomic position (Order and Family name), scientific name, local name, common group, habitat and their conservation status in Bangladesh and global aspects are presented in Table 3:

Order	Family	Scientific name	Local name	Group name	Habitat	IUCN Conser-vation Status (BD)	IUCN Conser-vation Status (GB)
Pleurinectiformes	Soleidae	*Brachirus pan*	Kayhalpata	Soles	E-R	-	LC
Synbranchiformes	Synbranchidae	*Monopterus cuchia*	Kuchia	Eels	R-E	VU	LC
	Mastacembelidae	*Mastacembelus armatus*	Baim	Eels	R-E	EN	LC
Beloniformes	Belonidae	*Xenentodon cancila*	Kakila	Gars	R-E	LC	LC
Channiformes	Channidae	*Channa punctatus*	Taki	Snakeheads	E-R	LC	NE
Cypriniformes	Cyprinidae	*Salmostoma acinaces*	Chela	Barbs & Minnows	R	LC	LC
		Esomus danricus	Darkina	Barbs & Minnows	R-E	LC	LC
		Devario devario	Banspata	Barbs & Minnows	R	LC	LC
		Amblypharyngodon mola	Mola	Barbs & Minnows	R	LC	LC
		Puntius sarana	Sarpunti	Barbs & Minnows	R-E	NT	LC
		Puntius ticto	Tit punti	Barbs & Minnows	R	VU	LC
		Labeo calbasu	Kalibaus	Carps	R	LC	LC
		Labeo rohita	Rui	Carps	R-E	LC	LC
		Labeo bata	Bata	Carps	R	LC	LC
		Gibelion catla	Catla	Carps	R-E	LC	LC
		Cirrhinus mrigala	Mrigal	Carps	R-E	NT	LC
		Cirrhinus reba	Raek	Carps	R	NT	LC
Siluriformes	Siluridae	*Wallago attu*	Boal	Catfishes	R-E	VU	NT
		Ompok pabda	Pabda	Catfishes	R	CR	NT
	Schilbeidae	*Silonia silondia*	Shilong	Catfishes	R-E	LC	LC
		Ailia coila	Kajuli	Catfishes	R-E	LC	NT
		Neotropius atherinoides	Batasi	Catfishes	R-E	LC	LC
		Eutropiichthys vacha	Bacha	Catfishes	R-E	LC	LC
		Clupisoma garua	Gharua	Catfishes	R-E	EN	LC
	Pangasidae	*Pangasius pangaius*	Pangas	Catfishes	R-E	EN	LC
	Bagridae	*Rita ritra*	Rita	Catfishes	R-E	EN	LC
		Sperata aor	Air	Catfishes	R-E	VU	LC
		Mystus bleekeri	Gulsha tengra	Catfishes	R	LC	LC

