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Research article

Adaptive alternative income generating activities by the small-scale fishing communities along the southeast coast of Bangladesh during fishing bans and COVID-19 pandemic

Mohammad Sadequr Rahman Khan[1]*, Mohammad Najmul Hasan[1], Sabuj Datta[2] and Harun Or Rashid[1]

[1]Department of Marine Bioresource Science, Chattogram Veterinary and Animal Sciences University, Khulshi, Chattogram-4225, Bangladesh
[2]Department of Fisheries Resource Management, Chattogram Veterinary and Animal Sciences University, Khulshi, Chattogram-4225, Bangladesh

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*Corresponding author:
Cell: +8801723229101

E-mail:
sadequr.khan@cvasu.ac.bd

A B S T R A C T

Seasonal closure of fishing severely impacts the livelihoods of small-scale fishermen, compounded by COVID-19, driving them to adopt diverse alternative income-generating activities (AIGAs) which are of great interest to the fisheries managers. This study assessed the impacts of COVID-19 and fishing bans on the livelihood of four coastal fishing communities in southeast Bangladesh, focusing on their diverse options for AIGAs. Eighty fishermen, twenty from each location, were interviewed through structured and semi-structured questionnaires, and Focus Group Discussions. The study revealed that sea fishing, a labor-intensive occupation, was predominantly performed by middle-aged fishermen who are mostly illiterate and have poor livelihoods. The highest catch/trip was recorded in Nunier Chara due to their partial involvement in commercial fishing. During COVID-19, fishing and loans from local money lender were the primary livelihood sources, trapping fishers in a debt cycle. One-third of fishers were jobless during fishing bans with some engaged in illegal, unreported, and unregulated fishing. Daily income was reduced by >65% during COVID-19 and >16% post-COVID. Fishermen alleged that government support was negligible during COVID-19 and inadequate during fishing bans with some anomalies in subsidy distribution by local leaders. AIGAs, particularly laboring and small businesses were vital. Though not directly involved in fishing, women significantly contribute to the coastal livelihood through AIGAs such as post-harvest processing, bivalve collection, seaweed culture, and small-scale household production. A co-management strategy involving adult education, skilled manpower development, financial support for promising small-scale AIGAs, low-interest loans, women empowerment, and inclusion of local fishermen in management decisions and implementations are potential remedies.

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1. INTRODUCTION

Fish and fisheries play a major role in the global food security and economy through providing nutrition, employment, poverty eradication, and export earnings (FAO, 2024; Shamsuzzaman et al., 2024). The production from the fisheries

sub-sector including aquaculture has reached 223.2 million tones which worth 472 billion US$ and supplies an average of 15% animal protein to humans (FAO, 2024). Fisheries support millions of fishermen on both small-scale and commercial scales. The small-scale fishers are around 90% of the total workforce who are involved in capture fisheries and contribute ~40% of the total global catch (FAO, 2022; FAO, 2024). The livelihood of more than 500 million people rely on small-scale fisheries in the globe with 53 million are involved in direct subsistence fishing (FAO, 2024). Therefore, a greater global recognition should be awarded to these huge small-scale fishers' communities, and their sustainable livelihood should be prioritized to manage fisheries resources. Global annual per capita consumption of aquatic animal foods rose from 9.1 kg in 1961 to 20.7 kg in 2022 (FAO, 2022). Global demand for aquatic foods is projected to increase further by 10% by 2032, therefore, combating hunger, malnutrition, and poverty remains essential for achieving the Sustainable Development Goals (SDGs) by 2030. It will therefore, be challenging to maintain sustainable production for ensuring healthy diets from healthy oceans. Aquatic animal production in oceans may provide a diverse range of solutions to food security, poverty, and unemployment for the many coastal countries around the world. The production from marine capture fisheries (79.7 million tonnes) shares 43% of the total global aquatic production (92.3 million tonnes) and is the principal source of human nutrition in many countries (FAO, 2022; FAO, 2024). The coastal and marine fishery stocks have already been decreased, i.e. biologically sustainable stocks from 64.6% in 2019 to 62.3% in 2021, due to overfishing and habitat destruction (FAO, 2024). If, restrictions are applied to fishers through temporary or seasonal bans, and if stresses like the COVID pandemic (lockdown) or natural disasters occur, then sustainable fisheries and aquaculture growth may further be hampered. Therefore, the vast majority of populations become vulnerable due to fishing restrictions or pandemics, which may trigger the fishers to adopt alternatives to fishing are of great importance to the fisheries managers.

The fisheries sector of Bangladesh is one of the country's most important and dynamic sectors that has played an important part in the economy for decades. It has a great contribution towards obtaining SDGs, especially alleviating poverty (Goal 1: No poverty), food security (Goal-2: Zero hunger), sustainable utilization and conservation of aquatic resources (Goal 14: Life below water), and women empowerment (Goal 5: Gender equality). In Bangladesh, total fisheries production has reached countries highest 4.7 million tonnes with the 3rd highest inland production 4.07 million tonnes (84.69%), and marine water production 0.70 million tonnes (15.31%) (DoF, 2023). The fisheries sub-sector contributes 2.43% of the national GDP, 22.14% in total agricultural production, and provides 60% of animal protein (DoF, 2023). Approximately 1.738 million fishers are involved in the fisheries sector, of which 0.311 million are directly involved with marine fishing (DoF, 2023). Bangladesh stands 12th in global finfish production from marine and coastal fisheries (FAO, 2022). The marine fisheries sector plays a vital role in the country's economy by providing food security, poverty alleviation, and job creation, particularly in improving the trajectory of socio-economic conditions of coastal fishing communities (Arif, 2017). Marine fisheries in Bangladesh is dominated by small-scale fisheries (SSF), or artisanal fisheries, which support the livelihood of more than 10 million coastal people (Alam et al., 2021; DoF, 2023). Small-scale fishers live on mostly by catching fish in the coastal areas through conventional techniques and facilities (Alam et al., 2021). The livelihood of small-scale fishing communities remains vulnerable due to their sole dependency on fishing for livelihood, limited alternative occupations, climate change, habitat alteration, illiteracy, insufficient logistic support, and lack of national policies (Islam, 2011; Islam et al., 2017; Sultana et al., 2021; Shamsuzzaman et al., 2024). Usually, coastal fishermen live from hand to mouth and in most cases below the poverty line and are fighting to meet daily basic needs (Ahsan et al., 2016).

Seasonal fishing bans in coastal and marine ecosystems are widely used conservation and management strategies to safeguard a species by

restricting fishing during their spawning or recruitment (Cohen et al., 2013; Islam et al., 2021). The government of Bangladesh has enforced seasonal fishing bans for the conservation of fishery resources in different coastal and marine areas of Bangladesh (Table 1). For example, a 65-day long monsoon ban from 20, May to 23, July in the northern Bay of Bengal on all types (artisanal and commercial) of marine fishing to facilitate increased fish breeding for conserving the fish stock and ensuring sufficient adult fish and crustacean species (Islam et al., 2021). In addition to this, a two-month fishing ban on six hilsa (*Tenualosa ilisha*) sanctuaries situated in some major coastal rivers has been forced to protect jatka (juvenile hilsa <25 cm length) (Sarker et al., 2019). There is also a 22-days nationwide ban on catching brood hilsa coinciding with the peak breeding season in October. As a whole, the coastal and marine fishers have to face nearly four months of fishing ban (Table 1) which has unavoidable socio-ecological trade-offs (Islam et al., 2021). The fishing bans enforce short-term negative impacts on the daily income and livelihood of the coastal fishers communities at the cost of improving fishery production and catch per effort after the bans (Brillo et al., 2019; Islam et al., 2021). As there are limited alternative employment opportunities, the fishing bans generate unemployment and poverty (Ali et al., 2010), which in turn, directly increase the socio-economic vulnerability of the small-scale artisanal including industrial fishers (Hoque et al., 2021). Therefore, small-scale fishers are bound to put more pressure on coastal, local nursery grounds and may destroy the larvae and juveniles (Islam et al., 2021). However, long-term socio-economic beneficial effects include the increase in total production, catch per person, and better-managed stock (Cohen et al., 2013; Islam et al., 2021). There is also the prospect of an increased employment rate at the end of the fishing bans (Cohen et al., 2013; Brillo et al., 2019).

