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Journal of Fisheries Science
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ARTICLE

Impact of Commercial Floodplain Aquaculture on Common-pool Resource Dependent Community

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ARTICLE INFO

Article history
Received: 16 June 2021
Accepted: 23 June 2021
Published Online: 30 June 2021

Keywords:
Blue revolution
Biodiversity
Small-scale fisher
Fisheries management
Food security
Gender relation
Access rights

ABSTRACT

Aquaculture in pond and floodplain was accelerated in Bangladesh in the 1990s as a means of better production and income which was backed by the donor agencies, NGOs, and the government. Currently, the commercial actors are involved in the aquaculture systems due to the availability of production technologies and inputs. This paper aims to explore how the commercialization and privatization of floodplain aquaculture become the cause of the sufferings of the natural resource-dependent people and biodiversity loss in the floodplains. Now, Influential people hold control of the common pool floodplains and restricted the access of the Small-Scale Fishers (SSF) to manage the aquaculture. Our findings suggest that the SSF, for whom the seasonal floodplains were an important source of livelihood, their livelihood has been destroyed and overall wellbeing have been negatively affected. Besides that, lending enough evidence to the increased inequality, a new group of poor has emerged. Because instead of ensuring the welfare of SSF, Bangladesh government has leased the floodplain lands to the powerful rich people. In addition to growing inequalities, natural resource degradation has welcomed social vulnerabilities. However, no development initiative will ever be sustainable and effective if the existing socio-ecological setting is not considered. Bangladesh government should take robust attempts to revisit fisheries policies to ensure livelihood resilience of fisheries resource-dependent community by managing the access rights of the common pool resources.

1. Introduction

Bangladesh holds the world's richest and most complex aquatic food systems [1] where fish and fishery resources are derived from mainly two sources- capture and culture [2]. Though capture fisheries cover 89% of the total freshwater areas of Bangladesh, production from capture fisheries plummeted during the past three decades [3,4]. In contrast, aquaculture has shown spectacular growth, which led Bangladesh to become one of the self-sufficient countries in terms of fish production [2,4,6]. This remarkable development of the aquaculture sector is known as the 'Blue Revolution', with the belief that aquaculture can contribute to fight against hunger, malnutrition, and unemployment problems [3,6]. Whilst this blue revolution in Bangladesh has impressed many and inspired much research on biological, economic, and governance aspects of the fishery, less attention has been paid to the socio-cultural issues around fishers' livelihoods. The

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 DOI: https://doi.org/10.30564/jfsr.v3i2.3371

blue revolution changed and transformed the aquatic food system to ensure the intensification of aquaculture production in a similar fashion as the green revolution did to the agricultural sector. To understand the overall process and impact of this transformation, it is needed to understand the local and global discourses supporting this course of action.

Privatization and market-friendly development policies in poor and third world countries were promoted following the discourse of development economics in the 1980s and 1990s [8]. Pioneers of these models didn't consider socioeconomic, cultural, political, and environmental factors associated with these in Latin America and most of the third world. As a result, some strategies prescribed by the World Bank to deal with hunger and malnutrition in some third world countries throughout the 1970s and 1980s led to aggravation and contradictory results [8]. For example, the World Bank Development Report in the 1970s portrayed Lesotho as a poor; agriculturally and commercially backward country with a homogenized entity prepared for benefits of development interventions [8]. Ferguson [8] has questioned the desirability, effectiveness, and beneficial value of the western development discourse in the context of rural Lesotho by analyzing the actual social effects of the development projects. Following this trend known as Green Revolution (GR), farming for subsistence was transformed enormously in favor of the intensification of food production systems in developing countries [9]. To ensure food security, employment, and income generation for the growing population, Bangladesh has also adopted GR strategies and technologies like high yield varieties of rice, fertilizers, irrigation, and chemical pesticides since the 1970s [2,6,9]. Though rice yield tripled by 2013 from 17 million tons to 52 million tons [11] in Bangladesh, still GR has been condemned for not giving the required attention to the social, ecological, and agricultural context which in turn has believed to be responsible for growing social and environmental inequalities, negative socio-economic transformation [6,8,9].

Aquaculture as a means of better production and income was generated as an outcome of the blue revolution and was backed by the donor agencies, NGOs, and the government [12]. As the leading authority, the Department of Fisheries (DoF), Bangladesh has always supported and changed policies in support of aquaculture development, including contribution to private sector development. Historically, seasonal floodplains of Bangladesh are common pool resources that are managed collaboratively and used by local communities [4,12]. But these floodplains have been under commercial aquaculture for the last two decades. Numerous evidence shows that the conversion of seasonal floodplains that were previously occupied by small-scale capture fishing into commercial aquaculture often comes with adverse social and environmental consequences [4,13,14]. The commercialization of flood plain aquaculture (FPA) coupled with new ways of privatization of land through the current leasing system and fisheries policies. This paper is based on a small-scale qualitative research among common pool resource users and commercial aquaculture in four seasonal floodplains in Bangladesh. This paper focuses on to what extent commercialization and privatization of FPA impact the traditional common-pool resource using system and how it has changed aquatic resource-dependent community's livelihood and social structures. Finally, it will briefly discuss the importance of understanding the long-term dynamics of the socio-ecological dynamics of flood plain resource use systems for designing and implementing sustainable fishery management.

