

Conservation of Mangrove Ecosystem through Labour Outmigration: Findings from Sundarban in India

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Abstract

This study examines the intergenerational occupational changes and their implications for reducing population pressure on the world's largest mangrove ecosystem and a biodiversity hotspot. Sundarban Delta, spread over India and Bangladesh with several million residents, is facing severe ecological stress due to overexploitation of aquatic resources. This study uses primary information on 1424 earning adults in 828 households in the periphery of the reserve forest on its Indian side and found a discernible trend of attrition from fishing activities. It is found that young males located near the reserve forest are increasingly opting for migrant labour jobs. Multinomial logit regression finds school education has a significant positive impact on individuals' migration decisions compared to fish/crab collection. Labour outmigration would reduce anthropogenic stress on the Sundarban ecosystem. This study concludes that providing incentives for school education up to the secondary level can be a crucial policy handle to reduce anthropogenic stress in this delta.

Keywords: Sundarban, Ecological stress, Occupation choice, Multinomial logit, Migrant labour, School education

1. Introduction

Sundarban is the largest mangrove delta in the world that is spread over India and Bangladesh and is also famous for Royal Bengal Tiger - its iconic species. On the Indian side alone, 48 out of 102 low-lying deltaic islands constitute the Sundarban Reserve Forest (SRF), while the rest of them are inhabited by almost 4.5 million people (Ghosh et al., 2015). The SRF and the local communities are located in close proximity but on mutually exclusive islands. The mangrove ecosystem is rich in detritus-based food webs supporting rich biodiversity. It is also considered a nursery ground that is crucial in maintaining aquatic diversity in the northern Indian Ocean (Neogi et al., 2017). Research interest in Sundarban has considerably increased in recent times as the densely populated region is highly vulnerable in the face of climate change (Chand et al., 2012; Dasgupta et al., 2020; Mishra, 2014).

The remote islands in this delta have experienced little infrastructural development over the years. Grid-based electricity reached a few of them only within the last couple of years. Manufacturing and industrial activities are absent due to power, transport and communication

difficulties. It resulted in a local economy based mainly on fish and crab catching that failed to keep pace with other parts of mainland India. Unsustainable fishing has significantly depleted resource stock in the delta (Dutta, Chakraborty, and Hazra, 2017). The resulting economic loss might have worked as a push factor in addition to other pull factors and translated into significant labour outmigration from the region over the last decade. Moving out for work appears to be a spontaneous livelihood coping strategy for the local poor against depleted natural resources. As an ecologically sustainable development strategy, labour outmigration might be encouraged to reduce anthropogenic stress on the ecosystem and improve the local economy through remittance flows.

This study is based on a large-scale primary survey of households and their earning adults located in the periphery of SRF. While studying the occupation choices across age groups, we found an interesting link between the earning activities, age and education of the cohort. We investigated the connection between the choice of migrant labour job and one's educational attainment, which led us to identify a policy handle for ecosystem conservation.

Education is emerging as a critical instrument in addressing many socio-economic challenges in various contexts. The number of evidence-based studies on the economics of education has seen a resurgence in the current millennium (Machin 2014). These studies, however, are less frequently carried out in countries outside Europe and North America. A considerable number of them examined the relationship between educational attainment and labour market participation of individuals - especially the inter-regional mobility of labour (Carlsen, Johansen, and Stambøl 2013; North 2013). Studies have also focused on the effect on children's education caused by parental migration status (Davis 2018). The existing literature, however, fails to provide empirical evidence of a link between ecological conservation and educational attainment in the local community. This study contributes to the existing literature in establishing the role of education in ensuring ecological sustainability. More so as it is carried out in a crucial ecological site – the Sundarban – which is also a UNESCO World Heritage Site (1987) and a biodiversity hotspot.

2. Background

2.1 Importance of the delta, livelihood and ecological stress

Sundarban is located in the Ganges-Brahmaputra-Meghna delta in the northern Bay of Bengal with around 10,000 square km of mangrove cover. The international border between India and Bangladesh runs through it, with approximately 40 per cent of the site falling in the Indian state of West Bengal. The population density, settlement history, livelihood and cultural practices are similar across the national borders. People started living on these islands starting from the 19th century under the colonial rulers' settlement policy. Poor people from the Indian mainland had moved into the mangrove-covered mudflats as settlers as they were promised new agricultural land. It happened in an active delta before the islands gained their matured heights. It was possible through the creation of earthen circuit embankments to protect agriculture from surrounding saline rivers. The early settlers depended almost entirely on agriculture. But as the population increased, people started relying more on openly accessible natural resources. Collecting fish and crabs from the rivers and mangrove forest creeks became the main alternative to agriculture.