COVID-19 has severely disrupted the supply chain, affecting livelihoods worldwide, particularly in the aquaculture and fisheries sectors through trade stoppages, lockdowns, and restaurant closures (Hoque et al., 2021; Nyiawung et al., 2024; Macusi et al., 2024). COVID-19 caused less demand for fish, labor shortages, and transport issues, and irrespective of location, fishers experienced a reduction in fishing time and income (Hoque et al., 2021; Sunny et al., 2021a,b; Nyiawung et al., 2024). So far, the adverse impacts have encompassed the total cessation of operations for certain fisheries, secondary economic consequences stemming from market disturbances, amplified health hazards for fishermen and other stakeholders, intensified susceptibility to additional social and environmental stresses, and provoked the illegal, unreported, and unregulated (IUU) fishing (Bennett et al., 2020; Macusi et al., 2024). Opportunities for earning alternative income-generating activities (AIGAs), a transparent rationing system, training facilities, and incentive programs could help to improve the issue (Sunny et al., 2021b). Due to COVID-19 shutdown and the government ban program, coastal fishermen being imposed to face in Bangladesh 'crisis within crisis' (Bennette et al., 2020), as they could not go for fishing almost six to eight months which must have impacted their livelihood, and socio-economic condition. Consequently, they left with no option but to have taken adaptive strategies particularly diverse alternative income generating activities which are of great interest to the fisheries manager to sustainably manage the small-scale fishers in the coastal countries. Several studies have focused on how the fishing bans and/or COVID-19 have impacted the socio-economic status of the fishermen (Dey et al., 2010; Rahman et al., 2017; Bhowmik et al., 2021; Sunny et al., 2021a; Sultana et al., 2021b; Nyiawung et al., 2024), however, the study on what are the potential AIGAs that the local fishermen have chosen or become adapted in response to stress, and what are the fishermen perceptions on the improvement options/ suggestions, are scanty. This study was therefore, undertaken to assess the socio-economic condition of the fishermen from four coastal fishers communities along the southeast coast of Bangladesh, Cox's Bazar focusing on the potential AIGAs options during bans and COVID-19 pandemic emphasizing the impacts of those stresses on the livelihood (income) and social demographies of fishermen, the potential role of women in coastal economy through

AIGAs, perceptions of the coastal fishing communities on the government support, pandemics.

Table 1**.** Existing fishing bans in the coastal districts and maritime area of Bangladesh.

Ban type	**Target/aim**	**Ban period**	**Government subsidy**	**Description/particulars**	**References**
65-days fishing ban imposed on artisanal and commercial fishing vessels in the Bay of Bengal	to conserve brood fish and crustacean species, and to reduce the pressure from overexploitation	20, May to 23, July	56–86 kg rice/ family	First applied in 2015 on large commercial trawlers, since 2019 the ban was extended to all fishing vessels, including small-scale artisanal fishing boats	Islam et al., 2021; Hoque et al., 2021
22-days seasonal ban on brood hilsa fishing	To facilitate gravid hilsa breeding	October to November - depending on the moon phase	25 kg rice /family under vulnerable group feeding (VGF) program	Started from 2007	Sarker et al., 2019; Islam et al., 2021; DoF 2019
08-months seasonal ban on jatka catching	To protect juvenile hilsa, (<25 cm) for recruitment in the stock	November to June	40 kg rice/ family/month (for 4 months) under (VGF)	Started ban from 2003 on catching, carrying, and selling jatka imposed by the DoF in collaboration with law enforcement agencies and local governments	Sarker et al., 2019; Islam et al., 2021; DoF, 2019
02-months fishing ban in the six *Hilsha* sanctuaries	to protect jatka (juvenile hilsa (<25 cm)	March to April for five sanctuaries; November to January 6th estuary	40 kg rice/ family/ month	Started from 2005, The government declared four riverine areas as hilsa sanctuaries in 2005, adding a fifth in 2011 and a sixth in 2018 in the potential hilsa nursery and breeding areas and all types of fishing is banned	Sarker et al., 2019; Islam et al., 2021; DoF, 2019

2. MATERIALS AND METHODS

Study area

The survey was conducted in 04 (four) fishing communities namely, Nunier Chara ($21^0$27’29”N, $91^0$57’58”E), Doria Nagar ($21^0$23’50”N, $91^0$59’46”E), Sonarpara besides Rejukhal ($21^0$17’39”N, $92^0$02’44”E), and Inani ($21^0$14’21”N, $92^0$03’09”E) in Cox's Bazar district, Bangladesh, where a large number of people being engaged in fishing operations (Figure 1). Cox’s Bazar district is a southeast coastal district, which also been a part of northern Bay of Bengal, with 155 km coast line have significant contribution through artisional and commercial fishery. This is also a favorite and common tourist place in Bangladesh, where different kinds of seafood are commonly sold in restaurants. There are some fish landing centers along the coastal area of this district. This district was selected for the study, as there are a huge number of coastal fishers who engage in fishing depending on the Bay of Bengal and a great amount of marine fish production comes from Cox’s Bazar every year.

Collection of data

Data were collected from September to October 2021 from the coastal fishers directly. Before collecting the data, a questionnaire was developed and improved. This questionnaire includes the socio-economic status of the fishers, income of the fishermen, fishing operation, COVID-19 situation appraisal, ban period, alternative income generating activities, etc. For questionnaire interviews, 20 fishermen were selected randomly from each community. A total of 80 fishermen were interviewed. Interviewees were selected from different places such as tea stalls, fishermen's houses, boats, net preparation areas, fishing sites, etc. from each community. Direct observation of fishermen's livelihoods was also conducted in selected areas that provided in-depth insights into their daily activities, such as fishing sites, landing centers, price haggling, and marketing channels, enhancing data validity. Seven focus group discussions (FGDs) were conducted during the survey with 5 to 10 fishermen involved in each group and the approximate time duration was 30 minutes to one hour. All the data were collected from the men fishers only as women were not directly involved in sea fishing activities. The information on the AIGAs of the women was also collected from their husbands. Field observation and data were collected maintaining enough COVID safety protocol.

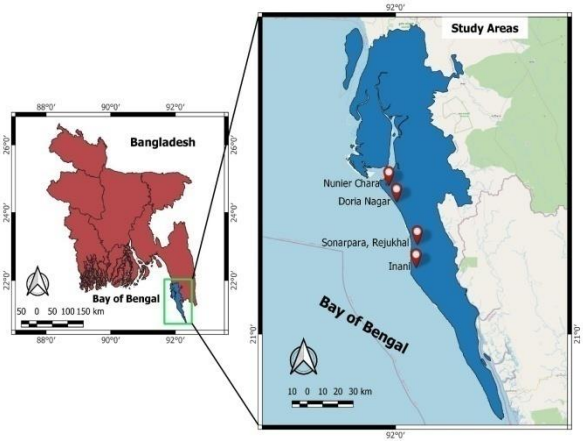

Figure 1. Map showing the locations of the four study areas in the southeast coastal district, of Bangladesh along the northern Bay of Bengal (using QGIS version 3.22.4)

Data analysis

The survey data were first entered, processed, and analyzed through Microsoft Excel to represent the means, standard deviations, percentages, and illustrations. The reduction in income as a percentage was calculated using the following formula:

Reduction of daily income during COVID-19 (%) = ((income before COVID –income during COVID) / income before COVID) × 100

Reduction of daily income after COVID-19 (%) = ((income before COVID – income after COVID) / income before COVID) ×100

One-way analysis of variance (ANOVA) was conducted to determine if there were any significant differences in the number of fishermen, number of fishermen’s families, fish catch per trip (Kg), frequency of catch per month, daily income of the fishers, percent of daily income decrease during COVID-19, and percent of daily income decrease after COVID-19 among the four surveyed areas. Tukey’s post hoc test was conducted to identify the homogenous subset groups. A paired samples *t*-test was conducted to determine if there were any significant differences between the daily income of the fishers before COVID and the income reduction during COVID-19 and after

COVID-19. The statistical tests were conducted using a statistical package for social sciences (IBM SPSS Statistics 27). In all cases, data were checked for normality and homogeneity of variance, and significant differences were assigned at 0.05% level.

3. RESULTS

Social demographics of the fishermen

The social demography of the fishermen interviewed from the four survey locations in Cox's Bazar differed between locations. Most of the fishermen surveyed were within the 21–30 (31%) and 31–40 (31%) age groups (Figure 2a). Very few farmers were older than 50 years (2%) (Table 2). The number of total fishermen in the survey areas varied significantly by location ($F(3, 76) = 56.08$, $p < 0.001$) (Table 2). The highest number of fishermen and their families were recorded from Nunier Chara and the lowest number was registered in Inani. The majority of the fishermen from all the areas were illiterate (70% on average). Very few fishermen from the surveyed areas passed the secondary level. None of the fishermen from both Doria Nagar, and Sonarpara passed the secondary level of education. The highest percentage of fishermen who passed the primary level was from Sonarpara (40%) among the four surveyed areas (Table 2).

The five types of housing conditions/structures were recorded from the surveyed areas such as brick-built (built with bricks), tin sheds (built with tin), fenced houses (built with mainly bamboo), straw houses (built using straw), and kaccha houses (built using mud, polythene sheets, grass or straw). The majority of the housing conditions were tin shed houses in all the surveyed areas with an average of 53% (Figure 3b). Brick-built and Kaccha houses were not found in both Doria Nagar and Sonarpara (Figure 2b). Straw houses were noticed in all the areas except in Inani (Figure 2b). The majority of the families (on average 78.75%) had electricity facilities with the highest percentages (85%) found both in Sonarpara and Inani (Figure 2c). Very few families (5%) were noticed to have solar facilities instead of electricity in Doria Nagar (Figure 2c).