2. Transformation from Traditional SSF to Commercial FPA

Geographically, Bangladesh is graced by large amount of open water resources known as rivers, canals, floodplains like haors, beels, and lakes. Historically rural people harvest fishes for subsistence and livelihood by using traditional techniques and equipment from these water bodies [12,15]. According to FAO (2005), these rural fishers are included in Small Scale Fishers (SSF). Basically, SSF is associated with different interchangeable terms, such as 'artisanal', 'local', 'coastal', 'traditional', 'small', 'subsistence', 'inshore', 'nonindustrial', 'low-tech', and 'poor' fishing [17]. SSFs play a pivotal role in the livelihoods and well-being of rural people. Besides, more than ninety percent of fishers are included under SSF who contribute to more than half of the total global fishery production [15]. Compared to the commercial fishery, SSF is considered ecologically resilient; sustainable in securing local resource users' livelihoods; accessible to more people and equitable in sharing socio-economic benefits derived from the aquatic resources [4,15,16]. Though SSFs play a pivotal role in developing countries' economies and fish production, the management and sustainability of SSF is a growing concern. Currently, many SSFs including Bangladesh's are facing numerous social and environmental challenges. Among them, transformations from artisanal fishing to aquaculture are now ubiquitous in developing and third-world countries. As part of the blue revolution, aquaculture has been introduced and promoted in Bangladesh, with the objective of

DOI: https://doi.org/10.30564/jfsr.v3i2.3371

enhancing food security directly by the production of fish for household consumption and by improving the supply and reducing the price of fish in the market [1,2,14]. Along with NGOs, both national and international research organizations, Bangladesh government has made tremendous transformation and improvements in pond aquaculture, floodplain aquaculture, community-based fisheries management and ecosystem approach to fisheries management by exercising technological innovation. The major shifts can be discussed under three broad categories- pond aquaculture, community-based fisheries management, and community-based flood plain aquaculture.

2.1 Pond Aquaculture Extension

In 1990, the DANIDA funded MAEP- 1 project was introduced in Mymensingh district, which continued up to 1994 [12]. This project focused on semi-intensive pond aquaculture through knowledge and input support with the help of a network of skilled extension workers. Their extension approach included demonstration ponds, credit farmers, and contact farmers. "Credit farmers" were poor pond owners having no experience of aquaculture who received training and input support on credit for doing aquaculture. On the other hand, "Contact farmers'' were selected to widen extension support among interested pond owners who only received training followed by a visit by an extension worker. In this way, MAEP-1 supported 823 credit farmers and 2,594 contact farmers [12]. After that, the Thana Level Fisheries Extension Project (TLFEP) was a Bangladesh Government-funded DoF project, which started implementation in 1994 [12]. It directly supported 12,000 demonstration model fish farmers and adopted a trickle-down approach to diffuse aquaculture technologies to 60,000 neighboring "Fellow farmers". This project supported not only pond owners but also people who were interested in cultivating fish and motivated them to lease ponds [12]. But this leasing process didn't remain confined in leasing ponds, rather lead to further leasing of government-owned water bodies.

2.2 Community Based Fisheries Management

DoF is the responsible authority for formulating policies, strategies, and preparing rules to conserve fisheries and enhancing fish production, but they do not hold the sole control over the using rights on the water bodies [15]. Instead, According to East Bengal State Acquisition and Tenancy Act, 1950, state-owned water bodies are under the control of the Ministry of Land, which leases out fishing rights to the highest bidder for generating revenue [1,14]. Though fisher cooperatives, consisting of existing artisanal fishers were supposed to get priority, researchers presented evidence that fishers have failed to gain exclusive fishing rights under the current leasing system [1,4]. In reality, though fishers received the lease of close water bodies, often by taking sublease or by renting the water bodies, wealthy and politically powerful people gained control over these [1,17]. This short-term tenure right leads to over-exploitation of aquatic resources, declining biodiversity, and a lack of conservation measures [15].

From the 1990s, DoF undertook proactive measures for capture fisheries management by adopting co-management approaches through a number of donor-supported projects (CBFM-1, CBFM-2 and MACH) and demonstrated good practices at different ecological settings with higher fish production, increased biodiversity, increased fish consumption, and increased incomes [12]. These projects mostly promoted group stocking of carp in closed water bodies and supported government initiatives to restore fish habitats [1,16]. In 2000, 300 among 12000 state water bodies were transferred to the DOF for 10 years to secure fishing rights for genuine small-scale fishers and to ensure sustainable community-based fisheries management [1]. Though, this initiative restored fishery productivity and biodiversity; improved the livelihoods and fish consumption of local communities, the independent functionality of these CBOs was not continued after the project is phased out [14,16,17].