		Mystus vittatus	Tengra	Catfishes	R-E	LC	LC
	Sisoridae	*Nangra nangra*	Gang tengra	Catfishes	R	LC	LC
		Gagata cenia	Gang tengra	Catfishes	R-E	LC	LC
		Gagata youssoufi	Gang tengra	Catfishes	R-E	NT	NE
		Bagarius bagarius	Baghair	Catfishes	R-E	CR	NT
	Ariidae	*Osteogeneiosus militaris*	Apuia	Catfishes	E-R	LC	NE
		Arius gagora	Gagla	Catfishes	E-R	NE	NE
Clupeiformes	Clupeidae	*Corica soborna*	Kachki	Clupeids	R-E	LC	LC
	Engraulidae	*Coilia dussumieri*	Olua	Anchovies	E-R	LC	NE
Osteoglossiformes	Notopteridae	*Notopterus notopterus*	Foli	Feather- backs	R-E	VU	LC
		Chitala chitala	Chitol	Feather- backs	R-E	EN	NT
Perciformes	Polynemidae	*Polinemous paradiseus*	Tapasi	Threadfins	E-R	LC	NE
	Mugilidae	*Rhinomugil corsula*	Khursula	Mullets	E-R	LC	LC
		Mugil cephalus	Bhangan bata	Mullets	E-R	LC	LC
	Anabantidae	*Anabas testudineus*	Koi	Perches	R	LC	DD
	Osphronemidae	*Trichogaster lalius*	Lal kholosa	Perches	R	LC	LC
		Ctenops nobilis	Neftani	Perches	R-E	LC	N
	Ambassidae	*Chanda nama*	Nama chanda	Perches	R-E	LC	LC
		Parambassis ranga	Ranga chanda	Perches	R-E	LC	LC
	Nandidae	*Nandus nandus*	Vheda	Perches	R-E	NT	LC
		Nandus meni	Meni	Perches	R	NE	NE
	Gobiidae	*Pseudopocryptes elongates*	Chewa	Mud-skippers	E-R	LC	LC
		Parapocryptes batoides	Dali chewa	Mud-skippers	E-R	LC	NE
		Awaous grammepomus	Bele	Mud-skippers	E-R	VU	LC
		Glossogobius giuris	Bele	Mud-skippers	E-R	LC	LC
		Trypaunchen vagina	Shada chewa	Mud-skippers	E-R	LC	NE
		Odontamblyopus rubicundus	Lal chewa	Mud-skippers	E-R	LC	NE
	Silaginidae	*Sillaginopsis panijus*	Tular dandi	Flathead	E-R	LC	NE

*Not Evaluated (NE), Data Deficient (DD), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR).

*River (R), River-Estuary (R-E), Estuary-River (E-R).

*BD=Bangladesh, GB=Global.

Table 3: List of fish species collected from the River Dhonagoda.

Impact of threats

Impacts of River threats:

Decrease of River wideness: Wideness of River was found to be decreased a lot and will be decreased in many areas if proper steps won't be taken urgently.

Destruction of natural River environment: Natural environment were found to be destructed due to the encroachment of River.

Decrease of River depth: Average depth of the River was found to be decreased as a result of man-made activities.

Degradation River ecosystem: River ecosystem was found to be degraded due to the River water pollution.

Changes in River course: River course or flow might be changed due to the effects of dams built in the River.

Sudden flooding: Sudden flooding may occur due to the decrease of wideness and depth of the water.

Rise of submersible char: At least 10-12 submersible char (silt bed) were recorded in the whole River due to the deposition of silt, sand and the number might be increased in future which is very alarming.

Closed naval route: The navigation route is almost close due to the rising of submersible char in the River.

River bank erosion: River bank erosion could be occurred due to the unplanned and massive withdrawal of sand from the River bank.

Impacts of fish biodiversity threats

Decrease of fish abundance: Mostly fish juveniles are caught in the Jakh or bamboo fencing system for which the abundance and diversity of fish were found to be extremely decreased and will be impacted severely (Figures 2-4).

Prevention/hampering in fish breeding: The gravid fishes which are being caught in mosquito nets could not be able to take part in breeding activity which means the failed to leave future generation.

Decreased survival of eggs and juveniles: Survival rate of eggs and juveniles were found to be decreased and will be seriously decreased due to the massive River water pollution.

Figure 2: Pictorial view of jakh farming in Dhonagoda River.

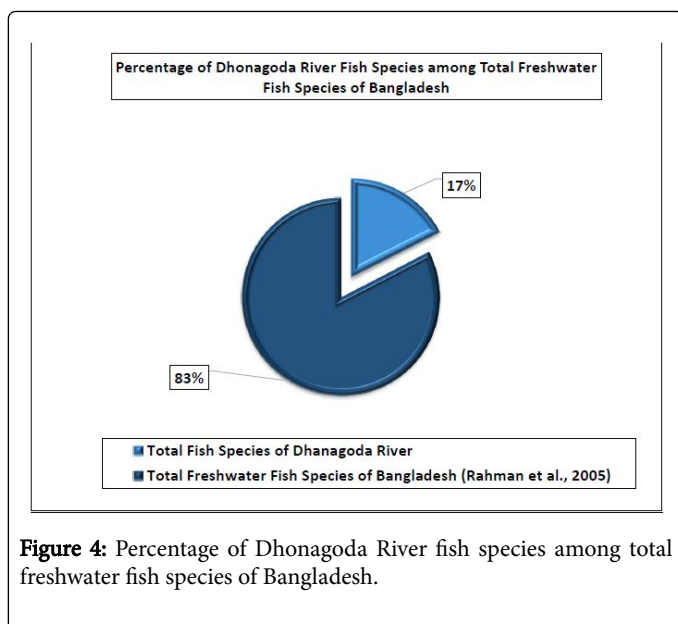**Figure 3:** Pictorial view of Dhonagoda River and its embankment.

