



Impact of shifting from rice to shrimp farming on migration aspirations in Bangladesh

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Abstract

The Ganges–Brahmaputra–Meghna delta is one of the most populous deltas in the world, threatened by diverse environmental stressors, including salinity intrusion, causing adverse consequences on livelihood adaptation. Shrimp farming has been recognized as one of the most practiced livelihoods among various livelihood opportunities. Growing global demand and higher economic returns encouraged many farmers to convert their agricultural land to shrimp farms by intruding saline water into the farmlands to produce shrimps. In this study, we investigated whether the growing trend of shrimp farming influences the migration aspirations of the vulnerable coastal communities in Bangladesh. The study employed qualitative interviews with individuals in four villages in southwest coastal Bangladesh. Satellite images were analyzed to detect land-use changes and changes in soil salinity in the last 28 years, confirming a rapid increase in shrimp farms. Results from the qualitative interviews indicate that poor people with limited resources cannot produce paddy on their land because of increased soil salinity caused by shrimp farming. Such a situation leads them to aspire to migrate. Thus, our analysis contributes to the discourse on “aspiration and capability” in environmental migration by adding the impacts of land-use changes on livelihoods.

Keywords Rice to shrimp · Land use changes · Migration aspirations · Environmental degradation · Livelihoods · Remote sensing

Introduction

The rise of shrimp farming for higher financial gains in the Bengal Delta (Bangladesh) is a prime example of short-sighted development approaches that trigger a widespread loss for the larger community (Swapan and Gavin 2011). Before 1970, salt-water shrimp farming was almost unheard of in southwestern Bangladesh, where people had relied on

rice cultivation for centuries. However, during the 1970s, powerful outsiders such as influential people, businessmen, and corporate elites introduced shrimp farming by intruding saline water from marine sources in Bangladesh, promising higher profits (Jamal 2024). Though beneficial for a few, this change caused livelihood disruption for many rice farmers, forcing them to face severe hardship caused by environmental degradation due to shrimp farms’ saline nature, which created many adverse impacts for ordinary people (Dewan 2021). Many people in this region have adapted to shrimp farming as an alternative livelihood source in response to the salinity intrusion (Amoako Johnson et al. 2016; Barua et al. 2023; Biswas and Mallick 2021; Hossain et al. 2013). Between 1986 and 2015, the shrimp farm areas have increased from 115,000 hectares to 215,305 hectares in coastal Bangladesh (Saha and Masud-All-Kamal 2023). Using political and economic power, many influential external investors have modified many rice fields into earthen enclosures called “bheri” (in Bengali) by building higher dikes to entrap the fingerlings from the tidal water exchange (Akber et al. 2017; Amoako Johnson et al. 2016; Swapan and Gavin 2011). At present, Bangladesh’s shrimp farming

Highlights

- It explains the impact of land use change on livelihoods and migration aspirations of people at risk.
- Results confirm a pronounced association between soil salinity and migration aspiration.
- Increment of soil salinity evolved through transformation from rice to shrimp cultivation.

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plays a crucial role in the national economy due to its contribution to GDP and export potential (Washim et al. 2020). Globally, the country ranks 8th in shrimp production and 7th in shrimp export (Boyd et al. 2022; Jamal et al. 2023). By exporting shrimp, Bangladesh earned 329 million USD in 2019–2020 (BER 2021). The southwestern districts of Bangladesh, especially Bagerhat, Khulna, and Satkhira, are the central hub of shrimp production, contributing more than 75% of the shrimp production yearly (DoF 2021).

Evident that there is much profitability in shrimp farming, it is also causing a lot of negative consequences on the environment and food security, such as prolonged stagnation of saline water on the farmlands, increasing the leaching of the base mineral, which causes the escalation of acidity and salinity in the soil, which may affect the productivity of the adjacent rice fields (Akber et al. 2018; Ali 2006; Douglas 1994; Flaherty et al. 1999; Landon 1991). In Bangladesh, several studies reported that converting agricultural land to shrimp farms has resulted in unstable food production, threatening agricultural sustainability (Ahmed and Ambinakudige 2023; Islam et al. 2015). Morshed et al. (2020) analyzed the temporal changes in land use and soil salinity using satellite data, soil salinity data, and farm-level data in the Kaliganj sub-district of Satkhira. They found that the increase in shrimp farms has caused higher salinity in adjacent paddy farms closer to shrimp farms. As a result, many conflicts were also visible at the local level, especially in response to land conversion from rice fields to shrimp farms (Hossain et al. 2013; Pokrant 2014), and any changes in land use can impose different forms of impact on the life and livelihood of the people. Hasan et al. (2023) observe that, in the Batighata Upazilla of the Khulna district in Bangladesh, the local livelihoods are affected as small landholders had no option but to shift to shrimp, and high salinity had upturned their livelihoods.

Such land use changes can negatively affect communities, resulting in loss of livelihoods and ultimately leading to migration, which can be voluntary or involuntary (Mallick and Schanze 2020). Any abrupt consequences of such environmental change, for instance, salinity-induced less rice production, can lead to migration, as it creates vulnerable groups who cannot cope with such changes in their regular livelihood choices (Van Praag 2021). It is essential to mention that “migration” is also an adaptation strategy when livelihoods are threatened due to environmental degradation. Etzold and Mallick (2016) indicated that while facing adverse livelihood conditions, some people regularly perform seasonal or temporary migration as “trans-local” livelihood options and cope with adverse challenges posed in their lives as a household strategy. Environmental degradation, leading to loss of livelihoods and income, can act as push factors for migration aspirations. By “migration aspirations,” we refer to desires, wishes, intentions, or needs

to migrate to a new location (Carling and Schewel 2018). Analyzing “migration aspirations” allows us to grasp how the migration decision-making process has gradually developed. This approach shifts the focus away from migration outcomes. It includes individuals who aspire to migrate but cannot do so and those displaced internally due to environmental factors (Mallick et al. 2023a; Van Praag and Timmerman 2019). Voluntary and involuntary migration (displacement) as trans-local livelihoods due to environmental changes has been a growing topic of discussion for many scholars (Mallick and Hunter 2023; Piguet 2010). Globally, several studies have focused on how out-migration for better livelihood resilience is driven by land use changes that influence farmer’s decisions to navigate or displacement. For example, in the Latin American context, Oslender (2007) and Ezquerro-Cañete (2016) show how land use changes to soy and palm-oil-based industrial land use have resulted in forced migration in Columbia and Paraguay, respectively. In Mekong Delta in Vietnam, Tran (2019) studied how the out-migration of poor farmers is driven by land use changes due to state-led water engineering infrastructure (dykes). However, comparatively less attention has been paid to the “immobile” or “trapped” population in response to environmental risk (Mallick et al. 2022). Fewer empirical studies focus on the migration aspirations of the “trapped” or “immobile” population facing various environmental degradation, and different potential factors that influence the aspirations of people not to migrate from the hazard-prone zone have been identified (Khatun et al. 2022; Mallick et al. 2023b; Priodarshini and Mallick 2021).

As per our knowledge, in Bangladesh, one of the most exposed countries to environmental change and climate extremes, no empirical study has been conducted that explains migration aspirations of the “trapped” or “immobile” population in the context of the transition from the rice-based livelihood to the salinity-induced shrimp-based livelihood driven by the changes in land use and coastal salinity. Chen and Mueller (2018) found that out-migration in Bangladesh is driven by coastal salinization and income loss. However, their study relied on large-scale socio-economic and migration datasets, representing a macro-level analysis. However, there is a noticeable absence of research at the local level linking the migration aspirations of immobile populations vulnerable to changes in land use and coastal salinity. Micro-level studies integrating diverse data sources have the potential to provide more precise insights into the processes shaping migration aspirations among such vulnerable groups. Therefore, this study addresses this gap by conducting empirical research at the local level, utilizing data from multiple sources, including land use/land cover (LULC), salinity data, and in-depth interviews.