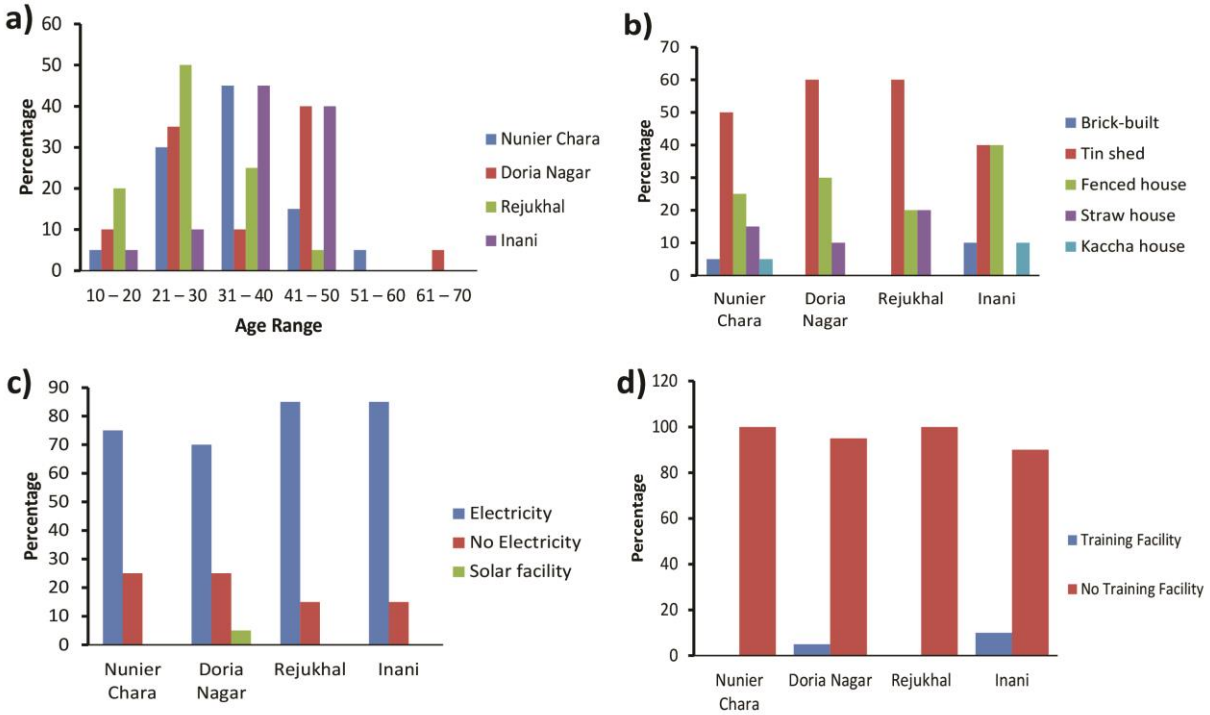

Figure 2. Socio-demographic characteristics of fishers: (a) age groups of the fishers, (b) housing conditions, (c) electricity facilities, and (d) training facilities of fishers from the four locations (n = 20 each) in the southeast coast of Bangladesh

Families were classified according to the members such as small family with one to four members; medium family with five to six members; and large family with more than seven members. In the four locations, on an average 25% families were small, 39% were medium and 36% were large family. In Nunier Chara, there were equal percentages (40%) of medium and small families (Figure 3). The highest percentages of large families were noticed in Doria Nagar (60%) and Inani (50%) (Figure 3). In Sonarpara, the majority of the families were medium (55%) (Figure 3).

The majority of the respondents (28%) from all the areas used to face pirates attacking during fishing (Table 2). They also face other problems such as net spoilage (5%), problems in boat engines (11%), natural disasters (13%), harassment from coast guards (16%), problems in cork sheet-made boats (5%), boat accident (9%), and some fishers (14%) reported that they face no problems during fishing activities (Table 2).

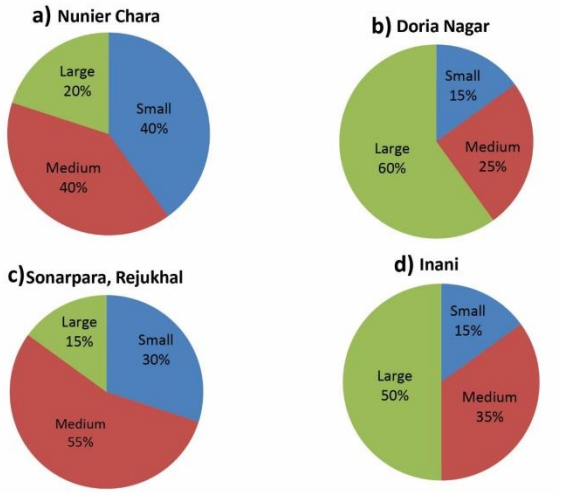

Figure 3. Family size of the interviewed farmers from (a) Nunier Chara, (b) Doria Nagar, (c) Sonarpara, Rejukhal, and (d) Inani in the south-east coast of Bangladesh

Fishing operation

Registration and gear used

The highest percentage of fishermen that were registered for fishing was 65% in Inani, compared to 35% in Rejukhal, about 30% in Nunier Chara, and the lowest percentage of fishermen (25%) were registered in Doria Nagar (Table 2). Different types of fishing gears and/or nets are used by the fishermen which seems to vary by location (Table 3).

Table 3. List of the fishing gears/nets used by the fishermen in the four surveyed areas.

Area	Fishing gear used (local name)
Nunier Chara	Vasa net, Suta net, Borshi etc.
Doria Nagar	Chanda net, Chapila net, Suta net, Foilla net etc.
Sonarpara, Rejukhal	Behundi net, Suta net, Foilla net, Potha net etc.
Inani	Suta net, Rockor net, Chamila net, Dopa net, Chappa net etc.

Gear ownership

Gear ownership is categorized into three groups such as self-ownership, shared, and hired from the Bahaddar (person who rents gear to the fishers). The majority of the fishers who use their self-ownership gears belong to Inani (55%) (Figure 4d) and the highest percentages of the fishers who use shared gears belong to Nunier Chara (55%) (Figure 4a). Very few fishermen use hired gears for fishing in all the areas (Figure 4).

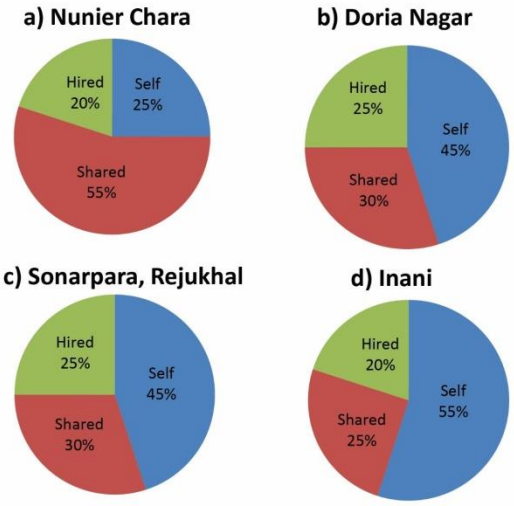

Figure 4. Gear ownership of the fishers from (a) Nunier Chara, (b) Doria Nagar, (c) Sonarpara, Rejukhal, and (d) Inani in the southeast coast of Bangladesh

Table 2. Socio-demographic characteristics of coastal fishermen in four surveyed areas of Cox's Bazar. Data represented as mean ±SD (range) or number of respondents (percentage); n = 20 fishermen from each location. *p*-value indicates significant differences were assigned at 0.05% level using ANOVA.