Figure 4: Percentage of Dhonagoda River fish species among total freshwater fish species of Bangladesh.

Interruption in fish migration: Hilsa Fish migration could be interrupted due to the obstacle created by the dam and submersible char in the River which generally migrate from sea to the River for breeding purpose.

Loss of fish habitat: Fish habitats were found to be lost at very fast speed due to various harmful human activities.

Increased exposure to predation: Fish were exposed to high predation due to less depth of River and water created due silt bed.

Decreased fish production: Overall fish production from that River could be seriously decreased in the future if no action taken as early as possible.

Extinction of fish species: Many species were found previously which were not recorded during the study meaning the species are going to be threatened.

Degradation of biodiversity: Decrease of fish species was found to be created negative impact on food chain. If any function is loss of an ecosystem then catastrophic situation might be occurred.

Fish Biodiversity

Percentage composition of Dhonagoda River fish species: The total identified fish species (56) of the River Dhonagoda is 17 % of the total fresh water fish species (265) recorded by Rahman [9].

Order wise percentage of Meghna River fish species: Siluriformes was found to be the most dominant order consisting 32% of the total fish population followed by Perciformes (30.4%), Cypriniformes (21.4%) (Figure 5).

Family wise percentage of Dhonagoda River fish species: The richest family was found to be Cyprinidae (21.4%) followed by Gobiidae (6%) and Schilbeidae (6%) (Figure 6).

Different common groups of Dhonagoda River fish species: Fifteen (15) common groups were recorded in the present study. Catfishes contributes the highest percentage (32%) followed by Perches (12.5%) (Figure 7).

Habitat percentage of Dhonagoda River fish species: River-Estuary was found to be the biggest habitat for the maximum number of fishes (50%) followed by Estuary-River (27%) and River (23%) revealed from the present study (Figure 8).

Local conservation status of Dhonagoda River fish species: In Bangladesh, 64 native freshwater fish species have been declared as threatened species [7]. Among them 13 fish species were recorded from the River Dhonagoda, which is 17% of total threatened fishes of Bangladesh (Figure 9). The threatened species was 19% of the total identified species of Dhonagoda River. Out of the 13 fish species, 6 species (46%) were found as Vulnerable (VU), 5 species (38%) as Endangered (EN) and 2 species (16%) as Critically Endangered (CR) (Figure 9).

Local conservation status of Dhonagoda River fish species showed that the highest percentage was recorded as Least Concern (63%) followed by Vulnerable (11%), Endangered (9%) and Near Threatened (9%). Only 2% fish species were occupied by both critically endangered and Data Deficient category (Figure 10).

Global conservation status of Dhonagoda River fish species: According to IUCN [8], the highest percentage of fish species was occupied by the Least Concern category (68%) followed by Not Evaluated (19%) and Near Threatened (11%) category. Only 1% of the total fish species was recorded as Data Deficient category (Figure 11).
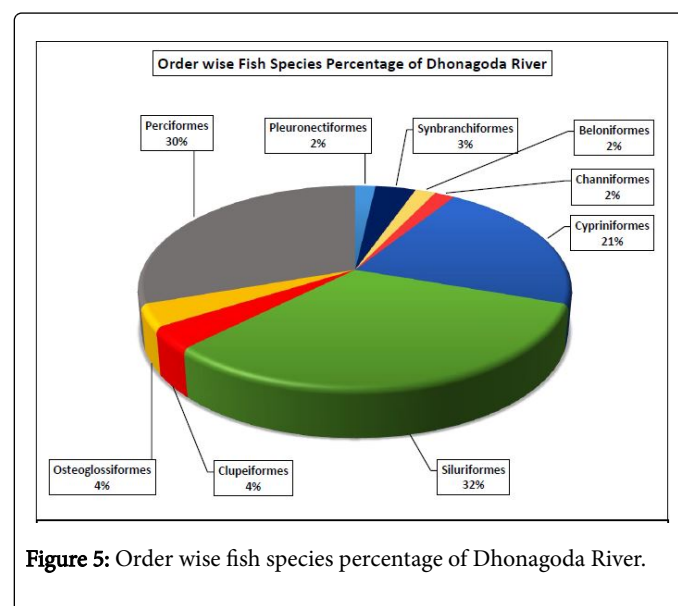