The SRF is under the direct control of the Department of Forests (Govt. of India). Local fishermen intending fish and crab collection in creeks of the reserve forest are required to

obtain permits which are limited in number. But outside SRF, rivers are openly accessed. There are regulations like a ban on fishing activities from mid-April to mid-June of every year – considered the spawning season for most fish species in the delta. But the ban is poorly enforced. On the Indian side, studies have identified the ecological stress in terms of the decline in fish production and varieties. It was estimated that fishing efforts had doubled during the past 15 years in the delta, but catch per unit effort has drastically declined to 58–65 kg per haul from 150 - 200 kg per haul (Mistri and Das, 2020). Secondary data also shows an overall negative trend in fish quality along with the decline in the major catch (*Hilsa*) on the Indian side (Hazra et al., 2002). Studies in Bangladesh have also identified similar signals of overexploitation of the ecosystem (Hoque Mozumder et al., 2018).

In Indian Sundarban, estimates show that around 20 per cent of the island inhabitants survive by exploiting these natural resources (Ghosh 2017). The comparable estimate in Bangladesh is 28 per cent, and the proportion is predicted to increase (Islam 2010). These collection activities exert significant stress on this delicate ecosystem and its regenerative capacity. As a consequence, the main workers of Indian Sundarban are found to have converted into marginal workers (Gupta and Sarkar 2014).

2.2 Vulnerability and livelihood coping strategy: labour outmigration

Agricultural land in this tidal delta continuously gets eroded by hydrological dynamics. There are accretions too. But newly formed mudflats are treated as government land, and no one is allowed to settle on them anymore. So, the delta on the Indian side is experiencing an increasing population with decreasing cultivable land. People increasingly depend on open rivers and forest creeks for fish/crab collection. Limited livelihood options compel the fishermen to venture into these creeks in spite of the increased risk of tiger attacks. A study on the tiger victims (both death and injury) between 1999 and 2014 estimated the risk of a tiger attack in the range of 0.11 to 0.88 for every 10,000 residents in the area surrounding the SRF (Das 2018).

Agriculture and aquatic resources are also facing a serious threat from climate change. There is a predicted increase in cyclonic storm frequency in the Bay of Bengal. The effect of storms on these low-lying islands was acutely demonstrated by cyclone *Aila* in 2009. The storm surges overwhelmed the protective embankments, and saline water overran the freshwater ecosystem on almost all islands. The increased salinity and alkalinity had damaged crop productivity and agricultural pattern in this region for a long time. The event showed the vulnerability of local people posed by climate change in the near future. These events are an immediate threat to local food security (Haldar and Debnath 2014).

An earlier study estimated that over the previous couple of decades, crop and forest property worth around USD 1 billion was damaged or lost and over 0.4 million people were affected in Indian Sundarban due to natural disasters (Hazra et al. 2002). Though the region faced many more such events thereafter, authentic damage estimates could not be found for the Indian side. However, studies have concluded that an increasing trend of labour outmigration is happening as these islands are no longer capable of sustaining traditional livelihood (Choudhury et al. 2011). The Human Development Report of North 24 Parganas District, where most of the Indian Sundarban belongs, found that migrant work was one of the effective coping mechanisms against livelihood loss from cyclone *Aila* (HDRCC 2010). Another study conducted in the aftermath of the disaster concluded that the cyclone might have helped in relieving some anthropogenic stress on the local ecosystem as a push factor for labour outmigration (Ghosh 2013).

A study has found that among the outbound labourers from the region, almost 75 per cent are inter-state migrants going to the relatively developed western and southern Indian states. Most of them worked as construction labourers who seasonally visited their homes during sowing time in monsoon months. The study estimated that almost 95 per cent of these migrants are male (Guha and Roy 2016). Another study estimated that 74 per cent of local households have migrant labourers with an average of one per household. The study found that inter-state migration contributes to two-thirds of the total migrants from Sundarban region (Mistri 2013).

2.3 Role of education in occupation choices

Evidence from literature establishes a direct link between livelihood coping and educational attainment under economic hardships. In the European context, studies have compared occupational mobility of different education groups to regional shocks. It was found that the response of migration flows to regional unemployment shocks increases with education level. Highly educated workers are more mobile than workers with little education (Carlsen, Johansen, and Stambøl 2013). Empirical evidence from Ecuador established that an individual with a lower-secondary level of education increases his migration propensity by 31.3 per cent (Falco 2015). A study in Malawi observed that the higher the qualification of adults in a household, the higher the propensity for migration and vice versa (Kamninga 2020).

