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Fishermen livelihood and fishery resources of the Sundarbans reserved forest along the Mongla port area Bangladesh

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Abstract
Fishermen livelihood and aquatic resources of the Sundarbans Reserved Forest area along the Mongla port, Khulna has been focused in this study. Poor fisher communities of Mongla upazila considered as marginalized communities as completely dependent on Sundarbans aquatic resources for their food security and income needs. The overall aim of this study is to monitor the availability of fisheries resources and to understand the livelihood of fisher folk. A set of socioeconomic based questionnaire survey of 4 different fisher folk communities, basic water quality measurement and fish availability monitoring were done to make sense the overall impact situation exists in that area. Basic water quality of Mongla port area were measured carefully and it was fine according to the accepted standard. Total 79 species were recorded from the study area where fresh water and marine fish species under 30 families, 18 species of shrimps under 2 families, 6 species of crabs belong to 4 families and 1 lobster. The unavailability of pure drinking water, unhygienic sanitation, food scarcity during falloff season of fishing, water pollution and drastic declination of fishes are making the livelihood of poor fishers more vulnerable. Poison fishing, Oil pollution, Overexploitation and unethical management of aquatic resources were found to be the key factors for the declination of fishery resources. Some earnest intervention for the fisher folk by the government with the creation of alternative jobs, pure drinking water supply, food and health security establishment are identified.

Keywords: Available Fisheries resources, Demography, Threats, Earnest supplication

1. Introduction
The Sundarbans mangrove forest, one of the largest such forests in the world (140,000 ha), lies on the delta of the Ganges, Brahmaputra and Meghna rivers on the Bay of Bengal. It is adjacent to the border of India's Sundarbans World Heritage site inscribed in 1987 [1]. The site is intersected by a complex network of tidal waterways, mudflats and small islands of salt-tolerant mangrove forests, and presents an excellent example of ongoing ecological processes. It is recognized as biodiversity hotspot including terrestrial, aquatic and marine micro to macro flora and fauna supporting which listed more than 200 fish species and 30 Crustaceans species [2]. It is estimated that over 6 million people are benefiting either directly or indirectly by the Sundarbans mangrove resources in the coastal region [3]. Mongla Port is situated on the East Bank of Pussur River near the confluence of Pussur River and Mongla Nulla at Channel distance of 71 Nautical Miles from the Fairway Buoy situated (Lat. $21^0$26.9` N. long. 89^0 34.4 E) in the Bay of Bengal. The port provides facilities and services to the international shipping lines and other concerned agencies providing shore based facilities like jetties, godowns, cargo handling equipment and maintaining adequate water depth in the channel as well as making provision for safe day and night shipping [4]. However, the port is very important and situated next to the world heritage site the Sundarbans Reserve forest, it plays a hazardous roles for terrestrial and aquatic biodiversity as well as for the surroundings. The vicinity of Mongla port area and livelihood of fisher folk are not well known. Hence, the present study concentrates on the availability of fisheries resources as well as fisher folk's socioeconomic status with a particular focuses on the impact of anthropogenic stressors and shocks on livelihood and aquatic resources.

2. Materials and Methods
The study carried out in Mongla Upazila and Mongla port vicinity of the Sundarbans area from December 2014 to June 2015. Basic water qualities of the study area were monitored such as pH, Salinity, Dissolved Oxygen (DO), Total dissolved solids (TDS), Electrical conductivity

(EC) and water temperature by using pH meter, Refractometer, DO meter and EC meter. The investigated values were compared with the previous studies to understand the existing scenario or any changes. Several routine investigations were done to monitor the availability of fishery resources of Sundarbans along the Mongla port area. The investigations were followed by the monitoring of local fish markets and different places where fishes generally are grounded after being caught by the fishers. To look into the livelihood of fishers, a total of 136 fishermen were interviewed by the structured questionnaire at their houses. The fisher folk survey sites were Dhanmari under Khulna and Joymonighol, Kanainagar, Katakhali, Chila bazar under Bagerhat district of Mongla port area (Figure 1). The final questionnaire included the questions on the socio demographic condition like age, family members, education, medical facilities, drinking water sources, fishing status and factors affecting the level of fish production. The collected fishes were identified by using books such as Fresh water fishes of Bangladesh [5], Encyclopedia of Flora and fauna of Bangladesh [6] and the fish resources of the Bay of Bengal [7]. The collected data from the study areas were analyzed and then presented in textual, tabular and graphical forms to understand the livelihood status and fisheries resources as well as the constraints of fisher folks.