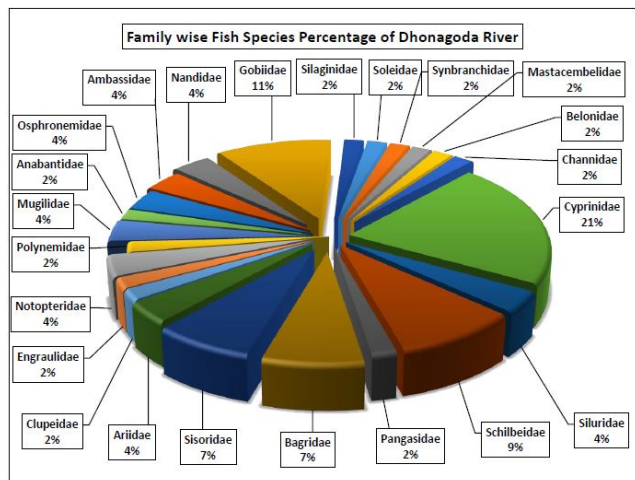**Figure 5:** Order wise fish species percentage of Dhonagoda River.

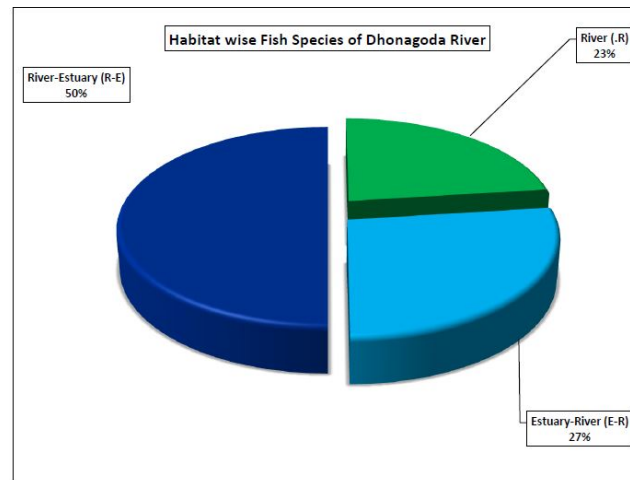**Figure 6:** Family wise fish species percentage of Dhonagoda River.

Figure 8: Habitat wise fish species of Dhonagoda River.
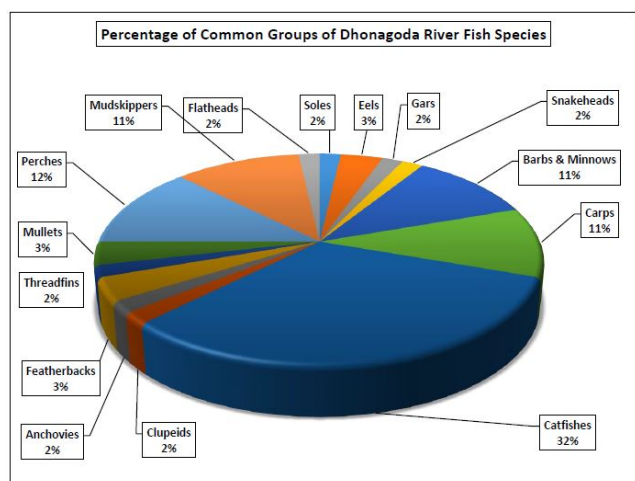

