Journal of Fisheries
Volume 10 Issue 2 August 2022
Peer Reviewed | Open Access

eISSN 2311-3111
pISSN 2311-729X

DOI: https://doi.org/10.17017/j.fish.449

Original Article

Expansion of aquaculture threatens the existence of wetlands in Bangladesh

Md. Taskin Parvez • ABM Mohsin

Department of Fisheries, University of Rajshahi, Rajshahi 6205, Bangladesh

Correspondence
Md. Taskin Parvez; Department of Fisheries, University of Rajshahi, Rajshahi 6205, Bangladesh
satil198@gmail.com

Manuscript history
Received 28 April 2022 | Accepted 5 August 2022 | Published online 19 August 2022

Citation
Parvez MT, Mohsin ABM (2022) Expansion of aquaculture threatens the existence of wetlands in Bangladesh. Journal of Fisheries 10(2): 102208. DOI: 10.17017/j.fish.449

Abstract
Despite positive role of aquaculture in food production, the practice may impact the environment negatively and it is difficult to quantify the loss. In this study, we assessed land use changes in four important wetlands (Hardoho Beel, Angrar Beel, Shaoil Beel and Gopalpur Beel) of Bangladesh through analysis of historical satellite images (1990 – 2020) to show how expansion of aquaculture activities threatens the existence of freshwater wetlands. Since 1990, the water area of all four wetlands decreased significantly over time (all $p < 0.001$). Mean yearly loss of 47.9 ± 79.3 ha, 99.2 ± 185.5 ha, 51.2 ± 61.9 ha and 2.6 ± 4.7 ha were recorded for Hardoho Beel, Angrar Beel, Shaoil Beel and Gopalpur Beel respectively. A decreasing trend in wetland area was recorded in all wetlands, primarily due to excavation of aquaculture ponds. In 2020, aquaculture ponds represented 72% of the core wetland areas. Two wetlands (Hardoho and Gopalpur) were almost totally lost and converted to aquaculture ponds and agricultural lands. This study concludes that the existence of freshwater wetlands in Bangladesh is at stake and recommends further studies to determine its impacts on people's livelihood and biodiversity.

Keywords: aquaculture expansion, aquaculture impact, biodiversity threat, land use change, wetland

1 | INTRODUCTION

There are numerous aspects of aquaculture practices that have an impact on ecosystem and biodiversity. Aquaculture is often considered mirror agriculture because during many aquaculture practices agricultural lands are being converted into aquaculture ponds. There is a growing trend of converting agricultural lands into aquaculture ponds and an opposite trend has been noticed for agricultural lands. There is a lost-lasting concern over the actual or potential impacts of certain aquaculture practices on biodiversity as such practices may be harmful to biodiversity (Diana 2009). This has been identified, at least speculated, by many researchers and organisations working with the environment. However, it is often difficult to determine or quantify the impacts of aquaculture on the environment.

The impacts of aquaculture activities on local biodiversity are usually negative; in some cases it may be neutral but rarely positive (Beveridge *et al.* 1997). Several negative impacts of aquaculture on biodiversity can be identified (Diana 2009). These include unwanted escape of aquaculture species capable of being invasive; interactions between effluents from aquaculture facilities causing eutrophication and aquatic fauna in receiving waters; expansion of aquaculture in important habitats including mangroves and wetlands; impacts on other aquatic resources for aquaculture inputs such as fish meal preparation can lead to overexploitation of required stocks; transmission of disease causing agents from aquaculture species to wild stocks; possible genetic degradation of natural stocks from escaped hatchery-bred species; increasing killing of fish predators such as birds near aquaculture farms; increasing use of antibiotic and hormone.

However, aquaculture may also positively impact

the biodiversity. Examples may include reduced fishing pressure on natural stocks especially those are already overexploited; release of aquaculture species from aquaculture systems may enhance depleted stocks, especially those have limited reproductive success; and nutrients (effluents and waste) from aquaculture facilities can also help increasing the population of other species (Naylor *et al.* 2000; Stotz 2000).

In Bangladesh, aquaculture activities have been started in wetlands, either directly in wetland by stocking hatchery-origin fish seeds or by constructing ponds with wetland areas. Unfortunately, no research work has been done to highlight this issue in the country. Moreover, biodiversity in the impacted wetlands may be negatively affected due to this practice; yet again, no research evaluated the impacts concerned. Therefore, the present study was conducted to quantify the expansion of aquaculture in wetlands of Bangladesh. We hypothesised that the area of wetland has decreased over time due to conversion of wetland into aquaculture ponds. Therefore, we examined the changes in land use pattern in four wetlands between 1990 and 2020.