Interestingly, early studies have also identified a negative relationship between a country's endowment of natural capital and the formation of human capital through education. In most countries that are rich in oil, minerals and other natural resources, economic growth over the long haul tends to be slower compared to countries that are less endowed. Natural resources are found to lock in people into low-skill natural resource-based industries. Nations deprived of such resources tend to invest more in acquiring education and skill and hence show more resilience (Gylfason 2001). This finding might apply to a sub-national level as well. People on the remote islands of Sundarban might have failed to educate themselves earlier due to the abundance of natural resources. However, no empirical evidence on this aspect for this region could be found in the literature.

Literature on education and employment in India, based on NSSO¹² data from several rounds, has found the existence of an inverted U-shaped relationship between the level of education and the duration of unemployment. It has been observed that the better-educated people look for jobs in the formal sector while people with a low level of education are predominantly looking for employment in the informal sector (Ahmed 2015). Another study on India highlighted the livelihood changes resulting from a change in education level across generations. This study on the cobbler community in Mumbai found that most cobblers of the first generation were illiterate. But the younger generation shows increasing educational attainment with an overwhelming desire to change their current social standing (Wankhede 2020). This study was carried out in the largest metropolitan city in India. The finding might not be readily extrapolated in a completely different socio-economic setting like our study area.

¹² National Sample Survey Office, Ministry of Statistics and Programme Implementation, Government of India

Sundarban has been in focus for researchers in recent years as millions of its resident population are highly vulnerable to climate change across both sides of the international border. Still, primary survey-based studies on its most remote islands are scarce. On the Indian side, available studies are mostly carried out in relatively accessible areas of the greater Delta region. But the poor fishing communities residing deep inside the delta – on the periphery of the mangrove forest and furthest from the mainland - are the people who exert direct pressure on the ecosystem. Very little primary information is available on these fishing communities based on a reasonable sample size. Any study on their occupational changes, and the role of education in effecting such changes, is conspicuous by its absence so far.

3. Study objective

Studies have identified anthropogenic stress on this vital mangrove ecosystem. Interventions for its conservation mainly concentrated on providing alternative livelihood opportunities to the local people through livestock distribution and vocational training carried out by NGOs and government agencies. While literature identifies labour outmigration as a growing phenomenon in this region, the characteristics of migrant labour are not studied in detail. We set our study objective to fill up this research gap. We aim to explore the occupational choices across generations of the local community, especially for those who are traditionally engaged in fish and crab collection, using primary information. We also focus on finding a link between attrition from natural resource exploitation and the role of school education.

4. Study area, data and sampling

In this study, we used individual-level information from 1424 earning members belonging to 828 households that were surveyed in 2017. We followed a multi-stage sampling procedure in which households were selected as a stratified random sample from 132 hamlets spread over several islands surrounding SRF. We focused on hamlets that are close to the reserve forest and with a larger concentration of fishing households. In the first stage of sampling, 20 Gram Panchayats (GP)¹³ were purposively selected, considering their location along the SRF boundary (Figure-1). Households within each GP are usually divided into 10 to 20 polling booth areas. Each booth sends an elected representative in the GP.

¹³ *Gram Panchayats* are considered as lowest administrative units.



Figure 1: Locations of selected GPs covered in primary survey

(Sourced from Google Earth)

In the second stage, we selected 2 to 3 such booth areas in each of these GPs after consulting with the currently elected booth representatives and ensuring the concentration of fishing communities therein. In the third stage, within each sample booth, we identified a few hamlets that are dominated by fishing communities. A total of 132 hamlets spread over 20 GPs were identified for the survey. Lists of households in each of these hamlets were generated along with their landholding information. Finally, these lists were merged, and a sampling frame was prepared for each selected GP. Approximately 40 households were selected as a stratified random sample from each GP, where stratification was based on landholding.

We collected information using a structured questionnaire and considering households - identified as individuals sharing a common kitchen - as sample units. However, personal information such as age, gender, education and occupation details was collected for each household member. Hence the dataset is also amenable to individual-level analyses. After pre-testing of the survey instrument, we decided on the following occupation categories that constituted the mutually exclusive and exhaustive set of earning options.

- | | |
|---------------------------------|---|
| (i) Agriculture and farm labour | :All agriculture related activities including inland fisheries, animal husbandry and farm labour jobs |
| (ii) Non-farm daily labour | :All forms of daily wage earners except in the farm-sector |
| (iii) Fish/crab catching | :All forms of collections from open rivers and mangrove forests, including shrimp-fry and honey collection. |
| (iv) Migrant labour | :All temporary labour jobs taken up in locations outside Sundarban delta |
| (v) Self-employed professional | :All specialized activities requiring skills like private |

- tuition, traditional medicine (quacks), priests etc.
- (vi) Enterprise/Business :Any other commercial enterprise requiring capital Investment
- (vii) Salaried employment (Govt.) :Regular employment in government offices/ establishments and government-aided institutions like primary schools, health centres
- (viii) Salaried employment (Pvt.) :Regular employment with NGO/ locally recruited field agents of private financial institutions etc.
- (ix) Other Miscellaneous : Rent earning, old age pension, widow pension, disability pension and any other earning activity

The following empirical results are based on individual-level information collected from the sample households.