2.3 Community Based Flood Plain Aquaculture

On one hand, the success of pond aquaculture motivated people to be involved in aquaculture, and on the other hand, community-based fisheries management pointed out the option and potential of leasing in government-owned water bodies. When these possibilities interlocked with each other, it resulted in Flood Plain Aquaculture (FPA). Typically, floodplains are deep depressions that become inundated in the monsoon during which they are naturally recruited by indigenous fishes, aquatic flora and fauna [1,4,18,20]. Most of the seasonal floodplains become the habitat of aquatic resources during the wet season and are used for rice cultivation during the dry season, which is widely known as the rice-fish system [18,20]. Historically, these public, public-private, privately owned floodplains were the major source of natural fish production and during monsoon, rural people had common and open access fishing rights over there [1,16]. However, inspired by the blue revolution to boost fish production and income generation; some seasonal floodplains were brought under Community Based Fish

 DOI: https://doi.org/10.30564/jfsr.v3i2.3371

Culture (CBFC) and Flood Plain Aquaculture (FPA) project [4,16]. These projects combined public waterbodies with pooled private land and then transformed the natural hydrology of floodplains by building enclosures [4,18]. They adopted productivity-enhancing techniques, such as stocking exotic carp fingerlings, adding a supplementary feed, and fertilizing the pond, which resulted in high fish production [16,18]. Very few study showed that aquaculture in these flood plains had created some negative impacts, such as destruction of natural fishery and biodiversity by enclosure of floodplains, restriction on small scale fishers' fishing rights during the wet season, social exclusion of the poorest part of the community, and unequal distribution of profit [4,16,18,19]. Findings pointed that these negative impacts have significant further impacts on the livelihoods of community people, including small-scale fishers [4,16,18,19].

Despite these negative environmental and socio-economic effects, aquaculture practices in floodplains continued expanding. After the project phase-out period, wealthy influential people accepted the learning of the projects and gave it a private and commercial shape. Sometimes they indirectly lease in the flood plains from the government through the help of registered fisher groups and sometimes they rent the floodplain from the owners or CBO. Thus, commercialization and privatization of flood plain aquaculture are happening in many parts of Bangladesh. But no evidence-based literature has been found regarding this commercial flood plain aquaculture (FPA) during this study.

3. Study Location and Data Source

Four adjacent floodplains named Bajail Beel, Cheera Beel, Boyrakuri Beel, and Dura Beel was selected for this study. These flood plains are located under the Brahmaputra river basin in Mymensingh and have similar agro-ecological and socio-economic characteristics.

Data for this study have been gathered from January 2020 to December 2020 by adopting qualitative tools such as in-depth-interview and focus group discussions. Empirical data have been collected from people who used to depend on aquatic food systems for their livelihood and current owners of commercial fisheries projects in respective study areas. To have a clear understanding of the changing social and economic pattern, some experienced and aged local people have been interviewed who have seen the changes over time. Respondents have been selected following the purposive sampling protocol. The total number of IDIs was 20 (12 with resource dependents, 4 with landowners, and 4 with commercial aquaculturists) and the total number of FGDs was 5 (3 with resource dependents and 2 with aquaculturists and service providers). Before data collection, consent was taken from the respondents. Finally, findings were recorded, transcribed, coded, and analyzed in a meaningful way.

4. Characteristics of Selected Beels and Their Resource Use System

Bajail Beel, Cheera Beel, Boyrakuri Beel and Dura Beel are located in Berunia Union under Bhaluka Upazila. They cover 100, 22, 18, and 6 acres of land respectively whereas all three beels except Boyrakuri comprises both public and private land. Geographically these beels were large deep depressions, which used to turn into floodplains during the monsoon by retaining rainwater and floodwater. They used to be seasonally flooded and remained submerged for 6 to 8 months. During the monsoon, indigenous wild fish and other aquatic flora and fauna used to enter and reproduce in these flood plains. No feeding or fertilization was added, the natural life cycle was favored by the siltation and organic decomposition of aquatic resources. In these flood plains, land boundaries were relatively clear and fixed during the dry season, whilst during the wet season these boundaries remained indistinguishable. As a result, in the wet season aquatic resources were considered as common-pool resources granting open access for both owners and non-owners of land. Different types of native species of fish, shellfish, wetland birds, and aquatic plants used to be found. Local communities used to secure their livelihoods through collaboratively managing and using these resources. Local people had inherited knowledge and adaptation techniques for making their livelihoods from these aquatic resources. They were heavily dependent on flood plains and a remarkable part of their livelihoods and the social structure used to receive shape by the common use of these aquatic resources. Many Small Scale Fishers used to fish using artisanal gears for subsistence and run their families. Small indigenous fishes captured from the floodplains were the main source of their animal protein intake and contributed to maintain nutrition standards. The common-pool resource distribution and its interdependence with the livelihood patterns of dependent communities was a good example of communal harmony.