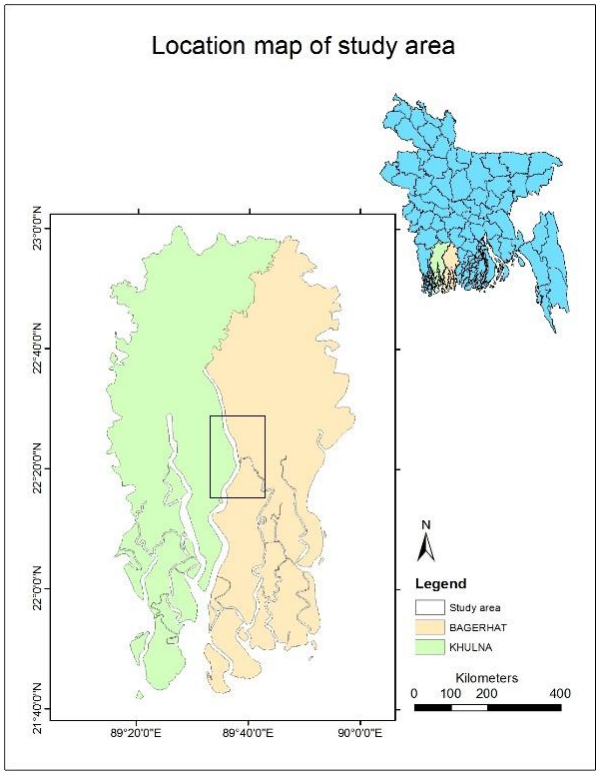

Fig 1: Mongla port and adjacent area of Sundarbans.

3. Results

3.1 Water quality of Mongla port area

The range of water temperature was between 26.9 ºC-27 ºC, pH value was 7.4, Dissolved oxygen (DO) was 6.3 mg/L, Salinity was 8 ppt, Total dissolved solids (TDS) was 6.5 g/L and Electrical conductivity (EC) was 12.98 MS/cm (Table 1). A study found that the highest temperature (31.1 ºC) was during the summer season and the lowest temperature (19 ºC) was in winter season [8]. The maximum pH of 8.1 was observed at Dhanmari point and however, the minimum pH of 7.1 was observed at Mongla. Another study found that EC of the Pussur–Sibsa water around the Sundarbans Reserve Forest (SRF) was 12.7–47.9 MS/cm [9].

Table 1: Basic Water quality of Mongla port area

Parameter	Value
Temperature ºC	26.9
pH	7.4
DO mg/L	6.3
Salinity ppt	8
TDS g/L	6.5
EC mS/cm	12.98

3.2 Total Fishery resources observed in Mongla port Market and Sundarbans area

Total 79 species of fresh water fishes, marine water fishes, shrimps and crabs were recorded in the study areas. The number of species recorded by the present study were alarmingly less than the previous studies and observation noted that the total number different fish species reported from the forest is 172 [10]. There are 120 species of fishes are said to be commonly caught by commercial fishermen [11]. The present studies where fresh water and marine fish species were under 30 families (Table 2, 3, 4), 18 species of shrimps under 2 families (Table 5), 6 species of crabs under 4 families and 1 lobster (Table 6). A great number of shark and ray species can also be found in mangrove environments besides the teleost [12].

A study observed 53 pelagic fish species belonging to 27 families and 124 species of demersal fish under 49 families in Sundarbans area. There were also 24 species of shrimps belonging to 5 families, 7 crab species under 3 families, 2 species of gastropods, 8 species of lobsters [13]. Various species of palaemonidae shrimps including the commercially important giant freshwater shrimp, *Macrobrachium rosenbergii* are related to the Sundarbans mangroves [14, 15]. Mangroves support the vast numbers of small shrimp of which *Acetes spp*. (Sergestidae) are the most important to fisheries [16].

Table 2: Catfishes

SI.no	Scientific n me	Order	Family	Common name
1	*Mystus aor*	Siluriformes	Bagridae	Long-whiskered Catfish
2	*Hemiarius Sona*	Siluriformes	Ariidae	Sona sea catfish
3	*Rita rita*	Siluriformes	Bagridae	Rita
4	*Pangasius pangasius*	Siluriformes	Pangasiidae	Yellowtail Catfish
5	*Silonia silondia*	Siluriformes	Schilbeidae	Silond catfish
6	*Mystus gulio*	Siluriformes	Bagridae	Long Whiskers Catfish
7	*Mystus vittatus*	Siluriformes	Bagridae	Asian Striped Catfish
8	*Plotosus canius*	Siluriformes	Plotosidae	Gray eel-catfish
9	*Eutropiichthys vacha*	Siluriformes	Schilbeidae	Batchwa vacha