2 | METHODOLOGY

2.1 Study area

The study was carried out in four wetlands (locally called beels) of north-western Bangladesh: Hardoho Beel (24°30′21.8″N 88°34′00.1″E), Angrar Beel (24°29′03.3″N 88°43′30.5″E.), Shaoil Beel (24°27′24.2″N 89°07′54.5″E) and Gopalpur Beel (24°11′18.1″N 89°08′36.6″E) (Figure 1). Hardoho Beel is situated in Tanore Upazila of Rajshahi district. This wetland is connected to Barnoi River. Angrar Beel is situated in Durgapur Upazila of Rajshahi district. Shaoil Beel is located in Singra Upazila of Natore district and this beel is connected to Gumani River and Chalan Beel- the largest wetland of the country (Galib *et al.* 2009, 2018). Gopalpur Beel is situated in Baraigram Upazila in Natore district and it was a part of Chalan Beel in past.

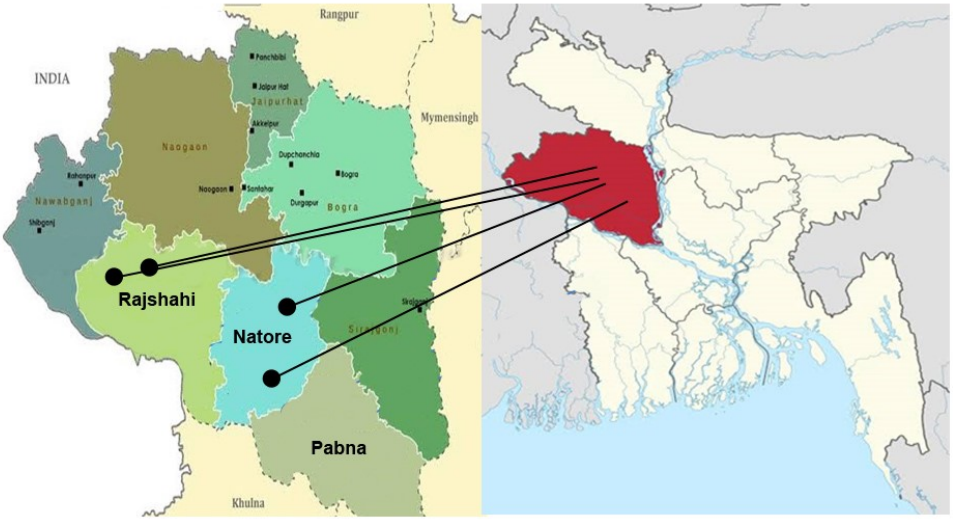

FIGURE 1: Map of the study areas (modified from Banglapedia).

2.2 Study approach

Yearly changes in wetland areas between 1990 and 2020 were analysed based on Landsat (NASA-USGS) satellite images of the study areas, captured on 31 July every year. Being captured in the mid of rainy months (i.e. 31 July), these satellite images effectively represent the wetland water area. The images were analysed using QGIS (version 3.12.2) software to calculate the water area. In addition, number of ponds and their areas were also calculated using QGIS to compare expansion of aquaculture ponds against total wetland area. The image processing and analysis were carried out in the Aquatic Biodiversity Lab of the Department of Fisheries, University of Rajshahi in 2021. In addition, three field visits were made to each of the studied wetlands in October, November and December of 2020 to compare the number of aquaculture ponds and to record relevant activities (e.g. excavation of new ponds).

3 | RESULTS

3.1 Changes in wetland area over time

In 1990, area of Hardoho Beel, Angrar Beel, Shaoil Beel and Gopalpur Beel were 1443.8 ha, 3155.4 ha, 1643.3 ha and 81.8 ha respectively. Analysis of the satellite images revealed that the water area of all four wetlands decreased significantly over time (Figure 1; all $p < 0.001$). Mean yearly loss of 47.9 ± 79.3 ha, 99.2 ± 185.5 ha, 51.2 ± 61.9 ha and 2.6 ± 4.7 ha were recorded for Hardoho Beel, Angrar Beel, Shaoil Beel and Gopalpur Beel respectively. In 2020, water area of the wetlands was 5.8, 179.5, 106.7 and 2.8 ha for Hardoho Beel, Angrar Beel, Shaoil Beel and Gopalpur Beel respectively.