5 Results

5.1 Respondents' profile

The 828 sample households include 3547 individual members with an average household size of 4.28. We found an average of 1.72 earning members per household. Many of them had reported multiple earning activities resulting in an average of 1.32 activities per earning member. Females constituted 20.5 per cent of them.

The sample hamlets had a large concentration of fishing households who are usually asset poor. As much as 44 per cent of them are found to be landless. Excluding them, the average holding size of the remaining households is found to be 0.27 hectares. The average age of earning individuals is 38.7 years, with only 4.8 years of schooling completed.

5.2 Livelihood mix

The sample households are located in the interior of the delta and are never far away from a river. But some of these hamlets are in close proximity to SRF and hence have relatively easier access to the forest creeks – which in turn has implications for fish/crab collection¹⁴. So, we divided the sample hamlets (and households therein) into two categories – adjacent to SRF (separated only by a single river) or not. Figure-2 shows the distribution of earning members across the nine types of earning activities and two location categories. The overall dominance of fish/crab collection results from the purposive selection of sampling locations and might not represent the relative importance of these activities across the larger Sundarban delta. However, this study does not arrive at any such population estimate either.

¹⁴ In fact, most of the landless households in the region who depend mainly on fish/crab collection had historically relocated themselves near the reserve forest.

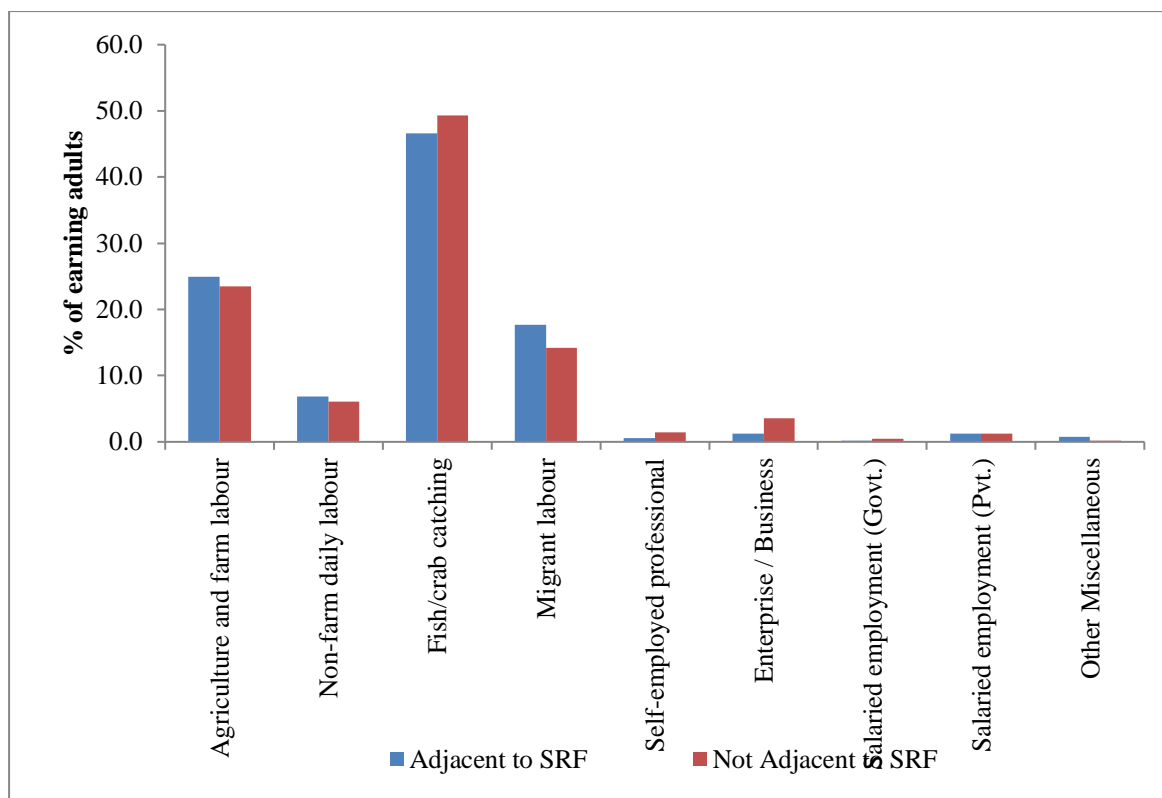


Figure 2: Distribution of earning activities across two location categories

We identify four activities that are prevalent irrespective of respondents' location. Fish/crab collection is found to be the most frequent and taken up by approximately half of the workforce. We find agriculture is carried out only by a quarter of them. It might be noted that there is considerable overlap between these two activities. In this delta, a fisherman is often a small farmer if he has some cultivable land. Hence Figure-2 includes the possibility of multiple activities by a single individual, and hence the heights of bars might add up to more than 100 per cent for either of the location categories.