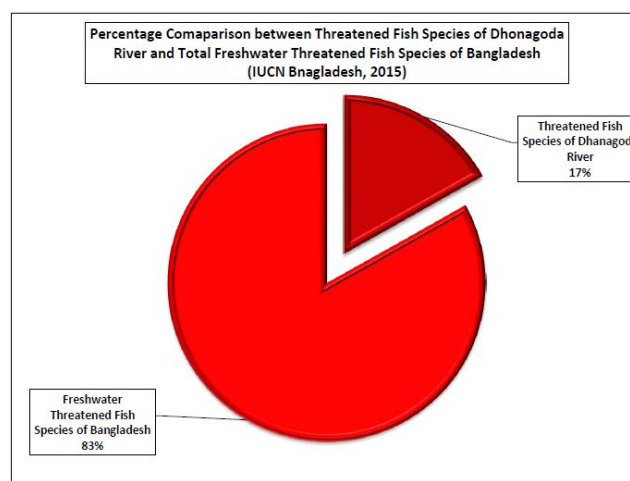**Figure 7:** Percentage of common groups of Dhonagoda River fish species.

Figure 9: Percentage comparison between threatened fish species of Dhonagoda River and total freshwater threatened fish species of Bangladesh.
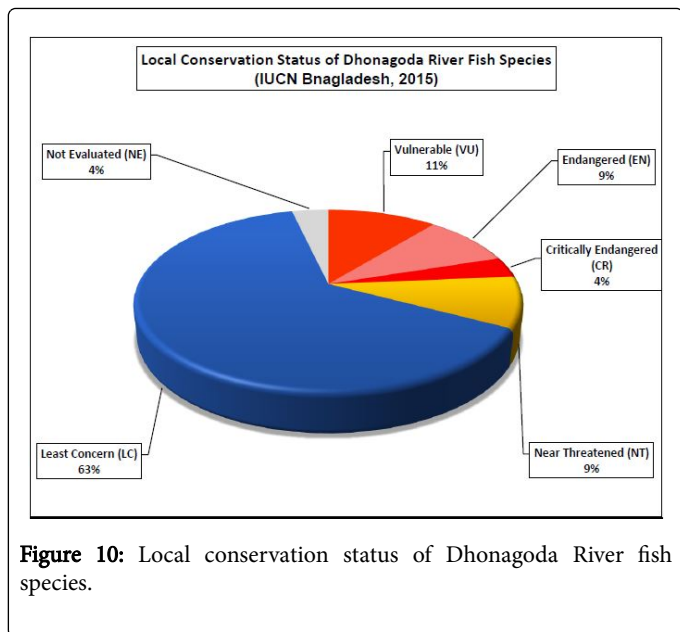
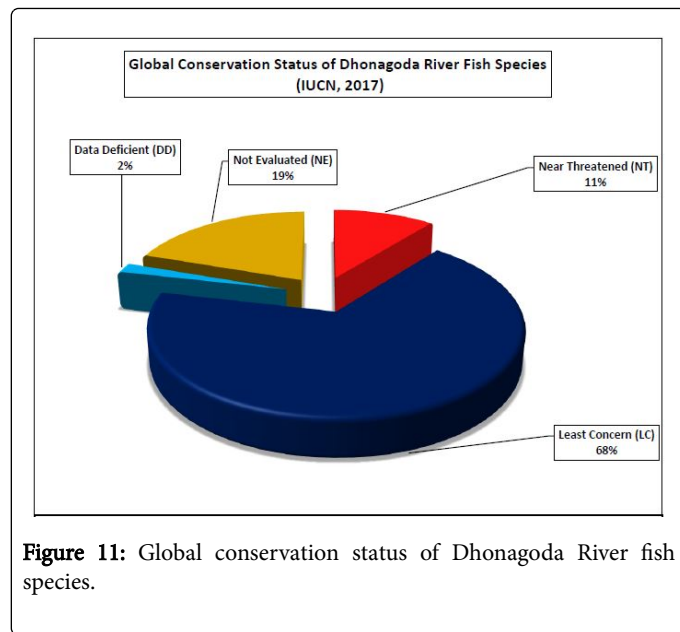**Figure 10:** Local conservation status of Dhonagoda River fish species.