Table 3: Elasmobranches

SI.no	Scientific name	Order	Family	Common name
1	*Carcharhinus macloti*	Carcharhiniformes	Carcharhinidae	Hardnose Shark
2	*Himantura uarnak*	Myliobatiformes	Dasyatidae	The reticulate whipra
3	*Himantura fluviatilis*	Myliobatiformes	Dasyatidae	Ganges stingray
4	*Rhinobatos annandalei*	Rajiformes	Rhinobatidae	Bengal guitarfish
5	*Rhynchobatus granulatus*	Rajiformes	Rhinobatidae	Guitarfish

Table 4: Bony fishes

SI.no	Scientific name	Order	Family	Common name
1	*Istiompax indica*	Perciformes	Istiophoridae	Black marlin
2	*Scatophagus argus*	Perciformes	Scatophagidae	Butterfish
3	*Sardinella fimbriata*	Clupeiformes	Clupeidae	Fringe-Scale sardine
4	*Toxotes jaculatrix*	Perciformes	Toxotidae	Banded Archerfish
5	*Ogcocephalus nasutus*	Lophiiformes	Ogcocephalidae	Shortnose Batfish
6	*Polynemus paradiseus*	Perciformes	Polynemidae	Threadfins
7	*Pomadasys hasta*	Perciformes	Haemulidae	Spotted Grunter
8	*Notopterus notopterus*	Osteoglossiformes	Notopteridae	featherbacks
9	*Lates calcarifer*	Perciformes	Latidae	Asian sea bass
10	*Glossogobius giuris*	Perciformes	Gobiidae	Flathead Goby
11	*Platycephalus indicus*	Scorpaeniformes	Platycephalidae	bartail flathead
12	*Taenioides anguillaris*	Perciformes	Gobiidae	eel worm goby
13	*Anabas testudineus*	Perciformes	Anabantidae	Climbing perch
14	*Cynoglossus lingua*	Pleuronectiformes	Cynoglossidae	Long tongue sole
15	*Congresox talabonoides*	Anguilliformes	Muraenesocidae	common eel
16	*Coilia dussumieri*	Clupeiformes	Engraulidae	Grenadier Anchovy
17	*Bronze croaker*	Perciformes	Sciaenidae	Bronze croaker
18	*Harpadon nehereus*	Aulopiformes	Synodontidae	Bombay-duck
19	*Argyrosomus amoyensis*	Perciformes	Sciaenidae	Amoy croaker
20	*Pampus argenteus*	Perciformes	Stromateidae	Silver pomfret
21	*Polydactylus indicus*	Perciformes	Polynemidae	Threadfins
22	*Escualosa thoracata*	Clupeiformes	Clupeidae	White sardine
23	*Otolithoides pama*	Perciformes	Sciaenidae	Long-finned croaker
24	*Securicula gora*	Cypriniformes	Cyprinidae	Gora-chela
25	*Trypauchen vagina*	Perciformes	Gobiidae	Burrowing goby
26	*Xenentodon cancila*	Beloniformes	Belonidae	needlefish
27	*Gudusia chapra*	Clupeiformes	Clupeidae	Indian river shad)
28	*Monopterus cuchia*	Synbranchiformes	Synbranchidae	Mud eel
29	*Sillaginopsis panijus*	Perciformes	Sillaginidae	Flathead sillago
30	*Setipinna phasa*	Clupeiformes	Engraulidae	Gangetic hairfin anchovy
31	*Chelonodon patoca*	Tetraodontiformes	Tetraodontidae	Milkspotted puffer
32	*Oreochromis mossambicus*	Perciformes	Cichlidae	Mozambique Tilapia
33	*Labeo rohita*	Cypriniformes	Cyprinidae	Rui
34	*Tenualosa ilisha*	Clupeiformes	Clupeidae	Hilsa shad
55	*Catla catla*	Cypriniformes	Cyprinidae	Catla.
37	*Labeo calbasu*	Cypriniformes	Cyprinidae	Orangefin labeo
38	*Hypophthalmichthys molitrix*	Cypriniformes	Cyprinidae	Silver Carp
39	*Periophthalmodon schlosseri*	Perciformes	Gobiidae	Pug-headed mud skipper
40	*Cirrhinus cirrhosus*	Cypriniformes	Cyprinidae	Mrigal