So, in this study, we aim to investigate the migration aspirations of the local people driven by the changes from

rice-based livelihood to shrimp-based livelihood in the coastal villages of Bangladesh. Our study contributes to the “aspiration-capability” dialogue on environmental migration by studying the livelihood challenges and migration aspirations of rural delta communities affected by significant changes in land use and coastal salinity. It also suggests potential policy interventions to tackle these challenges. Thus, we seek to explore the following research questions: (i) How has land use and coastal salinity changed in rural coastal villages of Bangladesh over the past three decades in the context of shifts from rice-based to shrimp-based livelihood? (ii) How do these changes contribute to livelihood disruption and influence the migration aspirations of the local people in coastal Bangladesh?

Theoretical relevance and methodology

To understand the influence of land-use changes on people’s migration aspirations, we designed our research in the context of two approaches, i.e., (i) Theory of “Commons” and (ii) “Aspiration-Capability approach of Non-Migration.” The theory of “Commons” is used to understand how the change in land use is causing livelihood disruption, and the “Aspiration-Capability approach of Non-migration” is used to understand how this change impacts the migration aspiration of the local people.

Theory of “commons”

We discuss the change from rice-based livelihood to shrimp-based livelihood in light of “Commons.” Commons or common pool resources are natural or social resources that can be used jointly, collectively, and freely (Van Laerhoven and Ostrom 2007). They are also recognized as a resource vital for the community’s subsistence (Foster 2011). In the literature on commons, natural resources such as land, water, forests, and fisheries are well-documented examples. The management and mismanagement of these common resources in various locations and times have been extensively analyzed by scholars across multiple disciplines (Coward 1979; Hardin 1979; MacKenzie 1979; Ostrom et al. 1999). Regarding commons governance, Kim and Cho (2015) argued that two types of errors exist. Firstly, the unrestricted use of the “commons” can lead to overutilization and depletion of resources, and “commons” would be better utilized as private property; this problem is well recognized as the “tragedy of the commons.” Secondly, the erroneous privatization of “commons” can also lead to inefficient resource allocation, termed the “tragedy of privatization” by Kim and Cho (2015). McCarthy (2005) argued that the growing privatization of “commons” pollutes private rights and ultimately leads to collective tragedy, and it ultimately necessitates collective calls for

action, such as treating water or atmosphere as “commons.” The shift from rice farming to shrimp farming in coastal Bangladesh provides a practical example of these concepts. In Bangladesh, land, the essential resource for marginalized communities, has primarily private ownership, and some land is owned by the government and is known as “khasjomi” in Bengali (Das et al. 2012). The intrusion of saline water from rivers (for shrimp farms) in one’s private land poses a substantial risk to adjacent private lands. This practice can escalate soil salinity in neighboring lands, damage adjacent rice farms, and reduce rice production in adjoining land. As a result, even when land is privately owned, the decline in rice production due to increased soil salinity caused by the expansion of shrimp farms can deprive local rice farmers of their customary land rights and create common challenges (i.e., increase in soil salinity) which ultimately necessitate a collective call for action, as McCarthy (2005) mentioned. It could even exclude them from available private resources and livelihood opportunities in their locality and cause livelihood disruption, leading to a collective tragedy. As a result, such common challenges can affect the aspiration and capability of the local people to stay in their location. This situation could force the traditional rice farmers to either abandon their traditional livelihoods and convert their land to shrimp farming or seek alternative sources of income.

Aspiration-capability approach of non-migration

People migrate when their livelihood opportunities decline, especially in a resource-scarcity situation (Mallick et al. 2023b). Carling (2002) explored the role of “aspiration” and “ability” in the migration process while studying the people living in Cape Verde who wish to migrate but cannot do so. Taking the aspiration/ability model, Carling (2002) proposed three mobility outcomes, i.e., (i) *Mobility* (having both aspirations and ability to migrate), (ii) *Involuntary immobility* (having aspirations but not the ability to migrate), (iii) *Voluntary immobility* (having the ability but not having the aspirations to migrate). Drawing on Amartya Sen’s Capability approach, De Haas (2010) replaced the term “ability” with the more prosperous term “capability” and proposed the “aspiration/capability model.” However, despite environmental and climatic risks, many people remain in place or are known as environmental “non-migrants” or “immobile population.” Mallick and Schanze (2020) distinguish four categories of non-migration, i.e., (i) *voluntary non-migration* defines high aspirations and capability to remain in place, (ii) *involuntary non-migration* represents the trapped population with low aspirations and capabilities to stay, (iii) *voluntary migration* defines high aspirations and capabilities to migrate to other places, and (iv) *forced migration* defines low aspirations and low migration capabilities, but it has

to do so. We employed the theory of aspiration-capability approach of non-migration to understand how the livelihood disruption due to the transition from rice-based land use to shrimp-based land use could affect the local people’s migration aspiration.

Using the theory of “commons,” we argued that the deprivation of customary land rights of the rice farmers could lead to a decline in available livelihood opportunities or cause livelihood disruption (driven by the expansion of shrimp farms and salinity escalation), which is also associated with the loss of capability and aspiration of the people involved in rice-based livelihood to stay in the location. As a result of the change, the local people’s migration aspiration could also transition from voluntary non-migrants to involuntary non-migrants (trapped), voluntary migrants, and forced migrants. Thus, the theoretical integration of the “Commons” and the “Aspiration-Capability approach of Non-Migration” is employed to explore how land use changes from paddy to shrimp farming have led to a decline in livelihood opportunities and, as a result, how it ultimately impacts the migration aspirations of Bangladesh’s rural coastal communities (stayers).

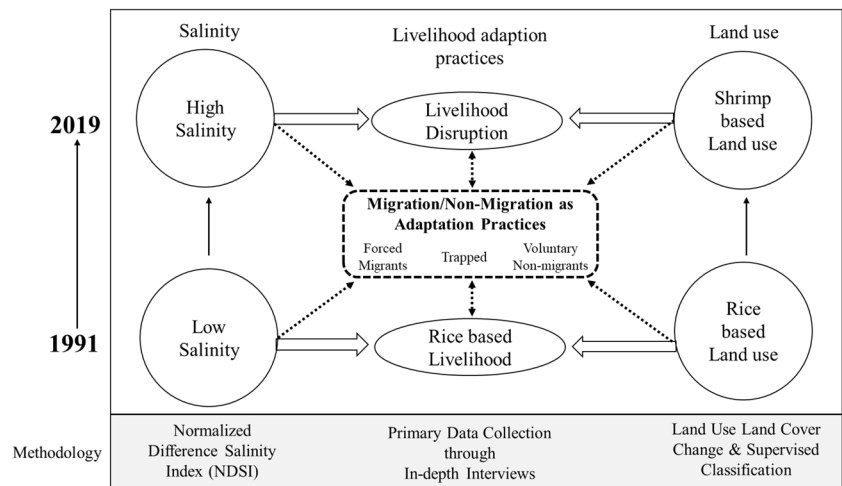
Analytical approach

We used an integrated theoretical approach to understand the temporal dimension of the decline of livelihood opportunities due to changes in rice-based land use to shrimp-based land use that ultimately affect the migration aspirations of the local people in coastal Bangladesh (Fig. 1). We have taken a timeline of three decades (from 1991 to 2019) to understand the process of temporal changes in land use and coastal salinity. As migration or staying aspirations can be influenced by the conversion from rice-based to shrimp-based livelihood caused by livelihood disruption driven by land use change and salinity escalation over the last three

decades, we have considered three significant components in our study: salinity, land use, and livelihood adaptation practices. These components are integrated into our analytical framework (Fig. 1). Using this analytical framework, we have provided a comprehensive approach that explains the complex relationship between salinity, land use, and livelihood adaptation practices and their interaction to understand the migration aspirations of the local communities. Figure 1 illustrates how rice-based livelihoods dominated three decades ago (during the 1990s) due to prevailing low salinity conditions and the predominance of rice-based land use, which could influence the aspiration of the locals to stay. Gradually, it changed into shrimp-based land use (during the 2020s) with prevailing high salinity conditions and predominance of shrimp-based land use that could cause livelihood disruption driven by salinity escalation; hence, it could influence the community’s staying aspiration differently.