Two wetlands (Hardoho and Gopalpur) were almost fully lost and converted to aquaculture ponds and agricul-

tural lands (Table 1). Yearly change in wetland showed a decreasing trend in wetland area in all wetlands. The highest yearly mean loss of wetland area was recorded for Angrar Beel (Mean ± SD: 99.2 ± 185.5 year^{-1}) whereas the lowest loss was recorded for Gopalpur Beel (2.6 ± 4.7 year^{-1}).

3.2 Expansion of aquaculture in wetlands

In 2020, 895.2 ha, 2524.3 ha, 1068.3 ha and 57.3 ha areas were converted into aquaculture ponds in Hardoho Beel, Angrar Beel, Shaoil Beel and Gopalpur Beel respectively. These represented 60%, 80%, 65% and 70% of the total area of Hardoho Beel, Angrar Beel, Shaoil Beel and Gopalpur Beel respectively. Analysis revealed that until 2006, there were no aquaculture ponds in the studied wetlands. Massive excavation work for aquaculture was recorded between 2011 and 2015 (Figure 2). A total of 326, 482, 378 and 42 aquaculture ponds were recorded in 2020 in Hardoho Beel, Angrar Beel, Shaoil Beel and Gopalpur Beel respectively. All aquaculture ponds were constructed in the middle of the wetlands. However, continuous excavation of new ponds for aquaculture was recorded in all wetlands.

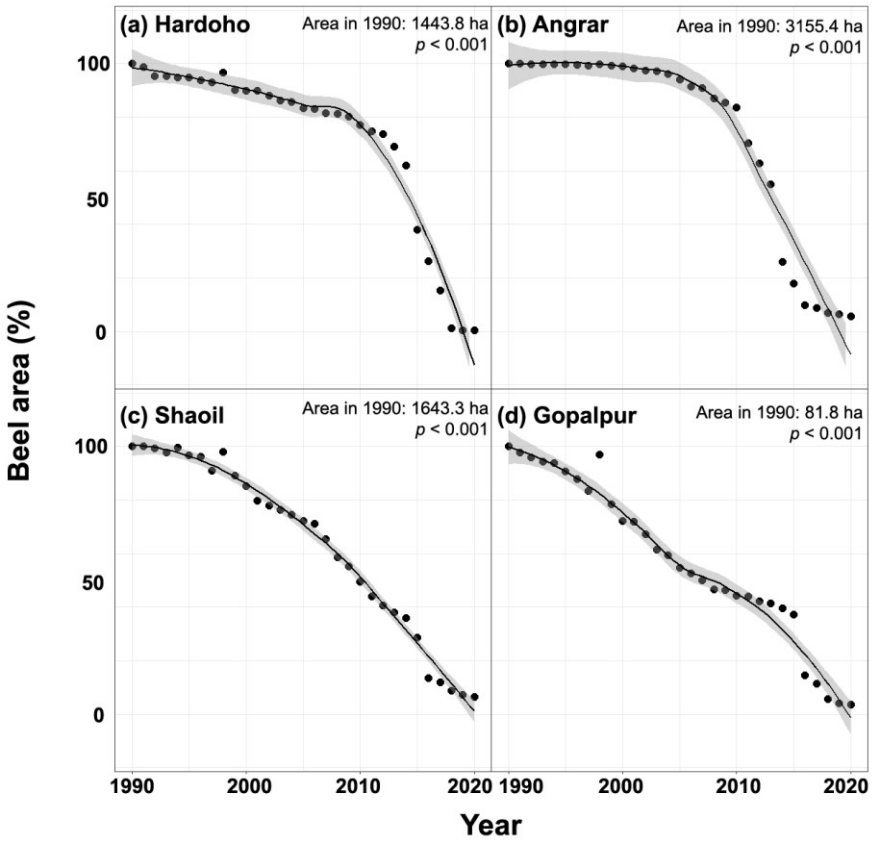

FIGURE 1: Loss of wetland areas between 1990 and 2020. Grey shaded area represents 95% confidence interval.