Table 5: Shrimps

SI.no	Scientific name	Order	Family	Common name
1	*Squilla mantis*	Stomatopoda	Squillidae	Mantis shrimp
2	*Macrobrachium rosenbergii*	Decapoda	Palaemonidae	Giant River Prawn
3	*Penaeus Monodon*	Decapoda	Penaeidae	Tiger shrimp
4	*Penaeus indicus*	Decapoda	Penaeidae	Indian prawn
5	*Penaeus japonicus*	Decapoda	Penaeidae	Kuruma prawn
6	*Penaeus marguinensis*	Decapoda	Penaeidae	Banana prawn
7	*Penaeus semlsulcatus*	Decapoda	Penaeidae	Green tiger prawn
8	*Macrobrachium birmanicus*	Decapoda	Palaemonidae	Birma river prawn
9	*Macrobrachium lamarrei*	Decapoda	Palaemonidae	Kuncho river prawn
10	*Macrobrachium villosimanus*	Decapoda	Palaemonidae	Dimua river prawn
11	*Metapenaeus brevicornis*	Decapoda	Penaeidae	Yellow shrimp
12	*Metapenaeus affinis*	Decapoda	Penaeidae	Jinga shrimp
13	*Metapenaeus lysianassa*	Decapoda	Penaeidae	Bird shrimp
14	*Metapenaeus monoceros*	Decapoda	Penaeidae	Speckled shrimp
15	*Parapenaeopsis sculptilis*	Decapoda	Penaeidae	Rainbow shrimp
16	*Parapenaeopsis hardwickii*	Decapoda	Penaeidae	Kiddi shrimp
17	*Acetes indicus*	Decapoda	Sergestidae	Jawla paste shrimp
18	*Solenocera subnuda*	Decapoda	Solenoceridae	Coastal mud shrimp

Table 6: Crabs and Lobster

SI.no	Scientific name	Order	Family	Common name
1	*Scylla serrata*	Decapoda	Portunidae	Mud crab
2	*Neptunus pelagicus*	Decapoda	Portunidae	Blue swimming crab
3	*Neptunus sanguinolentus*	Decapoda	Pompilidae	Herbst
4	*Macrophthalmus brevis*	Decapoda	Macrophthalmidae	Crab
5	*Gelasimus annulipes*	Decapoda	Ocypodidae	Porcelain Fiddler Crab
6	*Carcinoscorpi srotundicauda*	Xiphosura	Limulidae	Horseshoe Crab
7	*Thenus orientalis*	Decapoda	Scyllaridae	Flathead lobster

3.3 Demographic data of fishers

3.3.1 Age group

Among 136 studied respondent, the age range of 15-20 years occupied by 6.62%. The non-dominant age group was 26-30 years and comprised of 22.06% (Fig. 2) on the basis of percentage composition.

3.3.2 Religion

Among 136 studied fishermen, 77% of people were Muslims, 20% Hindus and 3% Christians respectively (Fig.3).

3.3.3 Marital status

86.02% of the respondent were married and middle age group (>22 years) while the unmarried respondent were only 13.97 % (Fig.4). Some of them were divorced which also included simply into the married group. Girls are married at 15-16 years of age. By the time she is 20, the girl has become the mother of two or three children.

3.3.4 Family type and size

The family size of 1 -2 members were 4.4%, 3-4 were 54.14%, 5-6 were 36.76% and 7-8 were 4.41% respectively (Fig.5). The average family size of surveyed household was 5.6 which is slightly better than the average of 5.58 for Satkhira District [17, 18].

3.3.5 Origin of residence

To account the migration, origin of residence was asked. 66.17 % of the respondent fishers were migrant (Fig.6). The migrant people generally came from different district mostly from Barishal, Patuakhali, Bhola.

3.3.6 Fishing Status

In this study, full time fishermen were 80.88% and part time fishermen were 19.11% (Fig.7).The previous study reported that 70% of respondents were fulltime fishers while 10% being engaged in other occupation [17].

3.3.7 Fishing experience

The fishing experience below the 10 years were 8.08%, 10-15 years were 32.35%, 16-20 years were 25.73%, 21-25 years were 7.35%, 26-30 years were 7.35%, 31-35 years were 6.61% of people, 36-40 years were 3.67% of people, 41-45 and 46-50 years were 4.41 % of the respondent fishers (Fig.8).

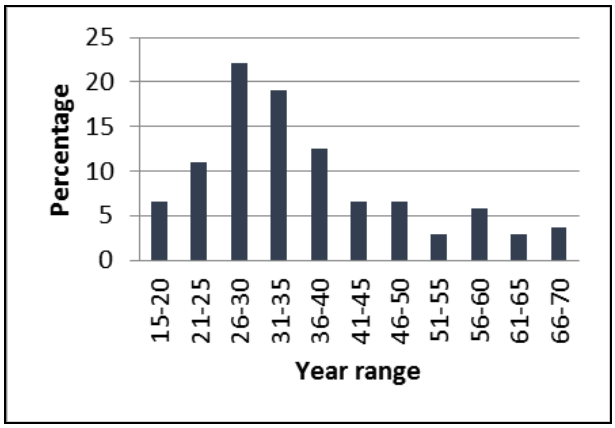

Fig 2: Age group of the respondents.