Using this framework, we analyzed three types of data: land use land cover change data (1991–2019), soil salinity change data (1991–2019), and primary data collected through in-depth interviews. To find out the migration aspirations of people in the context of shifting from rice-based to shrimp-based livelihood, these three sets of data were triangulated and integrated into the analysis process. Firstly, we investigated the three decadal changes (1991–2019) in the salinity and the primary land use land cover classes in the selected study sites by conducting normalized difference salinity index (NDSI) and land use land cover (LULC) classification, respectively. Then, we explored whether there is any causal relation between the expansion of shrimp-based land use and the salinity escalation (in the three decades) in coastal Bangladesh because the salt-water nature of the shrimp farms could escalate the soil salinity in the adjacent farmland and disrupt the rice production that could affect the migration aspiration of the locals. A Pearson correlation was performed to test if there is a relationship between the

Fig. 1 Analytical framework of the study



expansion of shrimp farms and salinity escalation. Findings from in-depth interviews are also used to cross-validate the relationships. Lastly, how these changes are causing livelihood disruption and influencing the migration aspirations of the local people in the selected study sites is understood in detail using the findings from the in-depth interview.

We used the theory of “commons” to analyze the impact of land use changes and salinity escalation on the livelihood disruption of the local people and the “Aspiration-capability approach of Non-migration” by Mallick and Schanze (2020) to analyze how these changes have impacted the adaptive capacities of the local communities from voluntary non-migrants to involuntary non-migrants (trapped) or forced migrants. The details of those components, sub-components, their measurement criteria and methodology, and relationships among the elements are outlined in Table 1.

Study area

We have conducted our study in four villages in two coastal districts of southwestern Bangladesh, i.e., Khulna and Satkhira (Fig. 2). The reason for choosing these two districts of Bangladesh is because those districts are considered the central hub for shrimp farming, as 75% of the shrimp in Bangladesh are produced in Khulna, Satkhira, and Bagerhat districts (DoF 2021). The four study villages are located in those sub-districts/Upazilla in Khulna and Satkhira districts that are classified as “very high” to “high” risk sub-districts/Upazilla in terms of multiple hazards (including salinity) based on INFORM sub-national risk index (INFORMRISK 2022) (Table 2). The reason for selecting those villages for the study is that they are prone to various natural hazards such as cyclones, saline water intrusion, and waterlogging

Table 1 Operationalization of analytical framework

Component	Sub-component	Measurement	References	Methodology	Relationships
Salinity	<i>Low salinity</i>	In the analysis, low salinity is denoted as “Non-Salinity affected area.” (with NDSI<0).	Tauhid Ur Rahman and Ferdous (2019)	Normalized Difference Salinity Index (NDSI) -To understand the three decadal changes in soil salinity (1991–2019)	Soil with <i>low salinity</i> (or “Non-Salinity affected area”) would provide a suitable environment for rice cultivation (i.e., traditional livelihood in Bangladesh). Hence, <i>rice-based land use</i> would dominate. The community would prefer to stay in place if the conventional <i>Rice-based livelihood</i> is available in their village.
	<i>High salinity</i>	High salinity is denoted as “Salinity-affected area” (with NDSI>0)NDSI value ranges from –1 to +1			
Land use	<i>Rice-based land use</i>	Agricultural land with standing crops (majorly rice) denoted as “Cultivated area” in the analysis	Hasan et al. (2023)	Land use land cover change and supervised classification -To understand the three decadal changes in land use (1991–2019)	<i>Shrimp-based land use</i> would provide an unsuitable environment for rice cultivation because it is also associated with <i>high salinity</i> . Soil with high salinity (or “Salinity affected area”) and shrimp environments could cause <i>livelihood disruption</i> which can affect the local people’s aspirations or adaptation practices, as they could not be able to practice the traditional rice based livelihood and they could be <i>trapped</i> or <i>forced</i> to migrate or become <i>voluntary non-migrants</i> .
	<i>Shrimp-based land use</i>	Surface water bodies with shrimp cultivation, denoted as “Shrimp Farms” in the analysis	Rahman et al. (2017)		
Livelihood adaptation practices (migration/non-migration as adaptation practices)	<i>Rice based livelihood</i>	Livelihood activities are primarily and traditionally comprised of rice cultivation	Hoque et al. (2018)	Primary data collection through in-depth interviews -To explore whether there is any relation between the expansion of shrimp-based land use and the salinity escalation (in the three decades) in coastal Bangladesh; if yes, then to what extent this three-decadal change is contributing to the livelihood disruption and ultimately affecting the livelihood adaptation practices, i.e., migration aspirations of the local people.	
	<i>Livelihood disruptions</i>	Decline in livelihood opportunities due to external stresses	Uddin et al. (2021)		
	<i>Forced migrants</i>	Low aspiration and low capability to migrate, but having to do so	Mallick and Schanze (2020)		
	<i>Involuntary non-migrants (trapped)</i>	Trapped population with low aspirations and capabilities to stay			
	<i>Voluntary non-migrants</i>	High aspirations and capabilities to migrate to other places			