Parameters	**Characteristics**	**Nunier Chara** n (%)	**Doria Nagar** n (%)	**Sonarpara, Rejukhal** n (%)	**Inani** n (%)	**Average % / *p*- value**
Number of fishermen	Fishermen (N=979)	340 (34.7)	232 (23.7)	243 (24.8)	164 (16.7)	
	Fishermen family (N=672)	272 (40.5)	167 (24.8)	137 (20.4)	96 (14.3)	
Education level	Illiterate	13 (65)	15 (75)	12 (60)	16 (80)	70
	Primary education	6 (30)	5(25)	8 (40)	3 (15)	28
	Secondary education	1 (5)	-	-	1 (5)	2
Fishermen registration	Registered	6 (30)	50 (25)	7 (35)	13 (65)	39
	Not Registered	14 (70)	15 (75)	13 (65)	7 (35)	61
Frequency	Frequency of fishing (days/month)	15.30 ± 7.80 (2 – 25)	14.70 ± 4.39 (5 – 20)	16.50 ± 3.25 (10 – 22)	17.50 ± 3.82 (10 – 25)	$p = 0.321$
Catch	Catch per trip (kg)	208.50 ± 125.12 [a] (40 – 610)	36.50 ± 40.27 [b] (10 – 200)	82.50 ± 41.94 [b] (25 – 180)	74 ± 42.23 [b] (20 – 200)	$p < 0.001$
Income	Daily income of the fishers (BDT)	547.50 ± 272.65 (300 – 1500)	567.50 ± 277.34 (300 – 1500)	442.50±153.28 (300 – 1000)	612.50±280.45 (300 – 1200)	$p = 0.188$
Problems faced during fishing	Attacked by robbers	8 (40)	5 (25)	4 (20)	5 (25)	28
	Net spoilage	2 (10)	1 (5)	-	1 (5)	5
	Boat engine problem	2 (10)	2 (10)	2 (10)	3 (15)	11
	Natural disaster	1 (5)	3 (15)	2 (10)	4 (20)	13
	Coast guard harassment	3 (15)	2 (10)	5 (25)	3 (15)	16
	Problem in corksheet boat	-	1 (5)	2 (10)	1 (5)	5
	Boat accident	1 (5)	3 (15)	2 (10)	1 (5)	9
	No problem	3 (15)	3 (15)	3 (15)	2 (10)	14

Commonly caught fishes

The frequency of fishing (days/month) by the fishermen from the four surveyed areas did not differ significantly (F (3, 76) = 1.19, p = 0.321) (Table 2). They catch almost similar species of fish with some differences location-wise (Table 4). Maitta fish (*Scomberomorus guttatus*) is caught in NunierChara only (Table 4). Tuna and Crab are usually caught by the fishermen from Doria Nagar only; Seabass and Lobster were seen to be caught in Inani; Rupchanda and Ayre fishes are caught only in Sonarpara (Table 4). Other fishes were also reported to be caught more or less by the fishers from the four areas (Table 4).

Table 4. List of fishes that are mostly caught by the fishers in the southeast coast of Bangladesh.

Common name	Scientific name	Local name	Nunier Chara	Doria Nagar	Sonarpara, Rejukhal	Inani
Hilsa	*Tenualosa ilisha*	Ilish	√	-	-	√
Indo-Pacific king mackerel	*Scomberomorus guttatus*	Maitta	√	-	-	
Indian river shad	*Gudusia chapra*	Chapila	√	√	-	-
Pama Croaker	*Otolithoides pama*	Poa	√	√	√	-
Bombay Duck	*Harpadon nehereus*	Loitta	√	√	√	√
Shrimp	*Penaeus monodon*	Chingri	√	-	-	√
Giant river-catfish	*Sperata seenghala*	Guizza	√	√	-	-
Largehead hairtail	*Trichiurus lepturus*	Churi	√	-	√	-
Congaturi halfbeak	*Hyporhamphus limbatus*	Tuitta	√	-	-	√
Indian Salmon	*Eleutheronem atetradactylus*	Tailla	-	√	√	-
Sardine	*Sardina pilchardus*	Sardine	-	√	√	√
Tuna	*Thunnuss* sp.	Tuna	-	√	-	
Tank goby	*Glossogobius giuris*	Bele	-	√	-	√
Phasa	*Setipinna phasa*	Faisha	-	-	√	√
Pomfrets	*Pampus chinensis*	Rup chanda	-	-	√	-
Long-whiskered catfish	*Sperata aor*	Ayre	-	-	√	-
Asian sea bass or giant perch	*Lates calcarifer*	Sea bass	-	-	-	√
Scalloped spiny lobster, Ornate spiny lobster, Mud spiny lobster, Painted spiny lobster	*Panulirus* spp.	Lobster	-	√	√	√
Mud and Swimming crab;	*Scylla* spp.	Crab	-	√	-	-
Three spotted crab	*Portunus sanguinolentus*	Tin fota kakra	√	√	√	√

Catch per trip

The total catch (kg) of fish per trip by the fishermen from the four areas varied significantly (F(3, 76) = 21.50, p< 0.001) (Table 2). The highest catch per trip (208.50 ± 125.12) by the fishermen was found in Nunier Chara (Table 2). So, it can be assumed that the fishers from Nunier Chara have higher potentiality rather than the fishers from the other areas. The fish catch per trip by the fishers of the other three areas was more or less similar with no significant variations (Table 2).

Training facilities

It was noticed that there were no training facilities in Nunier Chara and Sonarpara, Rejukhal (Figure 2d). A very minor percentage of fishers from Doria Nagar (5%) and Inani (10%) said that they got training by some organizations only on disaster and life safety but

not at all on professional or technical training (Figure 2d).

Daily income of fisher

The majority of the fishers from all the surveyed areas have daily income ranges from 300 to 500 BDT (Figure 5). According to the analysis of variance (ANOVA), the daily income of the fishers did not differ significantly location-wise ($F(3,76) = 1.64$, $p = 0.188$) (Figure 5, Table 2).

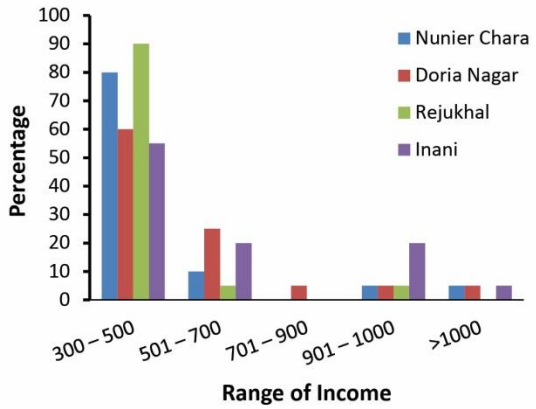

Figure 5. Daily income (in BDT) of the fishers in four surveyed areas in the Southeast coast of Bangladesh

COVID-19 situation appraisal

Livelihood during COVID-19

During the COVID-19 situation, the major livelihood options were fishing, loans from Bohaddar, and laboring in Inani (35%) (Table 5). The diversity in income sources or livelihood options was in greater numbers in Doria Nagar compared to other locations (Table 5). Small-scale fishing and loans from Bohaddar were the highest percentages of alternative income sources in the four surveyed areas during the COVID-19 period (Figure 6a). The majority of the fishers (83.75%) did not get support from the government during COVID-19, while 13.75% got 2500 BDT per month from the government, and very few fishers (2.5%) got 60 kg of rice only (Table 6).

Fish catch during COVID-19

From the survey, it was noticed that on average 50% of the fishermen from all the areas were involved in fishing during COVID-19 (Table 6). The highest percentage of the fishers involved in fishing activities were from Sonarpara, Rejukhal (60%) during the COVID-19 pandemic, and the lowest percentage was from Doria Nagar (40%) (Table 6).

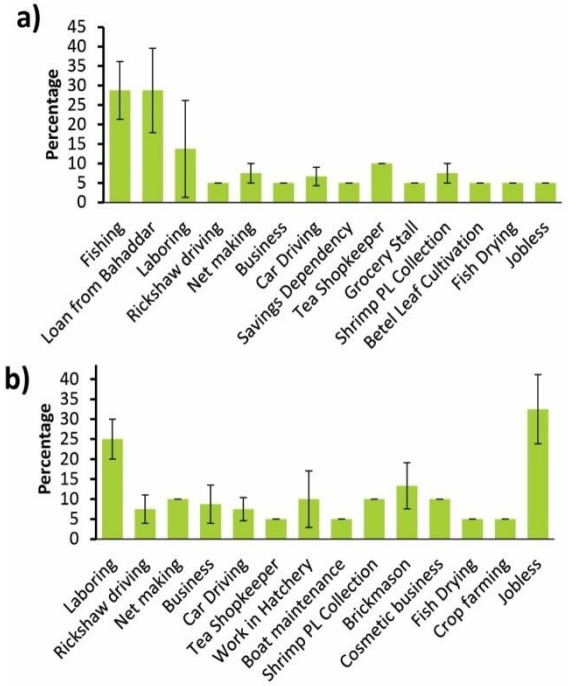

Figure 6. The percentage of fishers involvement (average ± SD) in the livelihood and alternative income generating options during COVID-19 (a) and during the fishing bans (b) in the four locations of southeast coast of Bangladesh.

Impact of COVID-19 on daily income

Daily income during COVID-19

The negative impact of COVID-19 was seen on the fishers' daily income in all the surveyed areas. A paired samples *t*-test indicated a significant difference (t (79) = 14.65, $p < 0.001$) in daily income between before (613.75 ± 269.78) and during (201.25 ± 155.08) COVID-19. The ANOVA showed that the percentage of income reduction during COVID-19 significantly varied location-wise ($F(3,76) = 3.13$, $p = 0.030$) (Table 6). The reduction of the daily income of the fishers was the highest 75.50 ± 23.43% in Sonarpara (Table 6).

Table 5. Location-wise variation in the livelihood options of coastal fishermen during the COVID-19 in four surveyed areas of Cox's Bazar with the number of respondents and percentage (in parenthesis); n = 20 fishermen from each location.