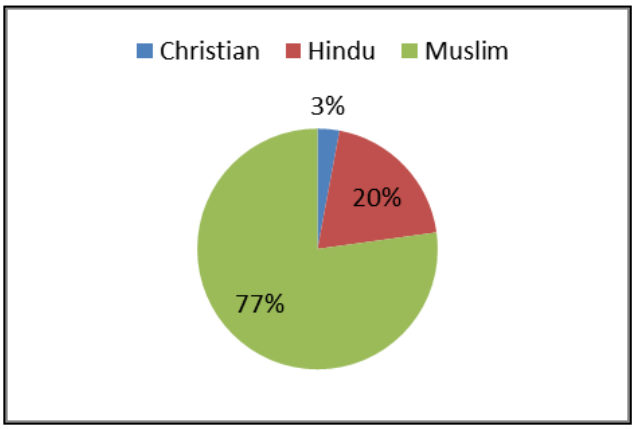

Fig 3: Religion of the respondents.

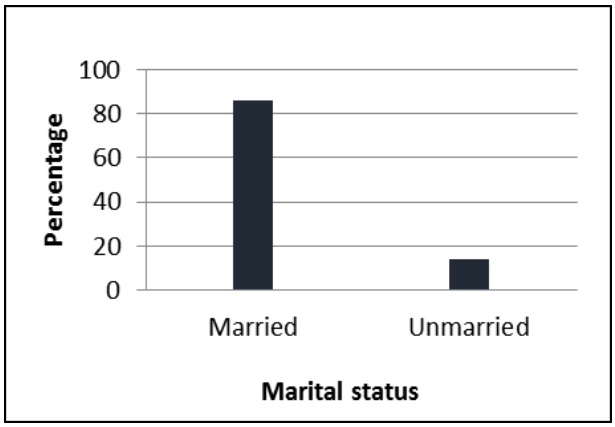

Fig 4: Marital Status of the respondent.

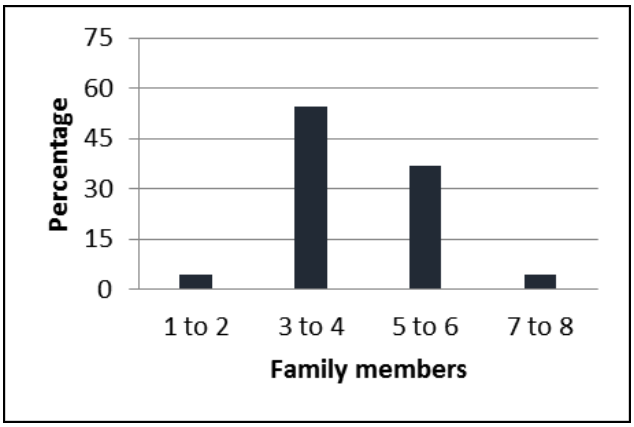

Fig 5: Family member size of the respondents.

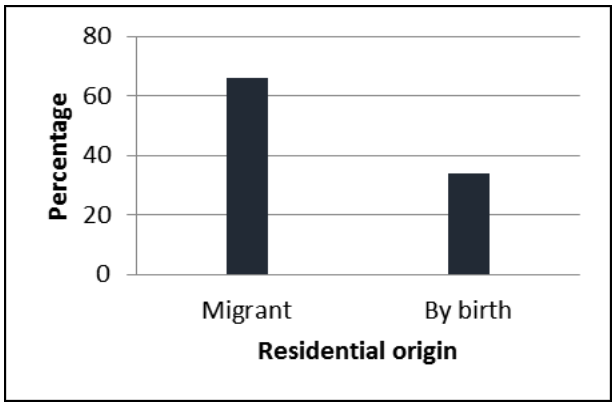

Fig 6: Origin of residential status.