Fig. 2 Map showing the location of the study villages and unions

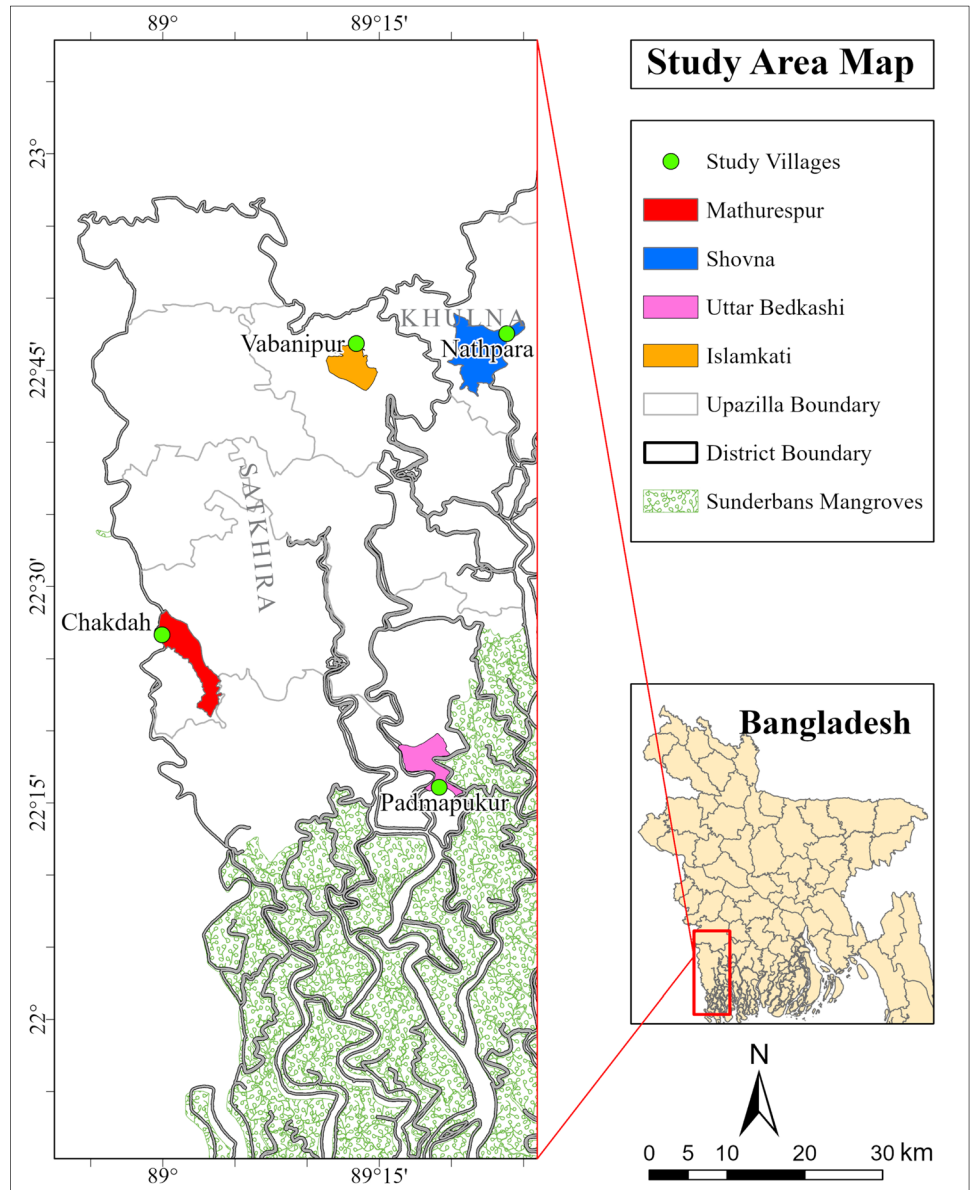


Table 2 Socio-demographic details and number of in-depth interviews in the study area

District	Upazilla	Union	Study village	Total population	Number of households	Interviews	Male	Female	Risks to multiple hazards
Satkhira	Kaliganj	Mathures-pur	Chakdah	225	49	5	3	2	Very high
		Tala	Islamkati	Vabanipur	498	128	6	3	3
Khulna	Koyra	Uttar Bedkashi	Padmapukur	1262	327	11	7	4	High
	Dumuria	Shovna	Nathpara	931	164	12	8	4	High

Source: BBS, 2011

(Mallick et al. 2020). Most of the livelihoods of the rural communities in these villages depend on farming and fishing (Mallick et al. 2020). The socio-demographic details of the study villages are mentioned in Table 2.

Data and tools

Land use and land cover classification

Satellite data has been used to determine the changes in land use and salinity-affected areas in 28 years (from 1991 to 2019) in the selected study villages of Satkhira and Khulna districts. Due to the unavailability of village-level shape files, we have analyzed the data in the smallest available administrative unit, i.e., the union level. We used the following geospatial methodology to understand the temporal changes in land use in the last three decades, i.e., land use land cover (LULC) classification using the supervised classification method. We identified four major dominant classes for the study those are “Cultivated land,” “Uncultivated land,” “Shrimp farms,” and “Forest.” ArcGIS Pro software was used throughout the entire process to detect the LULC changes in the selected study area. The maximum likelihood classification (MLC) technique of the supervised classification, which is recognized as a widely accepted classifier (Lázár et al. 2015; Otukey and Blaschke 2010; Rahman et al. 2017), in the study was used to find out the dominant LULC classes. Lastly, we estimated the temporal changes (from 1991 to 2019) in the geographical areas of significant dominant land use classes for the four study unions. The detailed geospatial methodology is discussed in Annex 1.

Soil salinity analysis

Traditional methods of estimating soil salinity involve soil sample collection from the field, laboratory processing and analysis, and ultimately calculating the solute concentration or electrical conductivity (EC), which is time-consuming and costly (Farifteh et al. 2007; Ghabour and Daels 1993). To map and visualize the temporal changes in soil salinity, the remote sensing technique is an innovative tool that also overcomes all the hindrances above, especially where field data are scarce (Hossen et al. 2022). We used the Normalized Difference Salinity Index (NDSI) to map soil salinity, and two significant classes were categorized: “Salinity-affected area” and “Non-salinity affected area.” Lastly, we estimated the temporal changes (from 1991 to 2019) in the geographical areas of salinity-affected classes and regions for the four study unions.

In-depth interviews

We collected the primary data through in-depth interviews during the field visits in the selected study villages in the

four unions chosen in March and April 2018 under the project on “Non-Migrability” funded by Open-Topic Post-Doc under TU Dresden Excellent Initiative (2017–2019). Thirty-four in-depth interviews were conducted with individuals in the selected study villages and with open-ended questions to gain insights into the land use change scenario from the past to the present and its impact on the livelihood and migration aspirations of the people. The participants were selected purposively from fishermen, farmers, and community leaders. The interview was conducted in Bengali, recorded with prior consent, and then transcribed and translated into English. The interviewee’s name was changed due to the data protection agreement and to maintain privacy. The number of in-depth interviews in each village is mentioned in Table 2.

Data collection and analysis are continuous processes (Corbin and Strauss 2008). Before coding the data, we thoroughly read the entire dataset, a practice Braun and Clarke (2006) described as “immersion in the data.” In the initial coding stage, we created both inductive and deductive codes. Firstly, the inductive codes were formulated by carefully reviewing the transcripts line by line. This approach allowed us to stay closely connected to the data and facilitated the generation of new theoretical concepts and categories (Corbin and Strauss 2008). Secondly, deductive coding has been performed based on the research question and the existing theoretical lens of the study. The codes were categorized into thematic groups described by Hennink et al. (2020), reflecting the changes in land use, coastal salinity, and migration aspiration. Details of the codes are presented in Annex 2.

Results

The result of the soil salinity analysis (NDSI) and land use land cover (LULC) classification shows that within the three decadal changes (1991–2019), there are significant expansions in the geographical area of the “salinity-affected area” and “shrimp farms” in the selected study sites and, specifically Mathurespur and Uttar Bedkashi, located near the coastline, exhibit increasing trends (Fig. 7) in salinity-affected areas and shrimp farms and decreasing trends in cultivated areas (i.e., rice fields) compared to other study unions, which are located far from the coastline. Figures 3, 4, 5, and 6 illustrate the LULC classified map and the Normalized Difference Salinity Index (NDSI) map, respectively, for the different study sites from 1991 to 2019. The findings from the in-depth interviews show a significant relationship between the expansion of shrimp-based land use and the salinity escalation in the three decades, affecting the livelihood adaptation practices, i.e., migration aspirations of the local people.