At the end of the wet season, the landowners used to restrict the open-access resource use system by installing temporary fences in the open sides. The remaining fish then used to be considered as private property, harvested jointly by the landowners, and distributed based on the amount of land ownership. During the dry season, the land boundaries were very clear. Due to the presence of

DOI: https://doi.org/10.30564/jfsr.v3i2.3371

water for a longer period, people used to produce 'Boro' rice once a year during the dry season in the same land. After the final harvesting of fish, the sheltered water used to be open accessed again, when water was irrigated from here to the surrounding croplands for agricultural production. However, common-pool resource dependency was a source of livelihood for the community people that can be characterized by a long tradition of adaptation to the dynamics of the social and natural environment.

Bajail Beel, Cheera Beel, Boyrakuri Beel, Dura Beel, and surrounding areas have been under commercial aquaculture for more than two decades. The landowners have excavated the beels and raised the peripheral dike of the beels, closed connecting canals, and installed enclosures to regulate water retention. Through this intervention, they have changed the seasonal flooding characteristics of these beels and stopped the natural recruitment of aquatic flora and fauna. Nowadays, via a mutual understanding process, the landowners are renting these beels. The landowners' association holds the exclusive power to decide the renting process, price, and duration. If none of the landowners is interested then the beels usually rented to people who are powerful either economically or politically. Though public land is included in Bajail Beel (25 acres), Cheera Beel (3 acres), and Dura Beel (0.5 acres), only the government land under Bajail Beel has been leased in through a formal procedure. As all four beels have gone under private ownership, so nowadays small-scale fishing and access of common people are not allowed. This change in resource allocation system has created threats to both the livelihood of resource-dependent people and to the community harmony. A snapshot of overall characteristics of studied beels has been presented below.

Table 1. Characteristics and status of selected Flood Plain

Name of Flood Plain	Land Ownership	Area (Acre)	Leasing Status	Rent/year (BDT)	Duration of Aquaculture
Bajail Beel	Private- Public	100	Leased	48,00,000	1996
Cheera Beel	Private-Public	22	No	10,56,000	1998
Boyrakuri Beel	Private	18	N/A	10,08,000	2013
Dura Beel	Private-Public	6	No	3,84,000	2013

Data Source: This study

5. Findings

The findings focus on the livelihood patterns and strategies of the four study beels in terms of resource access rights, social relations, gender norms and roles and practices, poverty and inequality, vulnerabilities and risks in pursuing livelihoods, and social wellbeing.

5.1 Impact on Small Scale Fishing (SSF)

Historically people of Mahmudpur and Chandorati village had inherited knowledge and adaptation techniques for making their livelihoods from locally available aquatic resources. Community people had open fishing rights during monsoon and were allowed to use and collect all sorts of natural resources around the year from Bajail Beel, Cheera Beel, Boyrakuri Beel, and Dura Beel. According to field data, around 500 families currently live around these four beels, among which 80% families were involved in full-time or part-time fishing previously. These Small Scale Fishers used to depend on native species of fish for food and earn a living by selling fish in the past. Subsistence fishing from these beels used to create significant contributions to meet protein intake and good health. Fishing was not only a source of livelihood for the researched community but also an 'art of living' which has portrayed as a style of adaptation to the dynamics of the social and natural environment [16]. These small-scale fishers used to depend on different types of local crafts, gears, technologies, and indigenous fishing knowledge [16]. But currently the beels have been rented to aquaculture businesspersons who have invested a large amount of capital. As consequence, small-scale fishers are no longer allowed to capture fish from the Flood plains. One fisher said-

"*I along with other community people used to go for fishing in the beel at night. We used to spend the whole night and capture a good amount of fish. Income from one night was sufficient to meet the weekly expense of my family. It was fun and life was relaxed then. Now I can't go to the beel and catch fish. So, I work as a day laborer for income-earning which I don't enjoy at all*."

In this circumstance, small-scale fishers and beel dependent communities no longer capture natural fish for their livelihood. They are forced to change their income generation sources, which has a broader socio-economic impact on their life. Many people were involved with it and at the same time, many native species of fish and aquatic resources were available. Since the beel was open, water irrigation took place from here to the surrounding croplands. In other words, community people had open tenure rights and many people had employment opportunities. People used to fish in this beel and earn a living by selling fish. Now, these native fishers have changed their occupation, as they do not have the opportunity to do so. There is increasing evidence

 DOI: https://doi.org/10.30564/jfsr.v3i2.3371

that inland aquatic resources are drastically declining in both quantity and quality, and there is a severe loss of livelihood, depending on these resources. The causes behind this are the conversion of more and more wetlands into commercial aquaculture and agriculture to meet the demands of a rapidly growing population; over-exploitation of aquatic resources and siltation [13,19]. As a result most of the small-scale fishers have changed their occupation as they do not have the opportunity to do so.