Attributes	Nunier Chara	Doria Nagar	Sonarpara	Inani
	n (%)	n (%)	n (%)	n (%)
Fishing	8 (40)	5 (25)	6 (30)	4 (20)
Loan from money lender (Bahaddar)	6 (30)	3 (15)	9 (45)	5 (25)
Laboring	1 (5)	1 (5)	2 (10)	7 (35)
Rickshaw driving	1 (5)	-	-	-
Net making	1 (5)	2 (10)	-	-
Business	1 (5)	1 (5)	-	-
Car driving	1 (5)	2(10)	-	1 (5)
Savings dependency	1 (5)	-	1 (5)	-
Tea shopkeeper	-	2 (10)	-	-
Grocery stall	-	2 (5)	-	-
Shrimp PL collection	-	1 (5)	2 (10)	-
Betel leaf cultivation	-	-	-	1 (5)
Fish drying	-	1 (5)	-	1 (5)
Jobless	-	2 (5)	-	1 (5)

Daily income after COVID-19

The negative impact of COVID-19 on the daily income of the fishers until we were surveying data for this study in September 2021 sustained even after removing the restrictions of movement due to the pandemic. One-way ANOVA showed that the percentage of income decreased after COVID-19 was significantly varied location-wise ($F(3,76) = 6.45$, $p < 0.001$) (Table 6). The daily income of the fishers of Doria Nagar and Inani decreased by the highest percentage after the COVID-19 situation (Table 6). The lowest percentage of daily income reduction of the fishers was in Nunier Chara (Table 6). A very few cases of the daily income increase after the COVID-19 situation was observed in case of the fishers of Nunier Chara and Doria Nagar (Table 6).

Vaccination details

In all the surveyed areas, the fishermen were not so concerned about the COVID-19 vaccine. From all the respondents, it can be seen that on average 79% of the fishers did not get vaccine during the COVID-19 pandemic (Table 6). The fishers of Inani got the highest percentage (15%) of vaccines compared to the fishers of other areas (Table 6).

Effect of fishing ban

Support and punishment from the government

Fishers mentioned that every year the government declares two types of fishing ban (65 days and 22 days). Fishermen found this news through posters, leaflets, miking, newspapers, television, radio, etc. Different types of punishment are enforced if the rules of the fishing ban are not followed such as financial fines, burning nets, and even imprisonment. Overall, only 36% of respondents from the surveyed areas get support from the government during the fishing bans (Table 7). The majority of the fishers who do not get support from the government are the fishers of Inani (70%) (Table 7). The government provides 60–90 kg of rice to each Vulnerable Group Feeding (VGF) card-holding member in each banning season. Unfortunately, due to the dishonesty of the local leaders, they only receive 30–60 kg of rice. Several VGF cardholder fishers were also reported to have deprived of these facilities.

The local government authority punished the fishers if anyone was caught red-handed during fishing within fishing bans. A large proportion of the fishers (47.5%) from the four surveyed areas reported that they had to pay fines while fishing during the bans or due to illegal fishing (Table 7), indicating that IUU fishing was practiced in the coastal area of Bangladesh. Also, other punishment systems as reported were jail, burning nets, and seizing net (Table 7).

Table 6. Impact of COVID-19 on the livelihood of fishers among the four surveyed areas with the number of respondents and percentage. For income, data represented as percentage reduction and range in parenthesis; N = 20 fishermen from each location. P value indicates significant differences at 0.05% using ANOVA.

Parameters	**Characteristics**	**Nunier Chara** n (%)	**Doria Nagar** n (%)	**Sonarpara** n (%)	**Inani** n (%)	***p*- value / Average%**
Income reduction (%)	During COVID	55.5 ± 22.5^{c} (25 – 100)	63.7 ± 17.2^{ab} (33.3 – 100)	75.5 ± 23.4^{a} (37.5 – 100)	68.9 ± 21.5^{ab} (37.50 – 100)	$p = 0.030$ (65.9±22)
	After COVID	5.2 ± 16.8^{b} (-33.3 – 30)	23.3 ± 14.9^{a} (-20 – 57.1)	15.4 ± 12.9^{ab} (0 – 33.3)	20.7 ± 11.2^{a} (0 – 42.9)	$p < 0.001$ (16.2±15)
Vaccination	Vaccinated	1(5)	2(10)	1(5)	3(15)	9
	Not Vaccinated	17(85)	16(80)	17(85)	13(65)	79
	Registered	2(10)	2(10)	2(10)	4(20)	12
Fishing activities	Fishing	11(55)	8(40)	12(60)	9(45)	50
	Not Fishing	9(45)	12(60)	8(40)	11(55)	50
Government support	2500 BDT	3 (15)	2 (10)	2 (10)	4 (20)	13.7
	60 kg rice	-	1 (5)	-	1 (5)	2.5
	No support	17 (85)	17 (85)	18 (90)	15 (75)	83.7

Table 7. Support and punishment of the government during the fishing ban of coastal fishermen in four surveyed areas of Cox's Bazar with the number of respondents and percentage (in parenthesis); N = 20 fishermen from each location.

Attributes	**Support/punishment**	**Nunier Chara** n (%)	**Doria Nagar** n (%)	**Sonarpara** n (%)	**Inani** n (%)	**Average %**
Support received by the fishermen	30–60 kg of rice	8(40)	7(35)	8(40)	6(30)	36
	No support & need the VGF card	12(60)	13(65)	12(60)	14(70)	64
Punishment if breaking the fishing ban rules	Fine	9 (45)	8 (40)	7 (35)	14 (70)	47.5
	Jail	7 (35)	4 (20)	3 (15)	2 (10)	20
	Burning net	3 (15)	5 (25)	5 (25)	2 (10)	18.7
	Fine 10,000 BDT	1 (5)	1 (5)	4 (20)	1 (5)	8.7
	Seizing net	-	2 (10)	1 (5)	1 (5)	5

Alternative income sources during the fishing ban period

During the fishing ban periods, the fishers lead their livelihood by earning from different alternative sources (Fig 6b, Table 8). The highest percentage of the fishers (25%) were engaged in laboring (30%) (Table 8). Very few respondents were found to be dependent on Rickshaw pulling in Nunier Chara (10%) and Doria Nagar (5%) (Table 8). Net-making activities were found in only Doria Nagar (10%) (Table 8). Some fishers from all the areas are more or less dependent on small businesses and car driving (Table 8). Working on shrimp hatcheries is also an alternative income source for some fishers from Doria Nagar and Sonarpara, Rejukhal (Table 8). Some fishers from Nunier Chara and Rejukhal were involved in boat maintenance (Table 8). The fishers from Sonarpara, Rejukhal are used to collect post larvae (PL) of shrimp and supply them to the nearest hatcheries during the fishing ban periods (Table 8). As an alternative income source, Brickmason is a good choice for the fishermen of Doria Nagar (20%), Rejukhal (10%), and Inani (10%). The fishers from Nunier Chara, Doria Nagar, and Rejukhal are also used to be involved in crop farming (5%), fish drying (5%), and cosmetic business (10%) respectively (Table 8). On average, 32.5% of the fishermen from all the areas became jobless during fishing ban periods (Figure 6b, Table 8).

Women's work facilities

During the fishing bans, the women also contributed to the livelihood of family members. The women from Nunier Chara (35%) work on seaweed culture activities under the projects of different government and non-government organizations (Table 9). The women from all the surveyed areas were more or less involved in net making, tailoring, and bivalve (clam, mussuel, and oyster) collection (Table 9). Some women from Doria Nagar (5%) and Rejukhal (5%) were involved in fish drying (Table 9). Shrimp post larvae (PL) were collected by the women of Rejukhal (10%) and Inani (5%). Sometimes, the women from Inani are involved in livestock farming (5%) and vegetable culture (5%) during fishing bans (Table 9). During the bans, the women of all the areas more or less became jobless and the highest percentage of jobless women was seen in Doria Nagar (55%) (Table 9).

Table 8. Alternative income generating activities (AIGAs) of the fishers during the fishing bans (percent of respondents; N = 20 from each location).

AIGAs during fishing bans	**Nunier Chara** n (%)	**Doria Nagar** n (%)	**Sonarpara, Rejukhal** n (%)	**Inani** n (%)	**Average** (%)
Laboring	5 (25)	-	4 (20)	6 (30)	25
Rickshaw driving	2 (10)	1 (5)	-	-	7.5
Net making	-	2 (10)	-	-	10
Business	2 (10)	1 (5)	1 (5)	3 (15)	8.7
Car driving	2 (10)	1 (5)	1 (5)	2 (10)	7.5
Tea shopkeeper	-	1 (5)	-	-	5
Work in hatchery	-	1 (5)	3 (15)	-	10
Boat maintenance	1 (5)	-	1 (5)	-	5
Shrimp PL Collection	-	-	2 (10)	-	10
Brickmason	-	4 (20)	2 (10)	2 (10)	13.3
Cosmetic business	-	-	2 (10)	-	10
Fish drying	-	1 (5)	-	-	5
Crop farming	1 (5)	-	-	-	5
Jobless	7 (35)	8 (40)	4 (20)	7 (35)	32.5

Mariculture activities

From all the surveyed areas, about 54% of respondents had no idea about mariculture, and 11% of respondents had no intention to be involved in mariculture activities (Table 10). Almost all the fishers from Nunier Chara (100%) and about 40% of respondents from Rejukhal were directly or indirectly involved in seaweed mariculture (Table 10). These maricultures are conducted under several projects of government organizations, non-government (NGOs) organizations, and universities such as the Department of Fisheries, World Fish, Eco Fish, Chattogram Veterinary and Animal Sciences University (CVASU), etc.