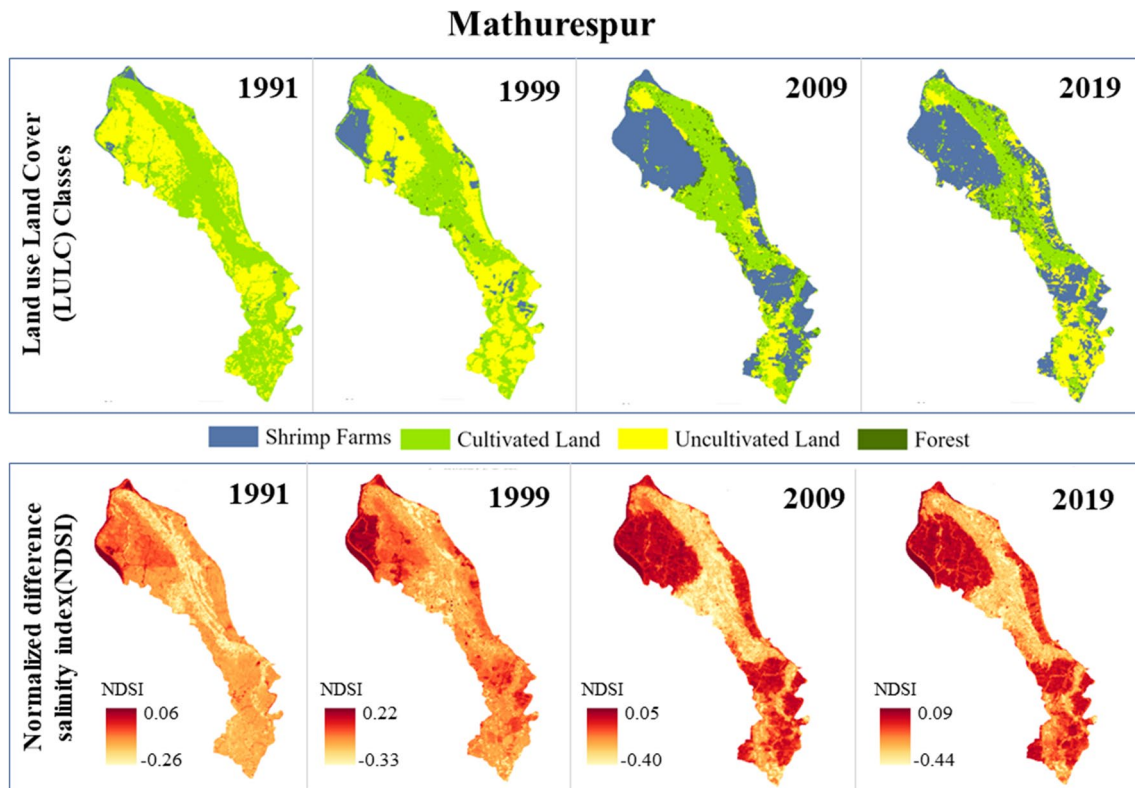


Fig. 3 Changes in land use land cover (LULC) classes and Normalized Difference Salinity Index (NDSI) from 1991 to 2019 in Mathurespur union. The area shows a significant increase in the area of shrimp farms from 1991 to 2019

Expansion of shrimp-based land use and salinity escalation

There was a significant positive association between the “shrimp farm” area and the “salinity-affected area” ($r = 0.57$, $p = 0.02$); thus, as the shrimp farm increases, the salinity-affected area also increases due to the salt-water environment of the shrimp farms (Fig. 7). As a result, it disrupted the traditional livelihood, i.e., rice cultivation for most populations.

I have seen two rice production in our field. But in the early 1990s, someone came from Khulna and started shrimp farming in the southern part of South Bedkashi. People noticed it was very profitable, and the rich local people started shrimp farming. Small landholders like me could not stop them. The situation worsened, and we had hardly any rice production.

-Male Fisherman (52), Padmapukur, Uttar Bedkashi

In the past, soil with low salinity provided a suitable environment for rice cultivation, and as a result, rice-based land use and rice-based livelihood dominated. After the introduction of shrimp farms by external influencers during the early 1990s, the soil salinity level escalated

rapidly, leaving it unsuitable for rice cultivation and disrupting rice-based livelihood. This rapid land use change is driven by external influence for higher profit aspiration, ultimately affecting many people’s livelihoods. This quote also highlights how the domination of external people undermined the private rights of the locals, leading to the collective tragedy, as local people have been left with no rice production, which aligns with the concept of “Commons” and its challenges. The collective tragedy caused by the salinity escalation, driven by land use change, is also visible in the local environmental condition.

Shrimp farming is good for our economy, but the environment has become unhealthy and insufficient for us because of the salt-water environment in shrimp farming. These trees were always green, but now, the trees are not green and not alive. Maximum fruits are damaged. Coconut trees are available, but their fruit is not available. If available, the size of the coconut is getting smaller, and the taste is also getting bad.

-Female Participant (32), Chakdah, Mathurespur Union

The expansion of shrimp-based land use in the three decades (1991–2019) has transformed the “non-salinity-affected

Islamkati

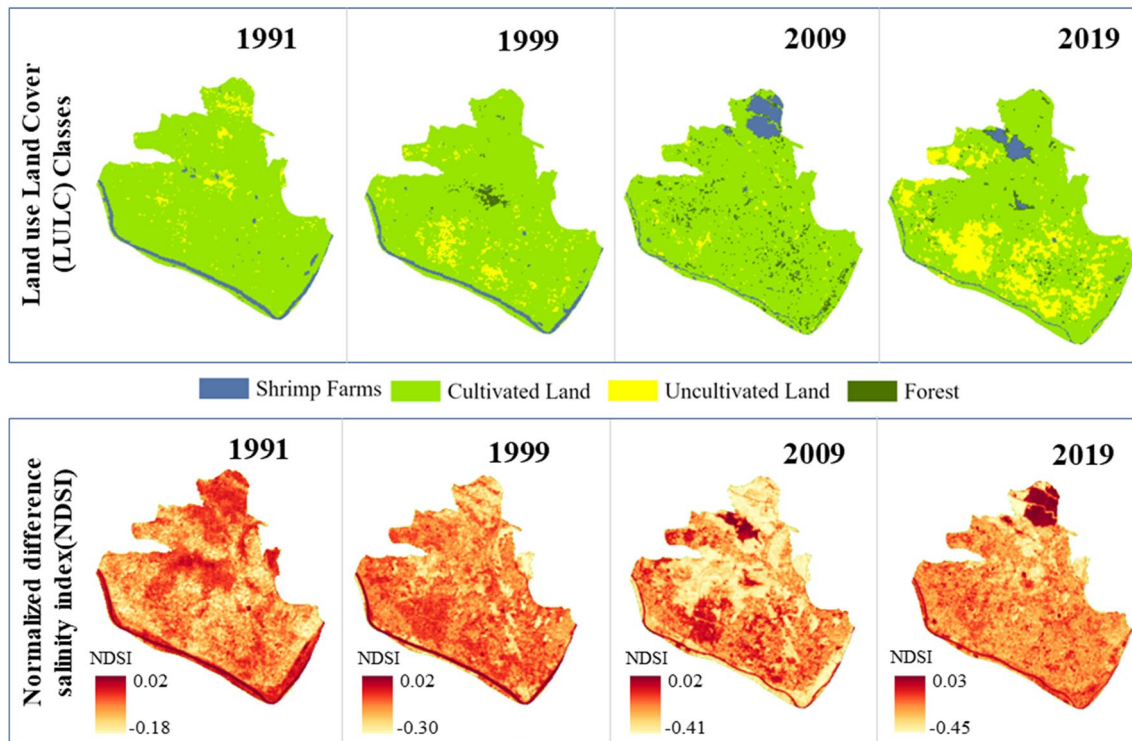


Fig. 4 Changes in land use land cover (LULC) classes and Normalized Difference Salinity Index (NDSI) from 1991 to 2019 in Islamkati union. The area shows not much increase in shrimp farms

area” into the “salinity-affected area”; as a result, it adversely affected agricultural production and greenery.

We had greeneries here; we could produce vegetables, fruits, and fish. Our environment was so lovely; people used to come to visit us. But when we started shrimp farming, we destroyed everything; we were greedy to be rich overnight.

-Male Participant (55), Padmapukur, Uttar Bedkashi

The land use change has significantly increased the soil salinity, and the transition from rice-based land use to shrimp-based land use has emerged with the aspiration for higher profits. Despite financial gains, intruding saline water from rivers into land for shrimp farming gradually damaged the neighboring lands and agricultural production and made it a salinity-affected area.

We did not see any of what we saw in our childhood. The happiness that we had here at that time is no longer there. We ate mango, blackcurrant, jackfruit, and banana delightfully from anywhere. It was fresh! We had a perfect environment here. The natural asset is no more. Yes. I’ve faced massive damage. And there was a lot of damage to the people outside. I can over-

come the damage by removing salt water from the area. The previous natural beauty will return if those making big business from shrimp farming stop. I am against shrimp farming!

-Male Participant (58), Padmapukur, Uttar Bedkashi

The massive shrimp farming boom and its adverse consequences on agricultural production also emotionally impacted the residents; the above interview reflects on the past environment and what happened after the introduction and rapid expansion of salt-water shrimp farming in the locality. The three decadal shifts in land use have resulted in rapid salinity escalation; as a result, it impacted agricultural production, leading to a sharp decline in “cultivated area.” This decline is particularly pronounced in the southern regions, such as Mathurespur and Uttar Bedkashi, which are closer to the sea compared to other locations. In these areas, river water is predominantly saline, making saltwater intrusion from marine sources easier to support shrimp farming than in regions further inland. Thus, the above findings from the in-depth interviews validate the change in land use and coastal salinity in selected study villages of coastal Bangladesh over the past three decades in the context of shifts from rice-based to shrimp-based livelihood.