We find that migrant labour jobs constitute the third most frequent activity. It has the potential to reduce direct anthropogenic stress on the ecosystem as it pulls people out of mangroves and creeks. Other non-farm daily labour jobs stand fourth in its relative prevalence - which mostly comprises of boat drivers and deck-helpers and also people engaged in loading and unloading of goods that are continuously traded with the mainland by boats. We see all other earning activities are negligible in their occurrences.

5.3 Participants' profile across earning activities

Table-1 provides a deeper understanding of the individual and household profile of the workforce across different earning activities. We find that the age and educational attainment of individuals engaged in two specific activities – fish/crab collection and migrant labour jobs – are markedly different but comparable in terms of household size and landholding. The table indicates that education plays a role in making activity choices even among the asset poor. For households with less agricultural land, the young members with better education seem to be opting for migrant labour jobs while their older and/or less educated counterparts are going for fish/crab collection.

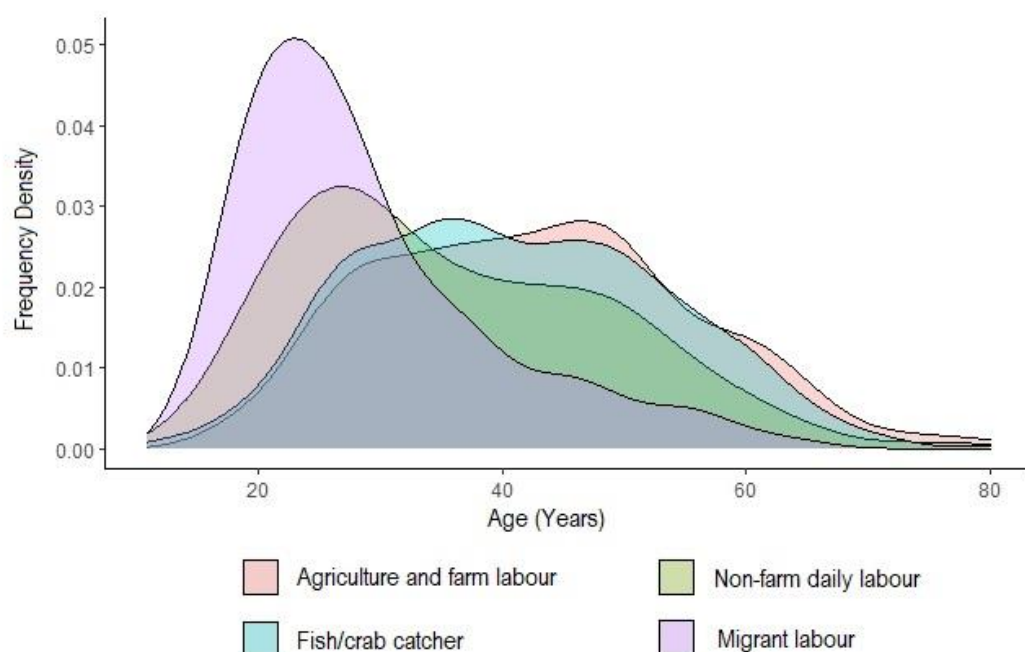
Table 1: Participants' profiles across earning activities

Earning activities	Average Values			
	Age (Years)	Education (Years)	Household Size	HH's agricultural land (Katha*)
Agriculture and farm labour	42.6	4.8	4.58	35.3
Non-farm daily labour	36.1	5.2	4.60	24.7
Fish/crab catching	41.0	3.9	4.59	19.8
Migrant labour	28.9	6.5	4.78	22.2
Self-employed professional	33.3	6.9	4.95	33.0
Enterprise/Business	42.8	6.3	4.61	32.9
Salaried employment (Govt.)	53.6	6.9	4.57	72.9
Salaried employment (Pvt.)	31.9	8.5	5.13	24.8
Other Miscellaneous	41.7	6.2	5.33	31.7

Source: Primary survey

*Katha is the lowest local unit for agricultural land (= 720 sq. ft.)