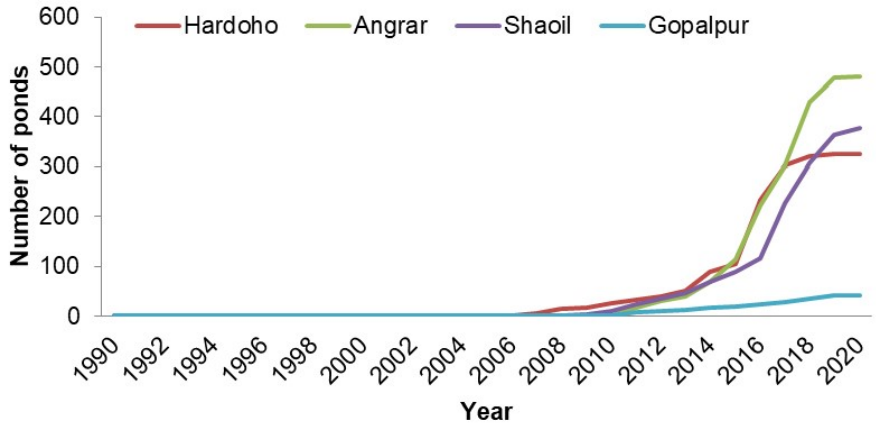

FIGURE 2: Excavation of aquaculture ponds in four wetlands between 1990 and 2020.

TABLE 1: Status of transformation of wetlands into aquaculture ponds and agricultural fields.

Wetlands	1990	2020			
	Total area (ha)	Pond area (ha)	Agriculture area (ha)	Water area (ha)	Total pond
Hardoho	1443.8	895.2	542.8	5.8	326
Angrar	3155.4	2524.3	451.9	179.5	482
Shaoil	1643.3	1068.2	468.4	106.7	378
Gopalpur	81.8	57.3	21.7	2.8	42
Mean±SD	1581.1±1258.2	1136.3±1025.3	371.2±236.3	73.7±85.5	307±188.2

4 | DISCUSSION

A remarkable transformation of natural wetlands took place in the study area, most into aquaculture ponds. This poses a grave threat to the existence of studied wetlands as most of ponds were excavated in the middle of the wetlands. There is a common perception among many people of Bangladesh that this practice could be beneficial as more fish can be produced and due to less or no flooding because of construction of aquaculture ponds people can produce more agricultural crops. This is because people in Bangladesh, especially those are with limited educational background, are not very conscious about biodiversity conservation (Galib *et al.* 2018). Moreover, aquaculture in wetlands is often encouraged by the governments to increase fish production. This is a common scenario in Asian countries, particularly in South and East Asian countries (Jones *et al.* 2021).

On average, yearly 47.9 ha, 99.2 ha, 51.2 ha and 2.6 ha areas were lost in Hardoho Beel, Angrar Beel, Shaoil Beel and Gopalpur Beel respectively. In Bangladesh, a reduction in overall wetland areas has been reported by Khan *et al.* (2022). Salam *et al.* (2020) conducted a study on beel (= wetland) encroachment where they found about 80% water of the total area have been decreased between 1981 and 2016. Arefin *et al.* (2020) carried out a study for the detection of changes in land use pattern of water surface area in Chalan Beel, Bangladesh using a hybrid modelling approach in the winter season and considered four sites and showed loss of 40%, 8%, 8% and 80% area decrease in site 1, site 2, site 3 and site 4 respectively. In another study, Islam *et al.* (2011) showed that the wetlands in Dhaka are undergoing rapid change. In 1960, water bodies and lowlands covered a total of 2952.02 ha and 13527.58 ha respectively and they shrank to 2103.62 and 12717.73 ha respectively in 1988. This further worsened, taking up an area of 1990.71 ha in 2008, showing that the lowlands continue to fall off. Thus, between 1960 and 2008, the aquatic water bodies and lowlands dropped by 32.57% and 52.58% respectively. Due to the losing the area, the Dhaka city face a great water logging problem.

The present study also showed that, a huge pond excavation work has taken place in every wetland. The conservation started in recent decades, around 2009 increased sharply in 2014 – 2015. Many influential people have started aquaculture in wetland areas of the country. In addition, people who owned lands within the wetland boundary have also started aquaculture to earn more profit. Influence of politically active and elite people in fisheries management of a habitat has been recognised (Bhuiya 2014). This was also true for the wetlands of the present study.