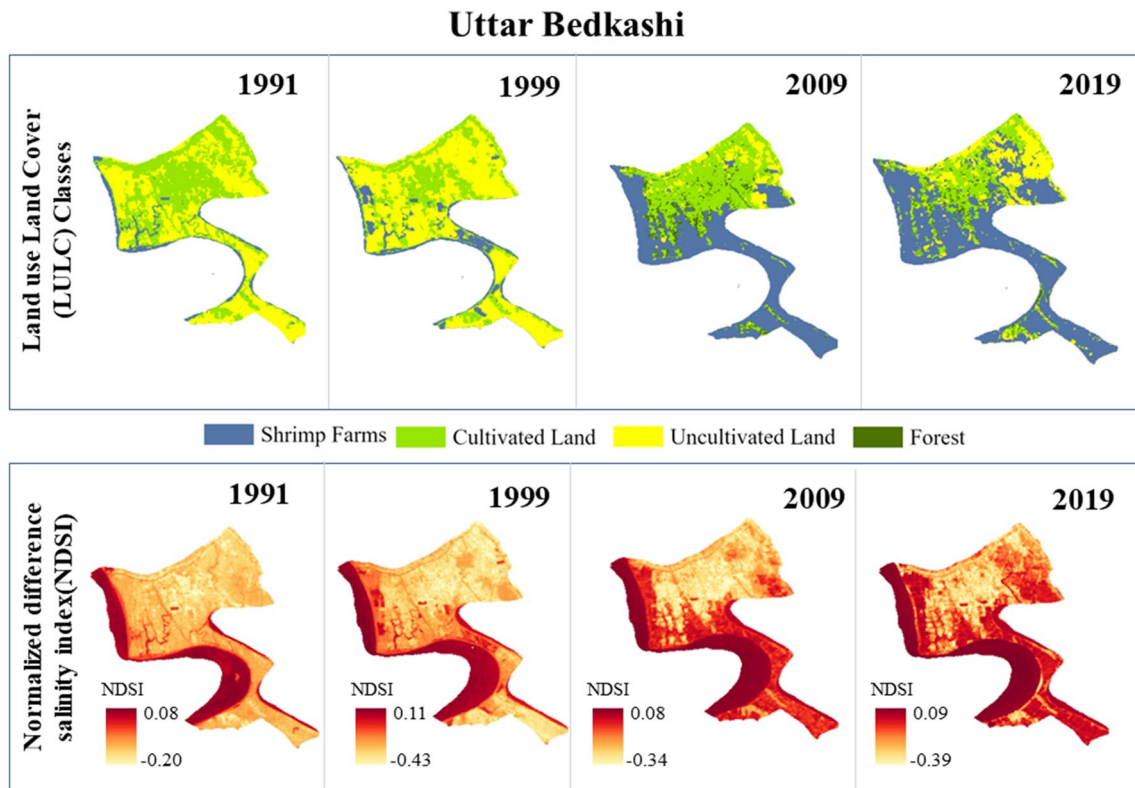


Fig. 5 Changes in land use land cover (LULC) classes and Normalized Difference Salinity Index (NDSI) from 1991 to 2019 in Uttar Bedkashi union. The area shows a significant increase in shrimp farms from 1991 to 2019

Livelihood disruption and impact on migration aspiration

This pronounced shift in salinity level, caused by the expansion of shrimp-based land use, has resulted in profound environmental impacts that cause livelihood disruptions and changes in migration aspirations of the local communities. Consequently, soil salinity levels have risen rapidly, rendering traditional rice-based livelihood economically unfeasible and profoundly impacting the resident's "desire to stay" in their villages. With this salinity escalation due to the transition from rice-based to shrimp-based land use, the livelihood adaptation practices of the local people are also affected; the local people are either compelled to "migrate" or stay as "involuntary non-migrants" (being "trapped") due to the loss of income-generating opportunities in their home villages.

We do not have many choices for income here, either shrimp or the Sundarbans, so what should I do? If I get the chance, I will go anyplace where I have at least regular income to buy rice for the family.

-A Male Fisherman (50), Padmapukur, Uttar Bedkashi

The internal ability of the local people to remain in that location is lost, as their customary rights from their land

also declined due to a significant increase in salinity, as they cannot cultivate rice anymore. The farmers have no other options than to work in the shrimp farms as laborers or migrate to different places for alternative livelihood. The above evidence shows how land-use changes and increased salinity caused livelihood disruption that, in turn, resulted in "involuntary non-migration" (low aspirations and capability to stay). Their internal "capability" is lost due to the loss of income sources, and their staying "aspiration" is also low.

Before shrimp farming, very few people went to the Sundarbans, but now people do not have any local alternatives, and therefore, more people are collecting resources from the forest so their families can survive. So changes in land use have impacted the majority's livelihood, and thus have had consequences on migration aspirations.

-A Male Participant (55), Padmapukur, Uttar Bedkashi

The transition of land use from traditional rice-based to shrimp-based also elucidates the transition of individuals from being "voluntary non-migrants" to "forced migrants." Local people were forced to migrate due to traditional livelihood disruption and had to pursue alternative livelihood options; for example, trans-local livelihood practices,

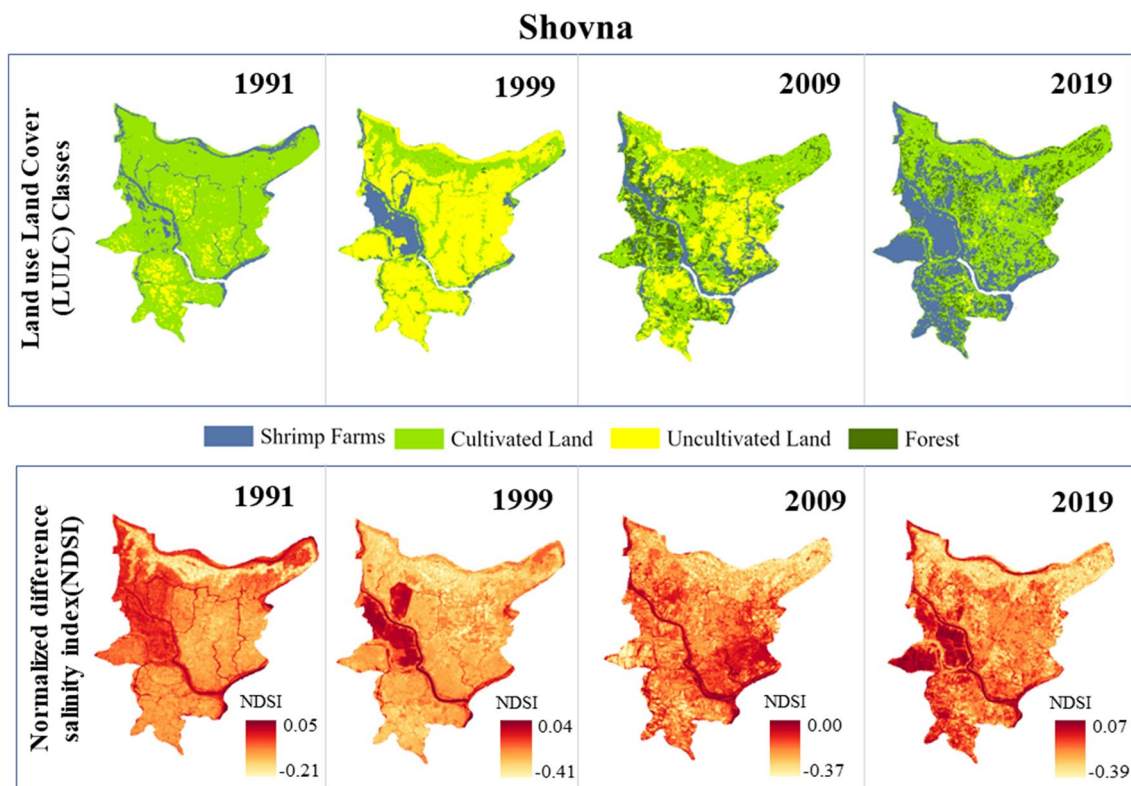


Fig. 6 Changes in land use land cover (LULC) classes and Normalized Difference Salinity Index (NDSI) from 1991 to 2019 in Shovna Union. The area shows a slight increase in shrimp farms from 2009 to 2019

seasonal migration, or other livelihood choices, such as collecting forest resources from the Sundarbans region, to have coping strategies or enhance resilience in the face of shocks.