These two aspects – age and education – are explored in further detail beyond their average values. The four most frequent activities (following Figure-2) are considered in making a comparison on these aspects. The dispersion and skewness of age and education distribution for these four activities result in the density plots in Figures 3 and 4.

**Figure 3: Age distribution for four major earning activities**

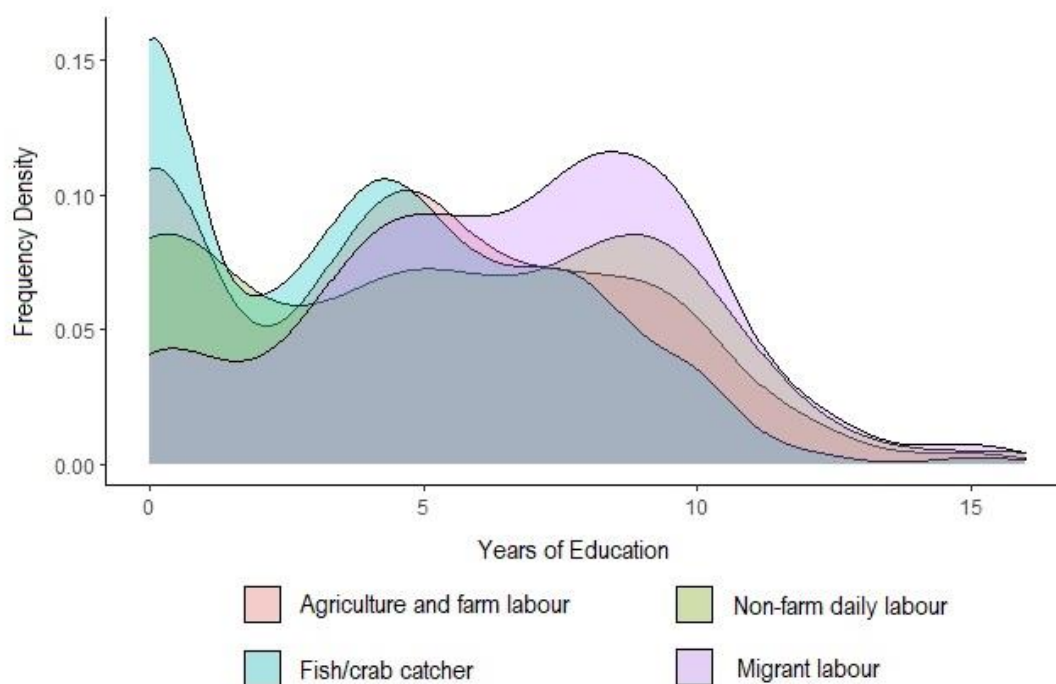


Figure 4: Educational attainment across four major earning activities

Figure-3 shows that age distribution for migrant labour is highly skewed towards the youth with a lower standard deviation. It stands distinctly apart from the other three activities. The median age for non-farm daily labour also appears to be less than that of fish/crab catchers and cultivators, which is expected as such jobs are physically more demanding.

A different, rather opposite pattern is seen in the case of 'years of education'. Figure-4 shows that migrant labourers have a distinctly better education profile compared to the participants in the other three activities. It also shows that the fish/crab catchers have the poorest education with the highest concentration of illiterates (years of education=0). Figure-4 indicates that the modal year of education for migrant workers is just below ten. It implies that a sub-secondary level of education might be very helpful in opting for such jobs.

These findings led us to further statistical exploration of the data to find out the determinants of the respondents' occupational choices.

5.4 Determinants of occupational choice and role of education: a regression analysis

The statistical significance of possible determinants of occupation choices is examined through a Multinomial Logit regression. In doing so, we considered individual information for all earning adults in the sample households. We considered their 'main activity' within the previous one year¹⁵. Also, we find that the main activity of almost 91 per cent (total 1294) earning adults was one of the four major activities identified before. To make our analyses simpler and focused on the study objective, we left out relatively rare occupations in the delta

¹⁵ Each earning adult was asked to self-identify his/her 'main activity' over previous one year that had generated maximum money income for him/her.

and concentrated on these four. A variable OCCU is generated for each earning individual which is coded as

1. Agriculture and farm labour
2. Non-farm daily labour
3. Fish/crab catching
4. Migrant labour

An individual's occupational choice (OCCU) is assumed to be determined by individual characteristics (age, sex, education), household characteristics (caste, religion, household size, asset holding) and other location-specific attributes. We assume that within this delta, all participants in the labour market are facing the same set of prices and have similar market information. The only variability, that could be observed beyond individual and household levels, comes from their location. One aspect of location is 'remoteness', which is expected to have a bearing on one's physical mobility and hence on the set of viable options in livelihood choice. Also, in the delta, location assumes importance vis-a-vis proximity to natural resources (i.e., mangrove forest and creeks). However, due to the geographical features of the delta, these two aspects of location are highly correlated. It is observed that the remoteness of the respondents has a strong relationship with their proximity to SRF. The closer a household is to the reserve forest, usually the more remotely it is connected to the mainland. So, a single indicator is considered to capture location attributes.