Table 9. Women's alternative income sources during the fishing ban period in four surveyed areas of Cox's Bazar with the number of respondents and percentage in the parenthesis; n = 20 fishermen from each location.

Attributes	Nunier Chara	Doria Nagar	Sonarpara, Rejukhal	Inani	Average
Seaweed culture	7(35)	-	-	-	8.7
Net making	6(30)	1(5)	5(25)	7 (35)	3.7
Tailoring	3(15)	5(25)	7(35)	2 (10)	21.2
Bivalve collection	1(5)	2(10)	1(5)	2 (10)	7.5
Fish drying	-	1(5)	1(5)	-	2.5
Shrimp PL collection	-	-	2(10)	1 (5)	3.7
Livestock farming	-	-	-	1 (5)	1.3
Vegetable culture	-	-	-	1 (5)	1.2
Jobless	3(15)	11(55)	4(20)	6 (30)	30

Table 10. Fishers' involvement in mariculture activities in the four coastal areas of Cox's Bazar, Bangladesh. Data represented as Number of respondents and percentage in parenthesis; n = 20 fishermen from each location.

Attributes	Nunier Chara	Doria Nagar	Sonarpar, Rejukhal	Inani	Average %
Seaweed mariculture	20(100)	-	8(40)	-	35
No knowledge	-	17(85)	10(50)	16(80)	54
No intention	-	3(15)	2(10)	4(20)	11

4. DISCUSSION

Socio-economic conditions of fishermen

This study exhibits that the fishing bans and COVID-19 pandemic have significantly impacted the socio-economic and livelihood conditions, and have reduced the income of the coastal fishermen in Bangladesh. Most of the fishermen were within the age range of 21-50 indicating that the sea fishing in Bangladesh is mainly done by males of middle age groups due to the hard-working nature of the job supporting Akter et al. (2023). The younger below 20 years old and older over 50 years old are usually not engaged in fishing in the coastal area of Bangladesh reflecting fishing is labour intensive masculine work and requires strength (Akter et al., 2023). Our study shows that coastal women were not usually involved in sea fishing, however, they have active involvement in bivalve (clam) fishing (Khan et al., 2024), post-harvest processing (making dryfish, fermented product), mariculture (seaweed), household farming (vegetable, livestock), tailoring and marketing as similar to seen in other countries in the world (Al Rashdi and Mclean, 2014; DeMattos et al., 2017). The contribution of women is usually underestimated though they play a crucial role in coastal food security (Crawford et al., 2010; Al Rashdi and Mclean,

2014; De Mattos et al., 2017). Illiteracy, social issues, and early marriage are the typical features of coastal women placing them in dependent roles, and restricting their economic contribution to society (Islam, 2011; Shakil et al., 2019).

The fishermen in the four localities on the Southeast coast of Bangladesh were mostly illiterate (70%), while some (30%) have finished their primary education, and very few have gone beyond primary school. Illiteracy is one of the most common problems among coastal and inland fishermen in the world, particularly in Asian countries (Dey et al., 2010). Illiteracy creates several problems such as sole dependency on fishing, therefore the fishermen do not get other jobs that pay good salaries but require literacy. Mass illiteracy in riverine and coastal fishermen in Bangladesh was also recorded by Dey et al. (2010), and Yasmin et al. (2023). This problem is probably due to their early engagement in fishing activities for their family requirement and the inherited tradition over the generationis seen in other coastal countries (Dey et al., 2010). Half of the fishermen in the survey areas had a daily income below 500 BDT, which is not sufficient to manage a family consisting of >5 members. Though few fishermen can earn a bit higher amount of income (>500 BDT), most of the fishers' daily income is far below (200–450 BDT) than the average minimum wage, a similar scenario seen in other countries (Da Rocha Araújo et al., 2009). Moreover, during bad weather conditions or sickness, they hardly have any income.

Most of the coastal fishermen (53%) had houses made of tin sheds, with just 4% living in pacca (half building: brick wall) in Cox's Bazar region. Different studies also exhibit the low livelihood of the small-scale fishers with the most common housing system being tin sheds to very few pakka houses (brick wall made), even their houses may be of bamboo fences only (Dey et al., 2010; Yasmin et al., 2023). A large portion of the small-scale fishers along the coasts are not registered yet, which hinders getting support from the government. Till now, more than 60% of fishermen are not registered and do not have VGF cards therefore, they are not under the government's social safety net. Fishermen mentioned that robbery/kidnapping is one of the major safety concerns during fishing which is occasionally seen for the coastal fishers in Bangladesh (TBS report, 2021).

Impact of Covid and fishing bans

COVID-19 has restricted fishing activity due to the lockdown, and reduced income by more than 75% during the pandemic and 16% after COVID-19 while we were conducting the survey. Half of the fishermen from these coastal areas could not go for fishing during COVID. However, Hoque et al. (2021) reported only 26% income reduction among coastal fishers in Bangladesh and only 15.43% from Cox's Bazar region, which matches our findings on income reduction after COVID. The effect of COVID-19 in world business and marketing systems was enormous, particularly in food marketing channels due to the cessation of shipping and air freight (Bennett et al., 2020; Nyiawung et al., 2024). The negative impacts of the COVID pandemic include but are not limited to lockdown, the complete shutdown of some fisheries, but also the economic recession from market disruptions, increased health risks for fishers and other stakeholders, increased vulnerabilities to other social and environmental stressors, and augmented the illegal, unreported, and unregulated fishing (Bennett et al. 2020; Nyiawung et al., 2024). A lack of eagerness in the vaccination program was observed among coastal fishers from a very low vaccine registration percentage (13%) in the four fishing communities in Cox's Bazar. The present study also indicated that small-scale fishers are not aware of their health, which was also reflected by their comment "COVID will not attack hard-working fishermen, rather Corona is the disease for rich people, not [of the] poor", which was also reported by Hoque et al. (2021). Macusi et al. (2024) reported that the pandemic also had an impact on the schooling of the children, mobility limitations, inadequate food, and travel restrictions for families of fishermen. The pandemic demonstrated the immense value of fisheries and the part that fishermen play in preserving the chain that provides food during times of emergency such as COVID-19 (Macusi et al., 2024).

Fishing ban or seasonal closure are common approaches worldwide to manage and conserve the fisheries stocks, however, these strategies may be unsuccessful if not monitored or maintained properly by the local fishers. During the fishing bans, more than 50% of the surveyed small-scale fishers were involved in artisanal fishing to support their family which falls under IUU (illegal, unreported, and unregulated) fishing. The IUU fishing during fishing ban in the coastal areas may cause additional stress to larvae and small fishes, which may result extinction of important fish species resulting in the loss of biodiversity, in consequence may increase poverty among small-scale fishers (Mozumder et al., 2023). IUU fishing poses a major threat to global fisheries and negatively impacts the livelihoods and operations of legitimate fishing communities by undermining marine biodiversity, depleting natural fish stocks, and disrupting sustainable fishery management (Donlan et al., 2020; Mozumder et al., 2023). The implementation of fishery regulations has major challenges including the poor livelihood of the coastal fishermen, inadequate incentives, lack of sufficient logistic support, lack of alternative professions, political interference, and lack of awareness regarding fishery regulations (Islam et al., 2017). The perceptions of fishers along the Bay of Bengal from a study by Islam et al. (2021) suggests that a seasonal monsoon fishing ban has a positive influence on fish abundance indicating a positive ecological response, however, the negative impact includes the reduction of income and food security that increase the vulnerability of the small-scale fishermen (Cohen et al., 2013; Islam et al., 2021). During the fishing bans, most of the fishermen in Cox's Bazar were involved in laboring and took loans from local Mohajonat very high interest rates. Similar findings were seen in the case of Hilsha fishermen in Monpura Island, Bangladesh, where in the worst-case scenario, fishers had to sell their own boats and nets for paying the loan and gradually become poor to poorer (Dey et al., 2010). Several factors like limited access to formal credit, high fishing costs, and insufficient government support are responsible for sustaining the mohajon-based debt cycle of the fishermen. Islam et al. (2017) suggested that loans at low interest from government banks, community-level finance schemes, and the creation of alternative livelihoods may reduce dependency on the dadon loan system thus helping the fishers to break the debt cycle and enhance fishers' socio-economic conditions.