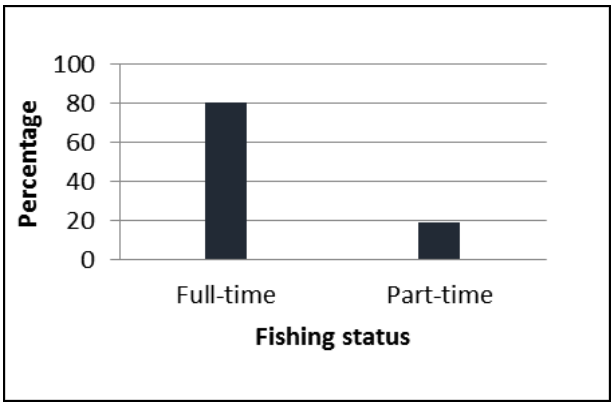

Fig 7: Fishing Status of the respondent.

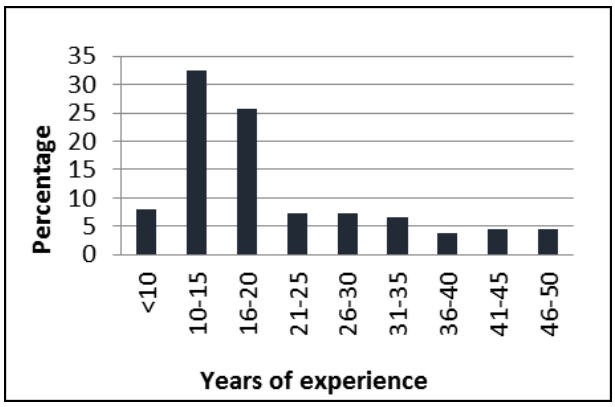

Fig 8: Fishing experience of the respondent.

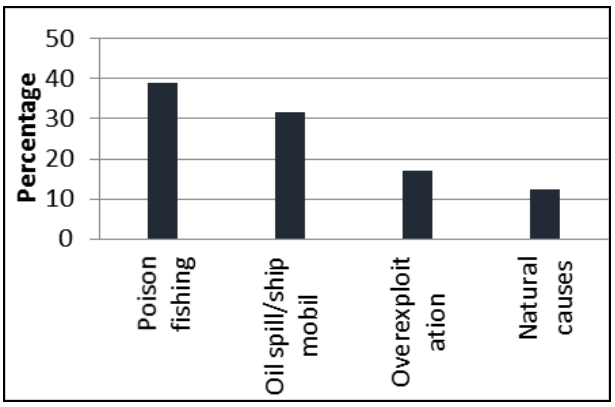

Fig 9: Causes of fish declination.

3.4. Social condition, Privileges and Institutions

3.4.1 Education

77.21% of the respondent fishermen were illiterate while 13.97% of the fishermen had completed up to primary education, 5.15% went for secondary (6 to 8) level where secondary (9 to10) was 3.68%. The present studies reported that no one received higher secondary and higher level of education (Fig. 10) which also reported by the previous study [17].

3.4.2 Drinking water

88.97% of people drink directly the pond water. Only 8.82% of people had the uncertain access to the cargo water and Drum water. 2.20% of people preserve rainwater (Fig. 11). There was no deep tube well for safe drinking water.

3.4.3 Sanitary facilities

66.18% of the respondent fishers had the latrine while 33.82% had no latrine facilities (Fig.12).

3.4.4 Solar electricity facilities

8.82% of people had the solar electricity facilities. The rest 91.18% of people had no access to the solar electric facilities (Fig.13).

3.4.5 Medical facilities

96.32% had poor access to the medical facilities as they depend on village doctor or quacks while 5.15% can have medical treatment from Upazila doctor (figure 14). Normally poor fishers had no affordability to have better medical treatment as it is too costly or unbearable.

3.4.6 Financial Status

87.5% of people had a bad financial status while the rest 12.5% of people had the good financial condition (Fig.15). Financial condition merely depends on the fishing and due to the seasonality it greatly varies.

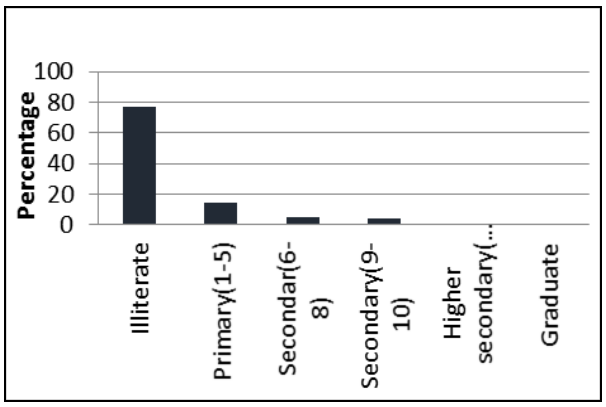

Fig 10: Education of the respondent.