In conclusion it should be noted that the wetland habitats are facing a great threat from multiple sectors and aquaculture is one of them. Although government encouraged people to protect these ecosystems from destruction but a lack of coordination between people and responsible bodies yields poor success in this regard. As monetary profit from aquaculture and agriculture can be obtained directly and rapidly than from the wetland ecosystem services, people are more interested in earning money. The loss of wetlands might affect the wild fish abundance and richness negatively. Adverse effects on fishermen's livelihood (e.g. income and fish consumption), a vulnerable community in Bangladesh (Islam *et al.* 2013; Galib *et al.* 2016; Shalehin *et al.* 2022), may be also expected. We recommend further studies to determine impacts of loss of wetland habitats on people's livelihood and biodiversity.

ACKNOWLEDGEMENTS

MTP received fellowship from the Ministry of Science and Technology of the Bangladesh government for this work. Special thanks to Dr Shams Galib of the Department of Fisheries, University of Rajshahi for his help during data analysis.

CONFLICT OF INTEREST

The author declares no conflict of interest.

AUTHORS' CONTRIBUTION

MTP & ABM research design; MTP primary data collection; MTP data analysis; MTP & ABM manuscript preparation; ABM research supervision.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are avail-

able on a reasonable request from the corresponding author.

REFERENCES

Arefin R, Meshram SG, Santos CAG, da Silva RM, Pushparaj J (2020) Hybrid modelling approach for water body change detection at Chalan Beel area in northern Bangladesh. Environmental Earth Sciences 79: 442.

Beveridge MCM, Phillips MJ, Macintosh DJ (1997) Aquaculture and the environment: the supply of and demand for environmental goods and services by Asian aquaculture and the implications for sustainability. Aquaculture Research 28(10): 797–807.

Bhuiya SI (2014) Towards sustainable co-management organization: a case study of the Baikka Beel, Moulvibazar, Bangladesh. Journal of Fisheries 2(2): 119–124.

Diana JS (2009) Aquaculture production and biodiversity conservation. BioScience 59(1): 27–38.

Galib SM, Hoque MN, Akter S, Chaki N, Mohsin ABM (2016) Livelihood, climate change and fisheries: a case study of three fishing communities of northwestern Bangladesh. International Research Journal of Social Sciences 5(8): 18–25.

Galib SM, Lucas MC, Chaki N, Fahad FH, Mohsin ABM (2018) Is current floodplain management a cause for concern for fish and bird conservation in Bangladesh's largest wetland? Aquatic Conservation: Marine and Freshwater Ecosystems 28(1): 98–114.

Galib SM, Samad MA, Mohsin ABM, Flowra FA, Alam MT (2009) Present status of fishes in the Chalan Beel-the largest beel (wetland) of Bangladesh. International Journal of Animal and Fisheries Science 2(3): 214–218.

Islam MR, Hoque MN, Galib SM, Rahman MA (2013) Livelihood of the fishermen in Monirampur Upazila of Jessore district, Bangladesh. Journal of Fisheries 1(1): 37–41.

Islam MS, Rahman MR, Shahabuddin A, Ahmed R (2011) Changes in wetlands in Dhaka city: trends and physico-environmental consequences. Journal of Life and Earth Science 5: 37–42.

Jones PE, Tummers JS, Galib SM, Woodford DJ, Hume JB, ... Lucas MC (2021) The use of barriers to limit the spread of aquatic invasive animal species: a global review. Frontiers in Ecology and Evolution 9: 611631.

Khan MAG, Galib SM, Hasnath M, Mia MR, Kibria R (2022) Exotic fish and decreasing habitats vis-à-vis conservation of freshwater fish biodiversity of Bangladesh. Journal of Fisheries 10(1): 101301.

Naylor R, Goldburg RJ, Primavera JH, Kautsky N, Beveridge MCM, ... Troell M (2000) Effect of aquaculture on world fish supplies. Nature 405: 1017–1024.

Salam M, Rana KS, Rahman MT (2020) Impact of beel encroachment on aquatic biodiversity and vulnerability of poor fishermen in Noagaon district, Bangladesh. Asian Journal of Medical and Biological Research 6(2): 244–254.

Shalehin MS, Parvez MT, Lucas MC, Galib SM (2022) A case study of illegal fishing causes during seasonal fishery closure in Kaptai Lake, Bangladesh. Fisheries Management and Ecology. DOI: 10.1111/fme.12536

Stotz W (2000) When aquaculture restores and replaces an overfished stock: is the conservation of the species assured? The case of the scallop *Argopecten purpuratus* in northern Chile. Aquaculture International 8: 237–247.

MT Parvez https://orcid.org/0000-0002-1444-2980
ABM Mohsin https://orcid.org/0000-0002-5493-2503