Fishermen mentioned that the subsidy from the government during the bans is not sufficient to maintain their livelihood, and the local leaders distribute incentives improperly, show nepotism, and give government subsidies to their relatives who are not actual fishermen. From the survey, it was found that only 35% of fishermen could get help from the government during the 65-days ban period. However, fishermen alleged that the subsidy of 84 kg of rice/family/month was not supplied properly by the local leaders, instead, they received 51–60 kg of rice. This phenomenon of the dishonesty of local leaders was also reported by Dey et al. (2010) in case of Hilsha fishers from Monpura Island, and Sultana et al. (2021) in case of coastal communities of Bangladesh. The fishers mentioned that the government subsidy in the form of single food subsistence (rice only) is not adequate to sustain their families, therefore they sometimes become bound to conduct IUU fishing. The economic situation of the fishers has not changed over the decades, and the fishermen are still below the poverty line and are struggling for basic needs such as health, nutrition, and housing problems if compared with the previous studies.

Alternative income generation activities

The fishers needed to augment their household income with AIGAs in order to maintain a viable livelihood as they had no other employment options, and they suffered greatly during the fishing ban and lean fishing season (Ali et al., 2010). Finding alternate sources of income for fishermen is becoming more and more popular as a means of protecting fish from overfishing, boosting fishermen's resilience to threats, and ensuring the sustainable management of coastal and marine fisheries (Hoque et al., 2021; Alam and Yousuf, 2024). We identified, 14 AIGAs for men and 08 AIGAs for coastal women. Among those, small-scale business, handicraft, net making, and duck and poultry rearing, driving are identified as important alternative income-generating sources

for men, while goat, sheep and cow rearing, bivalve collection, making ornaments, home-based vegetables, agriculture, net making, tailoring, are identified as important alternative income generating sources for women. Fish drying and seaweed farming are seasonal but could be a potential AIGA in the southeast coastal area of Bangladesh. The development of alternative livelihoods has become a popular policy to uplift the socio-economic status of small-scale fishers and to reduce fishing pressure on overexploited stock. It is noteworthy that some AIGAs are important ways to raise the local economy which is caused by decreased production of capture fisheries (Zamroni and Yamao, 2011). Seaweed farming was seen as one of the major alternative income sources for both men and women fishermen in Nunier Chara and Inani, Cox's Bazar coast. Seaweed culture was also suggested as an alternative to fishing in the South Sulawesi province of Indonesia (Zamroni and Yamao, 2011). Seaweed farming has been incorporated as an alternative livelihood option for fishers in tropical developing countries (Crawford, 2002; Sultana et al., 2023). Similarly, bivalve coastal aquaculture, particularly clam *Meretrix* sp., mussel *Perna* sp., and oyster *Crassostrea* sp. can provide ecosystem services, additional income, and job opportunities and will decrease the fishing pressure in the coastal area of Bangladesh (Khan et al., 2024). Rahman et al. (2012) identified the major AIGAs from Nijhum Dwip, Bangladesh are poultry and livestock rearing, crop farming, boatman, non-farm day laboring, small business, handicraft/swing, crab catching, and fish farming.

The economy of Bangladesh has greatly benefitted from small-scale fishing in terms of output, foreign exchange profits, and protein supplies. Worldwide, coastal fishers are facing livelihood challenges due to overfishing, environmental changes, and habitat destruction leading to declines in fish catch (Silas et al., 2020; Shamsuzzaman et al., 2024). In addition to these issues, various barriers such as access to fish markets, inadequate social amenities, health and education challenges, and fishing ban, the coastal fishermen are considering changing for keeping sustainability of their profession; i.e. in Tanzania, and Bangladesh (Ali et al., 2010; Silas et al., 2020). It is evident that due to the widespread belief that offshore areas remain fruitful while near shore areas have experienced significant declines in fish stocks, three-fourths of Tanzania's fishermen have shifted their fishing grounds from near shore to offshore over the past ten years (Silas et al., 2020). However, artisanal fishers in Tanzania still want to continue fishing as other alternative livelihoods have also faced negative impacts alike small-scale fishing (Silas et al., 2020). Therefore, AIGAs should be selected with great care, and necessary policy and infrastructural facilities should be provided both from GO and NGOs.

Coastal fishermen urge solutions through collaborative plans and policies between NGOs and governments to establish educational, medical, and social facilities in coastal and rural areas, and to make the required efforts to assist fishermen in adopting different forms of income other than fisheries (Ghosh et al., 2015). They also highlighted the importance of sufficient government support and transparent distribution of economic subsidies, as well as strict enforcement of fishing regulations, to improve income levels (Alam and Yousuf, 2024). Addressing these issues requires responsible and sustainable fisheries management (Shamsuzzaman et al., 2024). NGOs can help in linkages development to markets by facilitating the creation of a more pro-business environment and adopting the promising AIGAs at the local level.

To build resilience among coastal fishers, it is crucial to invest in small-scale marine fisheries through long-term livelihood improvements, asset creation, and the development of skills and knowledge related to natural resource-based alternative income-generating activities (AIGAs). Additionally, establishing a dedicated social safety net program for these fishers is essential (Bhowmik et al., 2021). The reliance on a single income source, inadequate aid, lack of skills, and poor social protection severely undermine fishers' resilience (Islam et al., 2017; Bhowmik et al., 2021). Researchers recommend co-management, participatory research, awareness-building, fostering environments conducive to promising AIGAs, empowering women in fisheries, involving local communities in management decisions, and developing fisheries cooperatives as vital

strategies for the sustainable management of coastal fisheries (De Mattos et al., 2017; Islam et al., 2017).

5. CONCLUSION

Small-scale coastal fishers are essential to food security, nutrition, and economy, yet unfortunately they are being subjected to face significant vulnerabilities due to fishing bans, climate change, and pandemics. To mitigate these challenges and promote sustainable management of coastal and marine fisheries in developing nations like Bangladesh, it is crucial to invest in adult education, skill development, and training facilities to create a competent workforce for both domestic and export markets. Additionally, implementing high-potential AIGAs, providing bank loans for small enterprise development, and promoting coastal aquaculture are vital steps. Despite their importance, the socioeconomic conditions of fishers have not seen significant improvement over time. Therefore, effective planning and intervention by both government and non-government organizations are essential to enhance their socioeconomic status.

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REFERENCES

Akter, A., Akash, A. I. Sultana, T. Tamzi, N. N. Afroze, S. and Faisal, M. 2023. Socio-economic status of fishermen in Cox's Bazar district of Bangladesh. International Journal of Fisheries and Aquatic Studies, 11: 208–213.

Al Rashdi, K. M. and Mclean, E. 2014. Contribution of small-scale fisheries to the livelihoods of Omani women: A case study of the Al Wusta Governorate. Asian Fisheries Science, 27: 135–149.

Alam, M. S. and Yousuf. A. 2024. Fishermen's Community Livelihood and socio-economic constraints in coastal areas: A exploratory analysis. Environmental Challenges, 14: 100810.

Alam, S., Rahman, M. and Arif. A. A. 2021. Challenges and opportunities in artisanal fisheries (Sonadia Island, Bangladesh): The role of legislative, policy and institutional frameworks. Ocean and Coastal Management, 201: 105424.

Ali, M. L., Hossain, M. B., Rokunuzzaman, M. and Bhadra, S. 2010. Access to fisheries resources by the poor fishers for income generation and livelihood and their coping strategies during lean and ban fishing period in Bangladesh. National Food Policy Capacity Strengthening Programme, Bangladesh Centre for Advanced Studies, Bangladesh, 1-39.

Arif, A. A. 2017. Legal status of maximum sustainable yield concept in international fisheries law and its adoption in the marine fisheries regime of Bangladesh: A Critical Analysis. International Journal of Marine and Coastal Law, 32: 544–569.

Bennett, N. J., Finkbeiner, E. M., Ban, N. C., Belhabib, D., Jupiter, S. D., Kittinger, J. N., Mangubhai, S. Scholtens, J., Gill, D. and Christie, P. 2020. The COVID-19 pandemic, small-scale fisheries and coastal fishing communities. Coastal Management, 48: 336–347.

Bhowmik, J., Selim, S. A., Md. Irfanullah, H., Shuchi, J. S., Sultana, R. and Ahmed. S. G. 2021. Resilience of small-scale marine fishers of Bangladesh against the COVID-19 pandemic and the 65-day fishing ban. Marine Policy, 134: 104794.

Brillo, B. B. C., Jalotjot, H. C., Cervantes, C. C. and Rola, A. C. 2019. Impact on income and livelihood of fisheries workers: Closed fishing season policy for sardines in Zamboanga Peninsula, Philippines. Journal of Coastal Conservation, 23: 1057–1067.

Cohen, P. J., Cinner, J. E. and Foale. S. 2013. Fishing dynamics associated with periodically harvested marine closures. Global Environmental Change, 23: 1702–1713.