5.2 Impact on Access Right and Social Cohesion

Floodplains of Bangladesh are under different types of complex ownership such as completely public, public land surrounded by private lands, and some are completely private [19]. Public floodplains are normally leased out by the Department of Land (DoL) in the auction. In most cases, the wealthy and politically- influential people who can afford to pay the lease take control over the floodplains for fish culture. Under the current leasing system, revenue collection is the main target that does not consider the biological impact, and local livelihood [1,4]. Three (Bajail Beel, Cheera Beel, and Dura Beel) out of four selected beels comprise both public and private land. Only public land of Bajail Beel has been leased following the formal process from DoL. At the same time, all the beels have multiple landowners (Bajail Beel- 40, Cheera Beel- 20, Boyrakuri Beel- 7, and Dura Beel- 5), who have rented the beels to aquaculture businesspersons. As a result, the external businesspersons have gained complete control over the respective beels. As part of the aquaculture intensification process, they have restricted the entry and allocation of resources of the community people. The fishing rights were not well established and the small-scale fishers were not able to defend their fishing rights in any of the two non-leased Beels (Cheera Beel and Dura Beel). The landowners of these two Beels are socially and economically powerful, who are enjoying the overall benefit through exercising threats and social pressure. Poor small-scale fishers have failed to gain fishing rights over the beels, mainly because of high rent value. In this circumstance, poor fishers and beel dependent communities no longer capture natural fish for their livelihoods. Due to enclosures built by aquaculture businesspersons around all four beels, most local residents lost access to their source of income, food security during scarcity, fodder of livestock, drainage, and irrigation for agriculture. According to one respondent-

"Because of renting the Beel for aqauaculture, we are in trouble. We can't catch fish for subsistance, cultivate rice by using Beel water, raise ducks depending snails, raise cattle depending natural fodder coming from the Beel. Current tenant came to our home and told us that he is the owner of the Beel now and warned us to not go to the Beel."

Common-pool resources, resource users, landowners, and all relevant stakeholders exist in webs of power and meaning [19,20]. Individuals and communities located in or near our selected beels had mutual understanding and arrangement of this resource utilization. But because of the commercialization and privatization of these beels, profit is being driven to some people over a mass community who was dependent on these resources. As common people's access has been limited, they have fallen into immense suffering. This has led to extremes of inequality in terms of access, wealth, and income. As a result, this increased gap between rich and poor is affecting community cohesion and resilience through increased social and economic disparities. Similar social resilience issue in the shrimp culture sector in Bangladesh has been observed where local elites and urban-based entrepreneurs built fortunes based on shrimp culture, leaving the coastal population to be worsen off [25].

5.3 Impact on Food Security

Both positive and negative impact of flood plain aquaculture have been observed in terms of household food security. Around 80% of rural households used to catch fish for subsistence and for selling, and the contribution of fish to the animal protein food basket was about 60% [1]. However, the poor people used to catch many "miscellaneous" small fishes from the floodplains, which have been neglected in official statistics. Small fishes were the accessible and affordable food of poor people and were good sources of micronutrients [26]. Three decades ago, unemployment was common and community people reported an annual great hardship, starting from August to November. During that time, subsistence fishing was the most important source of food and income to the people of Mahmudpur and Chandorati village. According to our data, beels were closely associated with their lives in the past. These were open where poor community people regardless of age and gender (around 80%) used to fish for their subsistence. But commercial FPA has changed the abundance of wild fish and the open fishing right, which resulted in a severe food security issue in the community. One of the respondent cited:

"*Native fish are no longer available in beels. Previously, whenever we didn't have anything to eat, I used to set nets in the beel and collect fish for our dinner. We always have a variety of fish in our food baskets. We have to buy fish from the market nowadays. As the price of fish is very high, sometimes I can't manage fish once a*

DOI: https://doi.org/10.30564/jfsr.v3i2.3371

month."

In contrast, fish production has increased a lot due to commercial FPA. Numerous studies have depicted the success of aquaculture in terms of increased fish production and contribution to animal protein consumption [2,4,20]. As a result, the supply of fish at the market has increased and the price of fish has decreased. Therefore, many argue that aquaculture contributes to improve the food security of the local population [2,4,20]. Our data also supports that more people can buy fish from the market and ensure household food security nowadays. In practice, people have to buy fishes produced by aquaculture from the market. Therefore, people's accessibility of these fish depends on their affordability, which is determined by their income. Thus, fish supply and cheap price in the market don't necessarily ensure household food security and protein intake.