There are no lands where people cultivate rice. I do not see any business or trade other than fishing! I work under a man in a gher. When I cultivate fish, I don't go to India. After the gher is in operation, I will return to India to sell towels. We get visas only for 6 months. We can't stay there for more than 6 months. After that, If there is not enough benefit in towel selling, then I move for building construction.

-Male Participant (49), Chakdah, Uttar Bedkashi

The above interview with a resident of Chakdah village in Mathurespur union reflects a similar example of adopting trans-local livelihood practices or practicing seasonal migration due to the livelihood disruption driven by the transition from rice-based to shrimp-based land use and salinity escalation.

The transition from rice to shrimp farming also caused forced migration due to the relatively low daily labor requirement in shrimp farms compared to rice cultivation. The disparity in labor requirements resulted in reduced livelihood opportunities within the villages, and as a result,

many people were compelled to migrate to other places for alternative livelihood options.

No worker is in this area, so everyone has gone out. The reason is shrimp cultivation. Everyone goes out. One person is enough to run a 5-bigha shrimp cultivation. But if there was a paddy cultivation in 5 bighas of land, at least 15 people were required. Job opportunities are lost here because of shrimp cultivation. People go out to harvest rice. Rice comes from the outside, bought from Noyabeki, Koyra.

-A Male Participant (62), Padmapukur, Uttar Bedkashi

This also reflects the impact of the three-decadal change of land use from rice-based to shrimp-based on the out-migration aspiration of local people due to the decline in available livelihood opportunities, which is also evidence of livelihood disruption caused by low labor requirements in shrimp farms. As a result, the change in land use has resulted in “voluntary non-migrants” to “voluntary migrants” and “forced migrants.”

We have a land, but it is under the water. We give this land to a person for cultivating fish. We can't cultivate agricultural products anymore. We have just

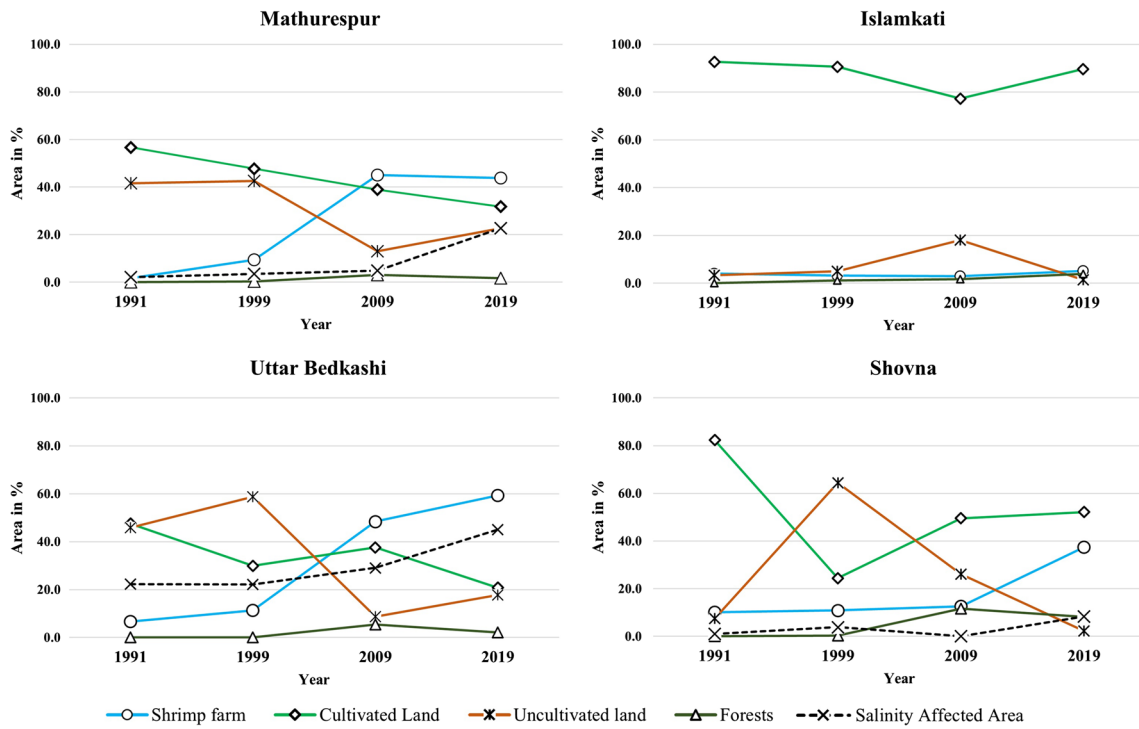


Fig. 7 Percentage changes in the area for the major land use land cover (LULC) classes and salinity-affected areas with respect to the total geographic area of each union from 1991 to 2020 across the

four study unions. Mathurespur and Uttar Bedkashi show increasing trends in shrimp farms and salinity-affected areas and decreasing trends in cultivated areas compared to the other two unions

a little portion of this land. They pay 7/8 thousand Taka. But this amount will be divided among two/three people because they are partners. There are no other income sources. We have to maintain this income. With this, we can't maintain our family. We buy rice every year.

-A Female Participant (48), Vabanipur, Islamkati

The escalating soil salinity levels caused by the expansion of shrimp farms have also compelled traditional rice farmers to opt for leasing their agricultural land for shrimp production, thus enabling them to voluntarily “stay” in their respective locations through the revenue accrued from these leases. The above interview also shows that despite owning private land, landholders cannot continue their traditional livelihood, such as rice cultivation, due to increased soil salinity; thus, the expansion of shrimp farms has led to the loss of customary land rights for private landowners excluding them from available private resources and livelihood opportunities in their locality. Due to the change in land use and salinity, the traditional livelihood was abandoned, and they could voluntarily stay in the location depending on the small earnings through the lease; thus, it affected the staying aspiration.

Discussions and conclusion

Reflection on the existing knowledge/literature

By integrating different data, i.e., land use, soil salinity, and in-depth interviews, our study is the first kind of local-level study that explains the impacts on the migration aspiration of the communities affected by the land use and salinity change in the context of three decadal transition from rice-based to shrimp based livelihood in Bangladesh. We showed how the land has changed and how shrimp farming has expanded rapidly over the three decades (1991–2019) in coastal Bangladesh, which is similar to the findings from other studies, for example, Ahmed and Ambinakudige (2023) and Islam et al. (2015). At the same time, we showed how the soil salinity also changed over the three decades (1991–2019) due to the land use change, causing livelihood disruption for the people who were involved in rice cultivation traditionally, which is similar to the findings of Hasan et al. (2023) as many people could not practice their traditional livelihood due to salinity escalation. In our study, we added a new dimension, especially by focusing on how these changes have impacted the migration aspiration of the local people in the context of the changes from rice-based to shrimp-based livelihood.