Colwell, J. M. N., and Axelrod. M. 2017. Socio-economic impacts of a closed fishing season on resource-dependent stakeholders in Tamil Nadu, India: Differences in income and expenditure effects by occupational group. Marine Policy, 77: 182–190.

Crawford, B. 2002. Seaweed farming: an alternative livelihood for small-scale fishers. Narragansett (RI): Coastal Resources Center, 1-23.

Crawford, B., Herrera, M. D., Hernandez, N., Leclair, C. R., Jiddawi, N., Masumbuko, S. and Haws. M. 2010. Small scale fisheries management: Lessons from cockle harvesters in Nicaragua and Tanzania. Coastal Management, 38: 195–215.

Da Rocha Araújo, A. R., Silva, F. D., Santana, R. F. and Lopes, D. F. C. 2009. Management of fishing for *Mytella charruana* (D' Orbigny, 1846) on the coast of the state of Sergipe: sustainability indicators. Brazilian Journal of Fisheries Engineering, 4: 56–72.

De Mattos, S. M. G., Wojciechowski, M. JMacnaughton, A. E., Da Silva, G. H. G., Maia, A. M. L. R. and Carolsfeld. J. 2017. Implementing the small-scale fisheries guidelines: Lessons from brazilian clam fisheries. In MARE publication series, 473–494.

Department of Fisheries- DoF. 2019. National Fish Week Compendium (In Bengali), Department of Fisheries, Ministry of Fisheries and Livestock, Bangladesh, 52–54.

Department of Fisheries-DoF. 2023. National Fish Week Compendium (In Bengali): Department of Fisheries, Ministry of Fisheries and Livestock, Bangladesh, 2019, 138–143.

Dey, S. C., Sarker, B. S., Saha, D. and Adhikary, R. K. 2010. Impacts of banning period on the socio-economic condition of Hilsa fishermen of Monpura Island, Bangladesh. International Journal of Bioresearch, 2: 31-36.

Donlan, C. J., Wilcox, C. Luque, G. M. and Gelcich. S. 2020. Estimating illegal fishing from enforcement officers. Scientific Reports, 10.

FAO. 2022. The state of world fisheries and aquaculture 2022. Towards Blue Transformation. Rome, FAO. https://doi.org/10.4060/cc0461en

FAO. 2024. Fishery and Aquaculture Statistics – Yearbook 2021. FAO yearbook of fishery and aquaculture statistics. Rome. 232 pp. https://doi.org/10.4060/cc9523en

Hoque, Md. S., Bygvraa, D. A. Pike, K., Md. M. Hasan, Rahman, M. A., Akter, S., Mitchell, D. and Holliday, E. 2021. Knowledge, practice, and economic impacts of COVID-19 on small-scale coastal fishing communities in Bangladesh: Policy recommendations for improved livelihoods. Marine Policy, 131: 104647.

Independent, T. 2019, March 13. Alternative Livelihoods for Poor Fishermen | The independentbd.com.https://m.theindependentbd.com/printversion/details/191273.

Islam, M. M. 2011. Living on the Margin: The Poverty-vulnerability nexus in the small-scale fisheries of Bangladesh. In *Springer eBooks*, 71–95.

Islam, M. M., Begum, A., Rahman, S. M. A. and Ullah. H. 2021. Seasonal fishery closure in the northern Bay of Bengal causes immediate but contrasting ecological and socioeconomic impacts. Frontiers in Marine Science, 8. 704056

Islam, M. M., Shamsuzzaman, M. M., Mozumder, M. M. H., Xiangmin, X., Ming, Y. and Jewel Md., A. S.. 2017. Exploitation and conservation of coastal and marine fisheries in Bangladesh: Do the fishery laws matter? Marine Policy, 76: 143–151.

Khan, M. S. R., Nahar, S., Bhowmik, P., Hasan, M. N., and Rashid, H. O. 2024. The survival and growth of adult and juvenile hard clam Meretrix meretrix exposed to variable estuarine salinities in aquarium settings. Research in Agriculture Livestock and Fisheries, 11(2): 239-254.

Macusi, E. D., Bersaldo, M. J. I., Katikiro, R. E., Fadli, N., Deepananda, K. H. M. A. and Mozumder, M. M. H.. 2024. Impacts, challenges, and adaptation of small-scale fishers during the COVID-19 pandemic in selected tropical countries. Aquatic Sciences, 86.

Mozumder, M. Uddin, M. H., Schneider, M. M., Deb, D., Hasan, M., Saif, S. B. and Nur, A. A. U. 2023. Governance of illegal, unreported, and unregulated (IUU) fishing in Bangladesh: status, challenges, and potentials. Frontiers in Marine Science, 10: 1150213.

Nyiawung, R. A., Ehrlick, T., Bennett, N. J. Brunet, N. D., Matos, F., Pita, C., Stoll, J. S. and Loring, P. A. 2024. Fisheries and the COVID-19 pandemic: A global scoping review of the early pressures, impacts, and responses in least developed, emerging, and developed countries. Regional Studies in Marine Science, 74: 103501.

Rahman, M., Rahman, M. M., Hasan, M. M. and Islam, M. R. 2012. Livelihood status and the potential of alternative income generating activities of fisher's community of Nijhumdwip under Hatiya Upazilla of Noakhali district in Bangladesh. Bangladesh Research Publications Journal, 6: 370-379.

Rahman, M. A., Pramanik, M. M. H., Flura, N., Hasan, M. M., Ahmed, T., Khan, M. H. and Mahmud, Y. 2017. Impact assessment of twenty-two days fishing ban in the major spawning grounds of *Tenualosa ilisha*

(Hamilton, 1822) on its spawning success in Bangladesh. Journal of Aquaculture Research & Development, 08.

Sarker, M. N., Naser, M. N., Uddin, M. S., Das, N. N. and Humayun, M. 2019. On the management of single fish species of hilsa shad (*Tenualosa ilisha*) resources of Bangladesh. Bangladesh Journal of Zoology, 47: 173–183.

Shakil, A., Talukder, A., Akter, S., Hoque, F. N. and Asaduzzaman, M. 2019. Experiences and opinions of mollusk fishers in the Cox's Bazar coast, Bangladesh. https://doi.org/10.60015/bjvas/v07i1a6.

Shamsuzzaman, M. M., Begum, A., Islam, M. M., Al-Mamun, M. A., Mamun, M. A. A. and Mozumder, M. M. H. 2024. Assessing legal and policy frameworks for small-scale fisheries in Bangladesh. In MARE publication series, 241–258.

Silas, M. O., Mgeleka, S. S., Polte, P., Sköld, M., Lindborg, R., De La Torre-Castro, M. and Gullström, M. 2020. Adaptive capacity and coping strategies of small-scale coastal fisheries to declining fish catches: Insights from Tanzanian communities. Environmental Science, & Policy, 108: 67–76.

Sultana, F., Wahab, M. A., Nahiduzzaman, M., Mohiuddin, M., Iqbal, M. Z., Shakil, A., Mamun, A.A., Khan, M. S. R., Wong, L. and Asaduzzaman, M. 2023. Seaweed farming for food and nutritional security, climate change mitigation and adaptation, and women empowerment: A review. Aquaculture and Fisheries, 8: 463–480.

Sultana, R., Irfanullah, H. Md., Selim, S. A., Raihan, S. T., Bhowmik, J. and Ahmed, S. G. 2021. Multilevel resilience of fishing communities of coastal bangladesh against covid-19 pandemic and 65-day fishing ban. Frontiers in Marine Science, 8: 721838.

Sunny, A. R., Prodhan, S. H. Md. Ashrafuzzaman, Mithun, M. H., Hussain, M., Alam, M. T., Rashid, A. and Hossain,. M. M. 2021a. Fisheries in the context of attaining sustainable development goals (SDGs) in Bangladesh: COVID-19 impacts and future prospects. Sustainability, 13: 9912.

Sunny, A. R., Sazzad, S. A. Prodhan, S. H., Md. Ashrafuzzaman, Datta, G. C., Sarker, A. K., Rahman, M. and Mithun, M. H. 2021b. Assessing impacts of COVID-19 on aquatic food system and small-scale fisheries in Bangladesh. Marine Policy, 126: 104422.

The Business Standard-TBS. 2021. Robber's kidnap 50 fishermen from Cox's Bazar coast. TBS Report. 07 August, 2021. https://www.tbsnews.net/bangladesh/crime/robbers-kidnap-50-fishermen-coxs-bazar-coast-284911

Yasmin, Mt. S., Md. Z. Alom, Md. Shahjahan, and Alam, Md. S. 2023. Impact of fishing ban on socioeconomic status of Hilsa fishers in Bangladesh. Bangladesh Journal of Fisheries 35: 57–74.

Zamroni, A., and Yamao, M. 2011. Sustainable household economics: A case of altering income of small-scale fishermen in Indonesia. In International Conference on Financial Management and Economics 11: 343 - 347.