5.4 Impact on Gender Relation

In the context of Mahmudpur and Chandorati village, maintaining household food security during scarcity is considered a domain of women. Their restricted access to beels has negatively affected their household food security and nutrition. Previously many snails were available in the beels which was a good source of Duck feed. Women of Mahmudpur and Chandorati village used to raise ducks depending on these types of natural feed. Duck meat and eggs were a vital source of their protein consumption and income. These aquatic snails have declined significantly due to FPA. According to one respondent-

"*I used to raise ducks and feed them snails collected from beel. Now snails are not available in our locality and I cannot afford commercial feed. Therefore, I can't raise ducks nowadays. Previously, if we had nothing to eat, I used to boil eggs and feed my children. Now I have to buy eggs from the shop*."

As a result, women's traditional source of income has been hampered. Besides, women used to collect stems and roots of water lilies, water chestnut, water spinach, Hydra fluctuant, and many other aquatic fauna for consumption during food scarcity in monsoon. Due to FPA, women's access to beels has been restricted and the abundance of the fauna also has been reduced significantly. This has an indirect impact on traditional gender relations of the community. According to female respondents, they are no longer able to maintain household food security and to contribute significantly to the household food security. As a result, their position in the household has become vulnerable and participation in decision-making has been affected negatively.

5.5 Impact on Biodiversity

No sustainable plan was required for leasing in Bajail Beel and renting all four selected flood plains. The current renting process gives the tenant's exclusive right to use the beels according to his or her very own need. Currently, all the tenants are doing mixed aquaculture in their respective rented floodplain. Based on the cost-benefit analysis and market demand, they are producing Rui, Katla, Mrigal, Sor puti, Tilapia in the flood plains. Their pond preparation process includes cleaning, applying lime, and eradicating all predators from the pond. Through the cleaning and liming process, they destroy all sorts of natural flora and through the predator eradication process they destroy the native fish species and aquatic animals. One respondent has rightly pointed out-

"Indigenous fish abundance is zero now. After renting the beels for aquaculture all of our small fishes are gone. How could they survive? Aquaculturists apply lime in the pond which destroys all sorts of eggs and fingerlings of fish."

There is no administration system to determine if their aquaculture practices are sustainable in the water bodies. In addition to fish, numerous flora, snails, reptiles, snakes and other wetland resources were abundant in these beels. Overfishing, enclosure of beels, and road construction were commonly cited causes of declining natural productivity and biodiversity of the beels. By negatively affecting the breeding and growth of flood plain resources, current aquaculture practice has accelerated the destruction of aquatic resources of selected beels.

According to this research, fish production has increased significantly in aquaculture, compared to capture fishery. But no specific data of capture fishery production from selected flood plains were found. According to the current aquaculturist of Cheera Beel and Dura Beel who also possessed land ownership in both the beels-

"Production of our target fish species has increased which contributes to income-earning. In contrast, we lost most of our native fish species, which were easily captured from the beel and taste good. Now I have to buy those neglected species at a high price from the market."

So, loss of biodiversity has been observed as an impact of commercial aquaculture in research areas. We have

 DOI: https://doi.org/10.30564/jfsr.v3i2.3371

asked the status of current and previous abundance of different fish species. The findings are as such:

Table 2. Status of aquatic biodiversity in selected flood plains

Local Name	Scientific Name	Previous Status	Current Status
Rui	Labeo rohita	Common	Common
Catla	Catla catla	Common	Common
Calibaus	Labeo calbasu	Common	Common
Koi	Anabas testudineus	Common	Common
Titputi	Puntius ticto	Common	Vulnerable
Sarpunti	Puntius sarana	Common	Common
Shing	Heteropneustes fossilis	Common	Nearly threatened
Magur	Clarias batrachus	Common	Nearly threatened
Tengra	Mystus tengara	Common	Vulnerable
Gulsha	Mystus cavasius	Common	Vulnerable
Chital	Chitala chitala	Common	Nearly threatened
Boal	Wallago attu	Common	Nearly threatened
Gutum	Lepidocephalus guntea	Common	Vulnerable
Boro baim	Mastacembelus armatus	Common	Nearly threatened
Taki	Chana punctatus	Common	Common
Gojar	Channa marulius	Common	Vulnerable
Rani mach	Botia dario	Common	Vulnerable
Madhu pabda	Ompok pabda	Common	Nearly threatened
Ketchki	Corica soborna	Common	Nearly threatened
Kani pabda	Ompok bimaculatus	Common	Vulnerable
Foli	Notopterus notopterus	Common	Nearly threatened
Bheda	Nandus nandus	Common	Nearly threatened
Kholisa	Colisa fasciatus	Common	Nearly threatened
Lomba chanda	Chanda nama	Common	Nearly threatened
Kakila	Xenentodon cancila	Common	Vulnerable
Dhela	Osteobrama cotio	Common	Vulnerable
Bacha	Eutropiichthys vacha	Common	Common
Baila	Glossogobius giuris	Common	Vulnerable
Darkina	Esomus danricus	Common	Nearly threatened
Shol	Channa striatus	Common	Common
Mola	Amblypharyngodon mola	Common	Common
Tara baim	Macrognathus aculeatus	Common	Common
Ghonia	Labeo gonius	Common	Nearly threatened