Information on 'caste' and 'religion' were originally collected as categorical variables. But the data shows very unequal representation of sub-categories. For easier interpretation of results, we recast them into binary variables. The description of regressors is provided in detail in Table-2.

Table 2: Description of regressors used

Characteristics	Regressors	Definition
	AGE	Age of the respondent in completed years
Individual	SEX	Binary: 0 = Male; 1 = Female
	EDU	Number of completed years of education
	CASTE	Binary: 0 = General ; 1 = Others
	RELIGION	Binary: 0 = Hindu ; 1 = Others
household	FSIZE	Number of members in the household (using a common kitchen)
	AGRILAND	Agricultural land owned by the respondent's HH in Katha (local unit = 720 square feet)
Location	NEAR_SRF	Binary: 1= if the respondent is located adjacent to the reserve forest across a river; 0 = Otherwise

Though we discussed around earning 'adults', we find five instances of 'earning' members who are aged below 15 years (out of 1294). They are some younger girls engaged in collecting prawn seedlings from river waters and thereby contribute to family earning. So, the

regressor AGE has a range of 11-80 in our data. Also, the highest agricultural landholding in the sample households is found to be 190 *Katha* (approximately 3.14 Acre). The summary statistics of regressors are provided in Table-3.

Table 3: Summary statistics for regressors

Regressor	Mean	S.D.	Min	Max
AGE	38.921	13.348	11	80
SEX	1.205	0.404	1	2
EDU	4.613	3.643	0	16
CASTE	0.698	0.459	0	1
RELIGION	0.030	0.171	0	1
FSIZE	4.655	1.765	1	12
AGRILAND	24.072	31.630	0	190
NEAR_SRF	0.301	0.459	0	1

N = 1294

Source: Primary survey

The multinomial logit model explains the occupational choices by the regressors listed above. In doing so, the category of the dependent variable (OCCU) is taken as 'Fish/crab catching' due to its highest frequency. The probabilities of choosing among the other three occupations (Agriculture and farm labour, Non-farm daily labour and Migrant labour), relative to the choice of Fish/crab catching, are obtained through the marginal effects of the regressors. The result is provided in Table-4.

Table 4: Determinants of occupation choices: Multinomial Logit

Average Marginal effects (dy/dx) with code:3 (Fish/crab catching) as the base outcome

Independent variables	Earning code:1 (Agri & farm labr)	Earning code:2 (Non-farm daily labr)	Earning code:4 (Migrant labr)
AGE	0.0036*** (5.02)	-0.0009** (-2.00)	-0.1001*** (-11.21)
SEX	0.0191 (0.77)	-0.0407* (-1.88)	-0.1246*** (-3.80)
EDU	0.0098 *** (3.44)	0.0001 (0.05)	0.0079*** (2.69)
CASTE	-0.0198 (-0.93)	0.0088 (0.67)	-0.0125 (-0.60)
RELIGION	-0.0421 (-0.58)	-0.0156 (-0.38)	-0.1562** (-2.14)
FSIZE	-0.0072 (-1.26)	0.0033 (1.12)	-0.0012 (-0.23)

AGRILAND	0.0018*** (6.67)	0.0003* (1.77)	0.0002 (0.54)
NEAR_SRF	0.0139 (0.65)	0.0102 (0.84)	0.0581*** (2.84)

Likelihood ratio chi-square statistics		367.15***	
Pseudo R-square		0.1407	
N		1294	

z - statistics are in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6. Discussion

The significance of the regressors and their signs are all in conformity with expectations. We find that an individual's age is a significant determinant in their occupational choice. Compared to an average fisherman, an average farmer is older and a daily labourer is younger. But a migrant labour is most significantly younger (with the highest marginal effect). We also see that the participation of female workers is not significantly different in agriculture compared to the base (fishing). But it is significantly less (10 per cent level) in daily labour and highly significantly less (1 per cent level) for migrant work. This result confirms our field observation that the young male participants in the labour market are significantly moving out of the delta to earn as migrant labour. The gender disparity in migrant labour from Sundarban is also identified in the literature, as discussed in section 2.2.

Education appears to be an important determinant of occupational choice. Previously, in Table-1, we found that the average years of education is lowest for people engaged in fish/crab catching (base category). The regression result shows that EDU can significantly influence one's occupational choice toward agriculture and migrant labour jobs. However, AGRILAND is the other enabling factor in this choice – which is highly positively significant for agriculture while insignificant for migrant labour jobs. The result in Table-4 implies that if an individual is better educated and has significantly more landholding than an average fishing household, he is expected to choose agriculture, while one with better education but constrained by land assets is more likely to chose migrant labour jobs.