Figure 11: Global conservation status of Dhonagoda River fish species.

Discussion

River is very important for a country like Bangladesh as it serves the people in many aspects. Blocking the movements of migratory fishes along River courses by dams is a major concern throughout Asia. Secondary environmental pressures such as increases in pollution and increased exploitation and extraction of the resources (primarily water, fish and substrates) might have severe negative impact on the River [10]. Fish exploitation through Jakh system (It's a one kind of attracting fish shelter which is made of Bamboo, brunches of trees, net, rope, feed etc.) in the River Dhonagoda was found to be harmful for the biodiversity of fishes.

Fisheries production in downstream reservoirs [11], River channels [12] and estuary and marine environments [13] might be affected significantly due to the blocking of nutrient flow throughout the ecosystem. Some Riverine fisheries can be enhanced because of foraging opportunities below dams particularly the migratory fishes [14]. Fisheries productivity throughout the system can be impacted negatively if the altered hydrology curtails or eliminates normal, historical downstream flooding occurred by dams [15-18].

Traditional and culturally-important fisheries can be challenged or eliminated due to the modifications to or loss of the natural River environment which supports fish stocks [19]. Suspended solids and sedimentation trapped by the reservoirs increases turbidity which can limit primary production and decrease depth that eventually influence the biotic community [10]. Increased pollutants from industrial, agricultural and urban wastes can reduce fish survival, reproduction, and growth and may bioaccumulate in fish tissue often rendering them unsuitable for human consumption [20]. Absence or excess of aquatic vegetation can be harmful for fish and fisheries [21]. Siltation can limit the fish production by degrading the availability of suitable spawning sites [22]. Water pollution was recorded as one of most dreadful threats for the River Dhonagoda as well as fish biodiversity.

Fish species composition as well as water quality, water depth and velocity can be affected by flow modifications [23]. Fish abundance and fisheries yields can be increased through stocking of fish juveniles which will eventually restore threatened and endangered species [24]. Depth of the River Dhonagoda was found to be lower which is not good for fish. Fishing mortality can be controlled through the implementations of fishery regulations, fisher education, and public awareness. Amarasinghe [25] demonstrated that through fisher participation, fishery regulations on artisanal fisheries could be effectively implemented imposed by the Sri Lankan government.

Fish passes can be a better option to facilitate the upstream or downstream migration of aquatic organisms over obstructions to migration such as dams. In Tasmania, to assist fish movements particularly for commercially important migrating eels, dams and gauging weirs have been constructed [26]. Yeamin et al. [27] identified major threats to the fisheries resources in the Rupsha River which include destructive fishing methods, indiscriminate fishing of fry-fingerlings and gravid females, habitat modification, water diversion, siltation, low water velocity which are also common in the present study. They also noted that Khan Jahan Ali Bridge over the Rupsha River might have detrimental effects on feeding and spawning ground for fishes and might interrupt the migratory routes. Several authors of Bangladesh reported different fish species composition for different Rivers [28]. Not a single work had been done previously on the Dhonagoda River and its fish biodiversity. Hossain et al. [29] gave a list of 293 fresh water fish species which includes 13 orders and 61 families. Rahman et al. [9] documented a list of 265 freshwater fish species in Bangladesh belonging to 154 genera and 55 families.
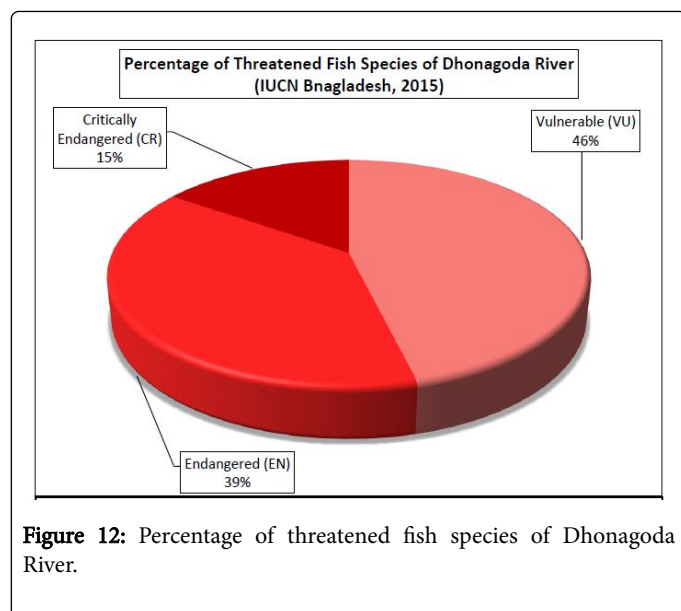
Figure 12: Percentage of threatened fish species of Dhonagoda River.