Data Source: This study

The destruction of aquatic biodiversity is affecting common pool resource-dependent people through the loss of nature's services. Conservation scientists are emphasizing biodiversity conservation including fish in a reversal of past trends. However, current aquaculture businesspersons of selected beels are not interested to concentrate on biodiversity conservation rather their focus is on profit maximization from FPA.

5.6 Impact on Agriculture

During the last few decades Bajail Beel, Boyrakuri Beel, and Dura Beel were very important parts of the agricultural production of Chandorati village, whereas the people of Mahmudpur village's dependency was on Cheera Beel. As these beels are in deep depressions, during monsoon these were usually utilized as agricultural water drainage systems through small connecting canals. As a result, people were able to save the agricultural land and crops from being flooded. On the other hand, in the dry season, people used to grow crops by irrigating water from the sheltered flood plain water. People used to grow rice in the flood plains during the dry season. But because of aquaculture in these beels, landowners have built embankments, which has changed the natural hydrology. As the natural water drainage system has been disturbed and blocked, the adjacent agricultural land becomes easily flooded during the rainy season now. It disrupts the cultivation of Aman rice according to some respondents. In contrast, people used to depend on beel water to irrigate their Boro rice production during the dry season. As beels are under aquaculture projects, people are no longer allowed to use the water for irrigation. Therefore, they have to depend on groundwater using deep tube wells, which is costly. One respondent has pointed out-

"How can I cultivate without water. The project owner does not give us irrigation water. If I use deep tube well water, then the production cost increases a lot and I cannot make a profit from agriculture. Therefore, now I depend on rainwater, if it comes, I will cultivate, otherwise, I will work as a day laborer."

Similar effects have been pointed out in the rice-fish culture study and findings show that how this system has altered the indigenous agricultural system and lead to technological intensification of agriculture [27].

6. Discussion

Growing commercialization and privatization of FPA in Bajail Beel, Cheera Beel, Boyrakuri Beel, and Dura Beel has marginalized community people whose livelihood was dependent on aquatic resources. Our analysis showed that aquaculture in four selected beels has increased targeted fish production, which has improved the supply of protein-rich food to the local rural and nearby semi-urban areas. All four commercial FPA produce low-value fish, which coupled with increased fish supply, is contributing to improved protein intake for poor and market-dependent consumers. In contrast, these productive aquaculture methods also have some potentially negative impacts at the community level, although these could not be formally

DOI: https://doi.org/10.30564/jfsr.v3i2.3371

demonstrated or quantified in this research.

All four beels have excluded a large number of subsistence fishers from getting the benefit of improved fish production and affect them adversely through the deprivation of their common property rights over the floodplains. For example, Cheera Beel and Dura Beel from our research area have some public land in it, which is being illegally pulled in and used by the current aquaculture businessperson. Though open conflicts specifically related to traditional open access to rights over public waterbody didn't occur on the beels, tension and jealousy among the community people have been found. However, common-pool resource-dependent people have already been used to with the profit-driven aquaculture practice. Where the role of government was supposed to ensure well being of common people, the government has leased out the land to some rich people. As a result, privatization of these FPA has taken the profit to a wealthy group of people, and restricted access for others especially for the commons.

Severe depletion of aquatic biodiversity has been observed because of changing the hydrology of flood plain by building enclosures and applying intensive aquaculture techniques. As poor households were dependent on small and capture fishes for their animal protein consumption, depletion of these stocks has seriously affected their food consumption pattern and household food security. Besides, these seasonal floodplains were an important source of livelihood for poor people, especially small-scale fishers who have fallen into immense sufferings. So they were bound to change their traditional profession and migration which has transformed their overall socio-ecological interdependency in a negative manner. Though FPA in selected beels has multidimensional actors (fingerling, feeding, fertilizing, fishing labor etc.) working with them all the aquaculturists depend on the market for their needs. As a result, though employment opportunities have been generated, those are not targeted at local poor people. In most of the cases, flood plain resource-dependent communities are marginally benefited or are negatively affected by commercial FPA in researched beels.

Eventually, a new group of poor has emerged and their sufferings have worsened while some people are making a profit and becoming rich. Together with growing inequalities, natural resource degradation is creating social vulnerability. However, there were certain types and levels of social dependency, community cohesion, and socio-political stability around these flood plain centered common-pool resources. Now individualism has been created which has affected the social cohesion and overall well-being of the community, if we look from the development perspective.