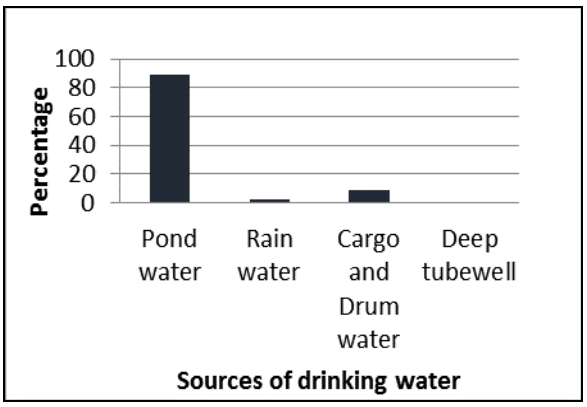

Fig 11: Drinking water facilities of the respondent.

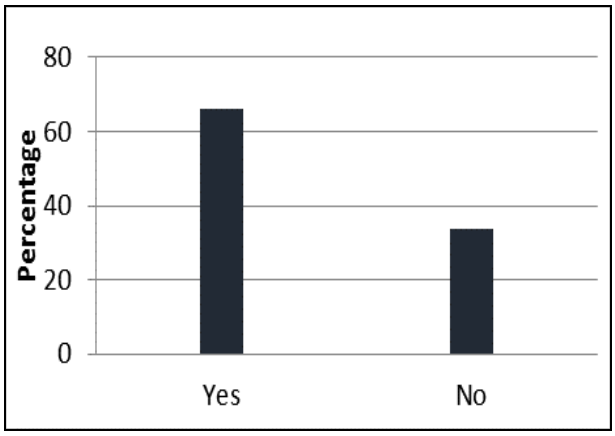

Fig 12: Sanitary facilities of the respondent.

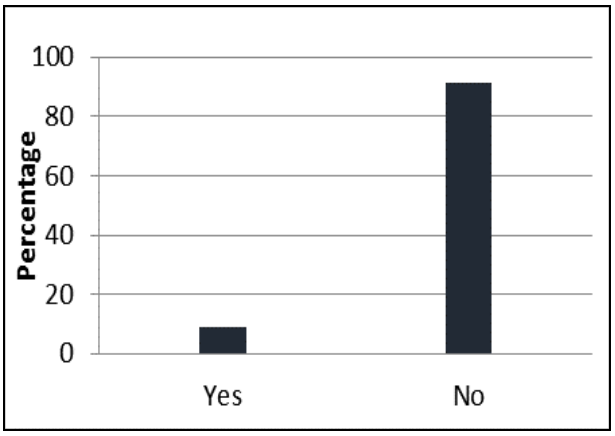

Fig 13: Solar power facilities at the**.**

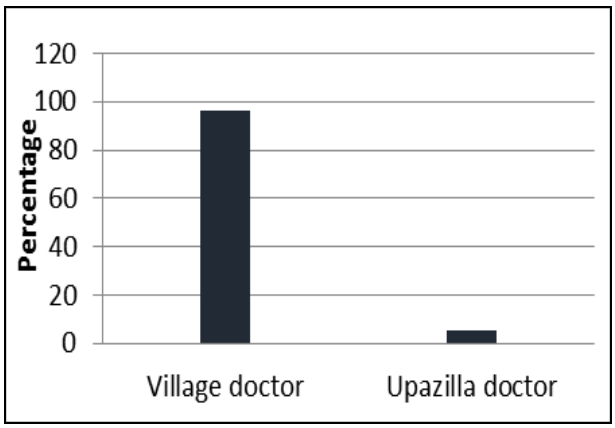

Fig 14: Medical facilities of the respondent.

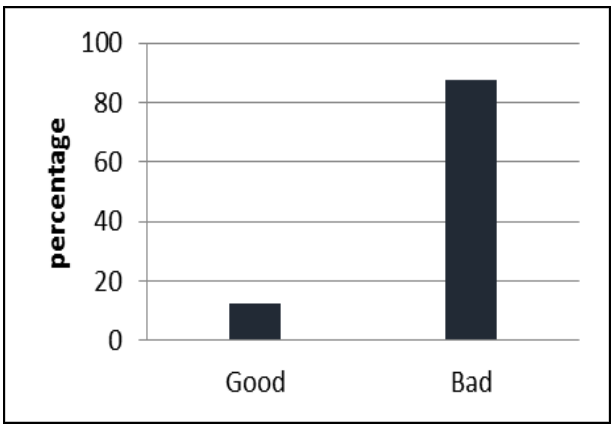

Fig 15: Financial Status of the respondent.