In the present study 56 fish species under 9 orders and 23 families were recorded whereas Pramanik, et al. [30] recorded a total of 107 species under 13 orders and 36 families in the River Meghna (Figure 12).

Siluriformes was found to be the most diversified order followed by Perciformes and Cypriniformes in the River Dhonagoda. Pramanik, et al. [30] recorded Perciformes the most dominant order consisting 32% of the total fish population followed by Siluriformes (29%) and Cypriniformes (16%). These three groups were also found to be dominant by Galib et al. [31]. In the present study was Cyprinidae was found to be the most dominant family which is similar to the study. Rahman [9] showed the dominance of this family in the fresh water fishes of Bangladesh. In terms of fish species composition Catfish was recorded the most dominant group in the Dhonagoda River which is similar to the findings. The biggest habitat for the fishes was found to be River-Estuary in the present study whereas Pramanik, et al. [30] recorded Estuary-River as the biggest habitat. The IUCN Red List tries to reduce species extinction through suggesting the importance of conservation issues to the public and policy makers [32]. Pramanik et al. [30] found 21 threatened fishes in the Meghna River whereas in the present study 13 fishes were recorded as threatened fish. Nearly one-third (59%) of the total species were belonging to Least Concern category of Global conservation status recorded by Pramanik, et al. [30] which is very similar to the present study (68%). In the Global conservation aspects not a single species of the identified fishes was found under threatened category. As for example, *Bagarius bagarius* was considered Critically Endangered (CR) in Bangladesh but it was categorized as Near Threatened (NT) globally.

Conclusions and Policy Recommendations

The present study aims to investigate the threats and impact of threats on the River Dhonagoda and its fish biodiversity. Present conservation status indicates the alarming threat to the fish species composition in Bangladesh. The River condition was not found to be good with respect to velocity, depth and navigability.

The followings are recommended for policy making, implementation, and conservation of fish biodiversity in the River Dhonagoda as well as to save the River:

- River borders should be restricted from encroachment.
- Navigation should be started to the whole River and excess aquatic vegetation should be controlled to facilitate navigation.
- Dredging should be conducted to increase the depth of the River.
- Use of agrochemicals such as pesticides, insecticides should be reduced and farmers should be encouraged to introduce integrated pest management.
- Dams, bridges should be reconstructed in such way which will neither alter water course nor decrease water velocity.
- Sufficient forest trees should be planted to protect River bank from erosion.
- Collaboration among Govt. and the political parties should be initiated to protect the River.
- Destructive fishing methods should be banned.
- Fish pass should be introduced to facilitate fish migration.
- Restocking of commercially important fish juveniles should be done every year.
- Fishing ban should be imposed for a certain period of time in the River.
- River-centric Community based organizations should be encouraged for better management and co-management: 'Jal jar jola tar'.
- Indiscriminate killing of gravid fish and juveniles by illegal harmful nets and traps should be stopped.
- Enforcement and strict implementation of legislation and proper monitoring should be done to protect River and fish.
- Awareness should be created among the fisherman and mass people and further research should be initiated.

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Conflict of Interest

There is no conflict of interest.

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