The results also establish that caste and family size has no influence on these occupation choices. However, non-Hindus (mainly Muslims) are significantly averse to migrant work, which might be influenced by their insecurity as a religious minority outside their native locations and culture. In this connection, as also noted in section 2.2 earlier, it might be noted that most of the labour outmigration from Sundarban region is inter-state in nature. Workers move out to distant locations in western and southern India.

It is interesting to observe that the location variable NEAR_SRF is significantly positive only for migrant labour jobs while it is insignificant for other earning choices. In other words, working adults located adjacent to SRF are more likely to move outside. This result has an important ecological implication. Field level discussions with older residents indicated that

the poor landless households living on fish/crab catching tend to locate themselves close to the SRF creeks - which are considered to be relatively rich in fish stock compared to open rivers. Hence, a greater probability of migrating out from these locations, with a base for comparison being fish/crab catching, is very interesting. This result substantiates the claim that people are moving out as migrant labour as a result of declining fish stock within SRF – a claim made in the existing literature and discussed earlier in section 2.1. It also points towards a reduction in anthropogenic stress on the mangrove ecosystem through labour outmigration.

The regression results establish a significant positive influence of years of education towards migrating out. Working at a distant location and in a completely different cultural environment might need a level of communication and information gathering skills that illiterate or minimally educated people do not possess. Our results suggest that better education might help in reducing ecological stress by inducing outmigration of youth, especially from the landless households located near the SRF – who otherwise show a greater probability in fish/crab related earning. In Figure-4, we noticed that the modal year of education for migrant labour is below the secondary level. Our findings culminate into a policy implication for ecological sustainability using school education in this delta. It brings out the role of education as an enabling factor toward local ecological conservation through occupation choices.

7. Conclusion

Sundarban is an ecologically highly sensitive delta and one of the least industrialized regions in India. The densely populated region faces anthropogenic stress on its fish and other aquatic resources as well as the threat from climate change. Various conservation and sustainability programmes are running in the area, sponsored by national and international agencies. The most frequent mode of intervention is to provide the local poor with alternative livelihood opportunities that induce attrition from fish/crab collection in rivers and mangrove creeks. Often it takes the form of providing free livestock and organizing various vocational training camps for the local youth. Yet, on Indian side, the large outmigration of the youth indicates the failure of these interventions in generating local employment. Local demand for vocational skills must be low in the absence of major industries and manufacturing.

Our study is based on a large primary survey focusing on the fishing communities in Indian part of the delta. Stakeholders' opinions in the pre-survey discussions strongly indicated a dwindling stock of fish and crab, which is also supported in the existing literature. However, discussions also indicated continued intensity in collection activities fuelled by better price realization, limited land resources and increasing population pressure. We used survey data to identify major earning options adopted by the local workforce. We found that while fishing and agriculture are the two most frequent activities, migrant labour jobs acquire third place. We also observe that the young males with relatively better education participate more as migrant workers. Interestingly, this phenomenon is found to be more pronounced in locations adjacent to the reserve forest, where traditionally a larger concentration of fishing households is observed. Multinomial logit analysis shows that years of schooling has a significant positive impact in inducing the youth to migrate out instead of getting stuck in fish/crab collection activities.

This finding has important policy implications. Additional government initiatives in increasing school enrolment, arresting school dropouts, and providing more incentives for education up to the secondary level can be a crucial policy handle with an ecological goal in this World Heritage Site. It appears that improving the basic education infrastructure in this remote deltaic region goes much beyond its apparent objective of building social capital in general. In this biodiversity hotspot, such investments would increase community resilience in the face of ecological stress and climate change threats to traditional livelihood.

We also have a word of caution on our results. We selected the sample households through a multi-stage sampling scheme. The last stage sample units were randomly selected, while the location selection in previous stages was biased towards fishing communities. So, the sample might not be representative of the whole population in the larger delta. But we are not attempting to make any population estimate in this study. Our conclusions are derived from a subset of Sundarban's population, who might be identified as the people who are directly responsible for exerting anthropogenic stress on the ecosystem.

Acknowledgement

This work is a partial outcome of a research project titled "Developmental interventions, rural transformation and environmental sustainability: A study on Sundarban in India", sponsored by the Indian Council of Social Science Research (ICSSR, New Delhi, India) under Grant No. Gen-44/2015-6/ICSSR/RPS. The authors, however, are solely responsible for any inadvertent error and omission in this study.

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