4. Discussion

More than 400 species have been reported in the mangrove of Bangladesh against 260 freshwater and 342 marine species [13]. The availability of fish species has been reported to be as high as almost 200 species in mangrove-dominated estuaries and embayments in other parts of the world such as in Australia and India [19]. The present study has been monitored the water quality of Mongla port area which was fine according to the accepted level suitable for the aquatic life as there was no indication of pollution or imbalance. The present study recorded total 79 of freshwater and marine fishes which are quite less than the previous studies conducted. Besides the marine and freshwater fishes, the aquaculture fishes were dominant in the fish market. The aquaculture fishes such as *Anabas testudineus, Cirrhinus cirrhosus, Labeo rohita, Catla catla, Oreochromis mossambicus and Hypophthalmichthys molitrix* were available in the market. The top aquaculture practiced fishes such *Oreochromis mossambicus and Hypophthalmichthys molitrix* were abundant in number at all the market. Moreover the fish catch unavailability is alarmingly going up as the fish declination is becoming worsened.

A study showed a graph where the trend indicates the steady declination of mangrove fisheries resources either due to overfishing or to habitat degradation or both [20] and the similar trends were also reported in other parts of Asia [21]. The present study showed that among 136 respondent fishers 38.97% said that the poison fishing is the major reason for the drastic declination of fisheries resources where the target and non-target species are killed mercilessly and remorselessly. The Poison fishing is done by using pesticides which is not only causing the severe situation for the fishes and aquatic habitat but also harmful for the human health. 31.61 % of respondent fishers said that Oil spill and Ship Mobil pollution while 12.5% of the people said natural causes like earth quake, flood, heavy rainfall, Storm, cyclone are responsible for the declination of fishery resources. 16.91% of people believe that overexploitation and population explosion are the reason where the spawns are not spared and are caught from the open seas by trawl nets (Fig 9).

Though the fishery resources are declining for various reasons, many studies have focused on overfishing or overexploitation as the prime reason of depleting resources. The fishes are declining because of the huge pressure on aquatic body as there are more fishing boats than before. A study was conducted for a period of over 8 years and showed that *P. monodon* PL in five major rivers in the Sundarbans declined and *P. monodon* PL fishery also suffers overfishing [22]. Another study also noted that the overexploitation results the increasing unavailability of shrimp fry from year to year [23]. So it is obvious that the trend of overfishing is doubtlessly has calamitous impact on commercial fishery and on biodiversity in near future.

Poor fishers cannot really afford the fishes other than the cheap aquaculture fishes because of the high prices which exceed their affordability. The most contemplating matter is that though poor fishers are mostly occupied to the Shrimp culture business; they cannot have shrimps for them as they have no the affordability of buying. Poor fishers only can have some low quality shrimps those are not supposed to be exported. Fishers are poor by any standard and over the years the economic condition had further worsened. Severe Scarcity of food and safe drinking water, poor sanitation facilities and poor livelihood are common. A study estimated that the

average per capital income of the fishermen families is BDT 2442 which is 70% lower than the per capital annual income of the country as a whole [24]. Poor fishers are always overlooked as the policy decisions are often based on national level priorities and this poses a severe threat to local livelihoods [25].

5. Conclusion

The fisheries of Sundarbans have been playing an important role in the coastal economy of the Bangladesh. Present study found that Poison fishing and Overfishing occurs many species are at risk. The fishery resources are declining alarmingly which are affecting the fisher's livelihood severely as they are completely dependent on fishery resources with no other ways. So the total insecurity and misery are obvious when the existing catches are fewer than their needs as they have no alternatives to feed their families. Over 3.5 million people are depending directly or indirectly on the resources of Sundarbans for their livelihood and it has been decreasing alarmingly since 20 years ago with obvious impacts on its fish and fisheries [26]. To identify fishery species and to obtain reliable catch data which are associated with mangroves directly or indirectly extensive research is needed. Many authors argue that the world's mangrove habitats are always under-evaluated [27]. Moreover there is no sufficient information available in Bangladesh on natural fisheries and even less is fishers and their livelihood. The livelihood and socio-economic condition of the fishers in the area was not good. The fishermen were deprived of many amenities as their education level was so poor. Pure drinking water is the chief identified problem. Good access to basic services, such as health, education, training and capacity building, and infrastructure are needed which would help in developing other skills and in reducing pressure on natural resources in the longer term. Moreover to restore the fish resources and to prevent the depletion of aquatic resources and its habitats, creation of the alternatives are must for the poor fishers. Alternative income generation is a vital to lower the pressure on aquatic resources and to make a sustainable livelihood security. Earnest supplication of the poor fishers such as pure drinking water, food security, medical facilities and creation of alternatives should be ensured by the help of government.

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