While conflict between the protection of biodiversity and the development of rural livelihoods is well known, findings of this study show that the extension of commercial FPA has a dual effect in terms of loss in livelihood opportunities and decreased biodiversity. If any sort of conversion of natural resources occurs as part of a development initiative such as the blue revolution, then considering the existing socio-ecological setting is a prerequisite. Otherwise, the overall impact will neither be sustainable nor be entirely effective. It has also been argued by Toufique and Gregory that [9], conjointly, the 'Blue Revolution' that boosted the development of the aquaculture sector in Asia is still struggling with the reminiscences of the severe environmental disasters that it engendered two or three decades ago [4].

This consideration is pivotal in understanding the true costs and benefits of management decisions. It is important to develop locally appropriate livelihood enhancement programs for individuals who are expected to suffer during the period under consideration, particularly those who are in disadvantaged positions [28].

7. Conclusions

Social scientists often point out the trickle-down effects of the commercialization of natural resources on the poorest and resource-dependent part of the community, because of the potential risk of restricted access to rights, economic exclusion, and overall well-being consequences. In this context, this research has been conducted using commercial FPA in Bajail Beel, Boyrakuri Beel, Cheera Beel, and Dura Beel as an empirical field study. This paper was designed to understand socioeconomic and environmental aspects related to the transformation of flood plains for aquaculture inspired by the blue revolution. The primary objectives of the blue revolution were to contribute to poverty reduction, income generation, supply vital nutrition to poor households, and improvements in the overall welfare of low-income households [2]. However, in practice, commercialization and privatization of FPA is now a well-established practice in Bangladesh, which is excluding a poor part of the community from getting the service of natural resources [4].

Most of the empirical researches have depicted the gains from FPA [4,18,19]. But its negative impact on the livelihoods of the common pool resource-dependent people, their social structure, and biodiversity haven't been assessed properly in contrast to the success. In reality, commercialization and privatization of FPA in our researched area has come with adverse social and environmental consequences including limited access to

 DOI: https://doi.org/10.30564/jfsr.v3i2.3371

common fishing grounds, changed traditional profession, increased social inequality, environmental pollution, and loss of biodiversity. All this evidence indicates the classic pitfall of developing commercial flood plain aquaculture. Similarly, the negative consequences of the World Bank proposed daudkandi FPA project has been portrayed by Toufique and Gregory [4]. They questioned the desirability and effectiveness of FPA by and for the common pool resource-dependent community through analyzing the distributional consequences in Daudkandi FPA.

Considering the success, aquaculture is important for increased fish production, but aquaculturists should find alternative and sustainable ways for its extension. Changing the hydrology, destroying the natural biodiversity of flood plains, and bringing them under commercial aquaculture should not be inspired and allowed as it has severe negative consequences. In Bangladesh, the distributional consequences of floodplain stocking has been ignored continuously in the design and implementation of fisheries policies [4]. There are knowledge gaps and consequent inconsistency in formulating policy for FPA in particular and fisheries in general. It has been admitted that large-scale enclosures of floodplains are destroying natural fishery and biodiversity and are preventing SSF from gaining access to fishery during the monsoon [21]. A genuine urge and recommendation have been observed in different literature to focus on policy measures and regulatory frameworks that facilitate common pool resource-dependent people's access to publicly owned land, water, and aquaculture extension services [2,4,8]. Besides, we have reliable and enough evidence (CBFM-1, CBFM-2, CREL, ECOFISH, and ECOFISH-2) which shows that increased fisheries production, income, and biodiversity conservation could be achieved by co-management of floodplains, wetlands and rivers. It has been argued that the economic value of conserving natural resources could be 100 times more than destroying and converting them to other commercial uses [29]. So not only conversion and degradation of floodplains for short-term private gain should be discouraged; but also sustainable use, conservation of natural resources should be followed. In extreme cases, compensation or payment for ecosystem services (PES) could be provided to the excluded part of the resource-dependent community. In all stages of designing appropriate fishery management and adaptation policies to navigate the effects of such transformations, it is required to understand and consider the traditional resource use system and dynamics of community livelihood [9]. Based on this small-scale qualitative study, no meta narrative was intended to be provided, rather this paper tried to focus on some empirical livelihood dynamics and wellbeing conditions of flood plain resource-dependent community that is being overlooked by the aquaculturists and policymakers because of the hype generated by the blue revolution following the dominant economic development discourse.

Researchers have examined how international development projects are conceived, researched, and put into practice [7]. It also looks at what these projects actually achieve. The idea of externally directed 'development' has been criticized for not taking proper account of the daily realities of the communities it is intended to benefit [8]. Instead, they often prioritize technical solutions for addressing poverty and ignoring its social and political dimensions, That's why the structures that these projects put in place often have unintended consequences. Development projects will continue to fail until the process becomes more reflective [8].

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