The findings from our in-depth interviews reveal how the aspiration for higher profits through shrimp farming leads to livelihood disruption and ultimately impacts migration aspiration. We found that groups of external influential individuals started and engaged in extensive shrimp farming in coastal Bangladesh during the early 1990s by forcefully intruding saline water from marine sources to maximize profits, which is also highlighted by several other scholars such as Akber et al. (2017) and Amoako Johnson et al. (2016). The interview findings indicated that the promise of higher economic returns has motivated many local farmers to convert their rice fields into shrimp farms. Consequently, areas once characterized by bi-annual rice production and lush greenery have changed into barren “deserts” devoid of trees and rice cultivation due to the saline environment created by shrimp farms. This shift has led to a decrease in the local environment of the study villages. Swapan and Gavin (2011) reported similar findings, noting that the rise of shrimp farming has caused significant negative ecological consequences, including soil and water quality degradation. As a result, we found that this transition adversely affects the primary livelihood of rural communities, namely rice cultivation. This finding is consistent with other studies in coastal Bangladesh, such as those by Ali (2006), Datta et al. (2010), and Hasan et al. (2023). This process ultimately threatens national food security, especially for the rural poor, as Sikder and Xiaoying (2014) highlighted, and agricultural sustainability, as Islam et al. (2015) and Ahmed and Ambinakudige (2023) studied.

The disruption of traditional rice cultivation is examined through the lens of “commons,” and its challenges, adding a unique dimension to our study. Issues related to the commons have been discussed across multiple disciplines (Coward Jr 1979; Hardin 1968; MacKenzie 1979; Ostrom et al. 1999). In coastal Bangladesh, land is a vital resource for local communities who have depended on it for their livelihood, primarily through rice cultivation, for centuries. Our study found that over the past three decades, land use has significantly changed from rice-based to shrimp-based cultivation, driven by the pursuit of greater economic returns. This shift has increased salinity-affected areas due to the forceful intrusion of saline water from marine sources and the prolonged stagnation of saline water on farmland that impacted the adjacent rice fields due to high soil salinity, as Morshed et al. (2020) noted. In our study, we emphasized the saline nature of shrimp farms, which has damaged adjacent rice fields, irrespective of private lands, creating a collective tragedy, highlighted by Donahue (2001) in the context of the rapid suburban sprawl in the United States. Taking the theory of “Commons,” we argued that despite owning the land, the rice cultivators are excluded from their land rights as soil salinity escalates due to the rapid expansion of shrimp farms,

damaging neighboring rice farms and reducing or stopping rice production, leading to livelihood disruption. While land in Bangladesh is not typically a common pool resource, the negative impacts on neighboring rice farms turn this issue into a common problem. Consequently, rice farmers are forced to abandon rice cultivation, switch to shrimp farming, lease their land for shrimp farming, or seek alternative livelihoods.

The findings of our study demonstrated the impact on adaptive practices of the local communities or stayers, transitioning from relying on rice-based livelihoods to adopting trans-local livelihood practices or practicing seasonal migration as coping strategies to enhance resilience in the face of shocks. Several scholars in environmental migration literature indicated that people regularly perform seasonal or temporary migration as “trans-local” livelihood options as household strategies while facing adverse livelihood conditions (Etzold and Mallick 2016); however, the immobile population receives less attention in response to environmental risk (Mallick et al. 2022). We addressed this gap by studying the migration aspiration of the local immobile population in three decadal shifts from rice-based to shrimp-based land use. We found how the changes in land use and salinity have impacted the adaptive capacities of the local communities from voluntary non-migrants to involuntary non-migrants (trapped) or forcibly displaced people. Our study found that soil salinity levels have risen rapidly due to the three-decadal expansion of shrimp farms, impacting the residents’ aspiration to stay in their villages. With this ecological shift, local people were either compelled to “migrate” or stay as “involuntary non-migrants” (being “trapped”) due to the loss of income-generating opportunities in their home villages. We highlighted the loss of income-generating opportunities as the loss of internal abilities (capabilities) of the local people, whose primary livelihood depends on rice cultivation, which was getting actively hampered due to the salinity escalation caused by saline-water shrimp farming. Local communities’ lack of internal abilities (capabilities) due to the loss of traditional livelihood options (i.e., rice cultivation) was under threat due to salinity escalation caused by land use changes. Thus, our findings showcased the role of “aspiration” and “capabilities” as the pillar of the migration decision-making process, which also compelled with the findings from other studies, for example, De Haas (2010), Mallick et al. (2023b), and Priodarshini and Mallick (2021). Thus, our study results contribute to the “aspiration-capability” discourses in the context of environmental migration as the study shows how the loss of livelihood caused by soil salinity escalation due to increasing shrimp farming — tends to influence the migration aspirations of the local people at the same time; it shows how it reduces the internal abilities (capabilities) of the local people.

Limitations and future research

Our study highlights how human-induced environmental changes, such as salinity intrusion and the shift towards more profitable but unsustainable practices like shrimp farming, are disrupting traditional livelihoods in rural coastal communities and fueling migration pressures, a phenomenon increasingly seen in climate-vulnerable regions worldwide. In our study, although we have considered the rapid expansion of shrimp farming to cause a salinity increase, it is also important to mention that there could be several other natural and man-made reasons for the soil salinity increase in coastal Bangladesh, for example, the prolonged waterlogging situation after cyclone Aila in 2009. In future research, the availability of local-level temporal data on agricultural production and field data on soil properties (including salinity) can provide a clearer picture of the impact of shrimp farming on land degradation at the local level. A more in-depth analysis of the power relations and conflicts between shrimp farm owners and local people will provide an in-depth analysis of the power dynamics associated with land use changes. The role of governance and institutions in overcoming these power dynamics must also be investigated. Lastly, studying how rural coastal communities cope despite environmental adversities is much more critical.

Policy implication of the study

Shrimp farming plays an essential role in Bangladesh's economy by contributing to the country's GDP in terms of export potential and creating income-generating livelihood opportunities. The massive land use change from rice to shrimp for the aspiration of higher profits has escalated the soil salinity at a massive level. Bangladesh's traditional livelihood, i.e., rice cultivation, is disrupted due to the rapid salinity escalation caused by the saline environment of shrimp farming. Disruption of rice-based livelihood options, caused by salinity escalation and shrimp farm expansions, has significant implications for the abilities and aspirations of individuals (particularly rice farmers) to remain in their current locations. The soil quality has degraded to a massive extent due to the leaching of saline water, leaving no options for further agricultural activities. Many people are migrating for alternative livelihood sources and are trapped in their current places. Thus our study also questions the sustainability and inclusivity of shrimp farming as an adaptation strategy in coastal Bangladesh, given its significant contribution to economic growth but also its detrimental impact on soil salinity, traditional rice cultivation, and the livelihood security of local farmers, which in turn drives migration and questions the long-term viability of shrimp farming.

We have suggested the following policy intervention to tackle the challenges posed by the shift from rice cultivation

to shrimp farming and the resulting impact on livelihood disruption and migration aspiration. In order to prevent involuntary migration (forced migration) and non-migration (trapped), it is important to create alternative income-generating opportunities for the traditional rice farmers in the respective villages. This can enhance the capability of stayers to stay in their respective locations despite having the changing scenario in land use and salinity. Our study recommends the following policy interventions to tackle such challenges such as the following: (1) identifying the vulnerable hotspots and the vulnerable people who can neither migrate nor adapt to the situation and become trapped is essential to prevent "forced migration" or distress migration and "involuntary non-migration" or trapped population. (2) Training those vulnerable people to acquire alternative livelihood options is essential, as traditional livelihoods, i.e., rice cultivation, are threatened. This can involve training and resources for alternative income sources, such as environmentally friendly sustainable aquaculture and cottage industry. Thus, from a global perspective, our study underscores the broader challenge of balancing economic development with environmental sustainability, highlighting the need for policies that support vulnerable populations for promoting sustainable livelihoods in regions where profit-driven land-use changes, like shrimp farming, disrupt traditional practices and exacerbate climate-related migration pressures.

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Declarations

Conflict of interest The authors declare no competing interests.

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