



Research Journal of Pharmaceutical, Biological and Chemical Sciences

Environmental Impacts and Adaptive Techniques to Cyclones in an Off Shore Coastal Island Of Nijhum Dweep in Bangladesh

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ABSTRACT

This paper explores the adverse environmental impacts of cyclone and its adaptive techniques using questionnaire survey and participatory rural appraisal (PRA) tools in a most vulnerable coastal community at Nijhum Dweep in Hatiya, Bangladesh. The study revealed that the loss of livestock, spread out of skin diseases, salinity intrusion were the most dominant impacts on the community during the cyclones. Besides, there was a dramatic change in the occupation of livelihoods and source of palatable water for various purposes. It was found that people shifted their livelihood option after the cyclones from farming (25.6 % to 12.2 %) to fishing (48.9 % to 61.1 %). On the other hand, water sources for various purposes were shifted from pond to tube-well after cyclones. The most popular adaptive techniques were planting wind protection efficient and fast growing tree species, practicing multi-occupation and community based constructions. However, people of Nijhum Dweep are well-adapted to this destructive natural event and this experience may be used in other vulnerable coastal communities of Bangladesh.

Keywords: Nijhum Dweep, Cyclone, Adverse impacts, Adaptive techniques, Coastal plantation

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INTRODUCTION

Coastal zone of Bangladesh is about 710 km long extending from Sahpari Dweep of Teknaf to Raimongal River of Satkhira along the Bay of Bengal, comprising estuaries and off-shore islands and covers 19 districts of the country. The coastal zone covers 47,201 square kilometer land area, which is 32 percent of total landmass of the country (Islam 2004). The population of this area is 36.8 million and more than half of them (52%) are poor and about 41% is below the age of 15 (Islam 2008a, b). The coastal zone of Bangladesh is highly prone to natural disasters, particularly tropical cyclones and storm surges (Siddiqi 2001; Quadir and Iqbal 2008). It was reported that a total of 539 tropical cyclones were formed in the coast of this region during last 131 years extending from 1877 – 2007. On an average 4.1 tropical cyclones were formed per year of which 1.7 belongs to intensive categories with wind speed of greater than 88 km/hr (Quadir and Iqbal 2008). In addition to these disasters, the estimated sea level rise was speculated to be 30 and 100 cm, with a corresponding rise in cyclonic intensity and magnitude by 10 and 25% respectively (BCAS-RA-Approtech 1994).

There is no doubt that the people living in coastal areas are more vulnerable to various disasters than the people in other areas. The devastating tsunami that occurred in 2004, hurricane *Katrina* in 2005, cyclone *Sidr* in 2007, *Nargis* in 2008 and *Aila* in 2009, that killed thousands of people in coastal areas, are obvious recent examples of climatic extremes and the associated vulnerabilities of coastal residents (Parvin et al. 2008). It was estimated that return period of super cyclone was reduced from 94 years to only 8 years during 1876 to 2007 in the Bay of Bengal (Quadir and Iqbal 2008). Annually, about 120 million people are exposed to tropical cyclone hazards, which killed 250,000 people from 1980 to 2000 (IPCC 2007). MoEF (2005) revealed that many projected adverse impacts of climate change including sea level rise, increased temperatures, enhanced monsoon precipitation and run-off, potentially reduced dry season precipitation, and an increase in cyclone intensity would in fact aggravate many of the existing stresses that already pose a serious impediment to the process of economic development of Bangladesh.

Nijhum Dweep (Calm Island) having an area of 6048 ha which is segmented as 2014 ha plantation area, 1257 ha settlement area and 2783 ha barren land; houses 30,000 people is one of the affected coastal areas of Bangladesh and very near to the Bay of Bengal (BFD 2010). Two devastating cyclones in Bangladesh named '*Cyclone 1991*' and '*Aila in 2009*' hit this area greatly. In 1991 cyclone, 138,882 people killed with an estimated economic loss Tk. 145 billion in the coastal areas of Bangladesh (Quadir and Iqbal 2008). Land erosion and accretion is a regular phenomenon in this area where the rate of accretion exceeds the erosion. Despite of these impacts, local communities of this area are highly adaptive by their own techniques. However, so far no research has conducted to explore the impacts of cyclones and its adaptive measures in Nijhum dweep. So, this study was aimed at determining the adverse effect of cyclones on communities of this area with their adaptation techniques.

METHODOLOGY

Description of the study area

Nijhum Dweep, the southeast portion of Noakhali district of Bangladesh located between longitude $90^{\circ} 59' W$ to $91^{\circ} 3' E$ and latitude $21^{\circ} 1' S$ to $22^{\circ} 6' N$, is a cluster of islands (mainly Ballar Char, Kamlar char, Char Osman and Char Muri, with a total landmass of about 6,048 ha) emerged in the early 1950s as an alluvium in the shallow estuary of the Bay of Bengal (Fig. 1)

The Forest Department took initiatives for raising coastal plantations in 1973 for the first time in Nijhum Dweep. The dominant species is Keora (*Sonneratia apetala*) and the main attraction in these forests is the herd of about 5,000 spotted deer. Keora also supplies posts for houses, materials for making boats and agricultural implements, and fuel for domestic use. In 2001, the government of Bangladesh declared Nijhum Dweep forests as National Park (Banglapedia 2007).

Data collection

A reconnaissance survey was conducted on April 2010 through visiting the whole Nijhum Dweep, collecting secondary data from Forest Beat Office and interviewing of local people. A semi structured questionnaire survey was conducted during April to June 2010 containing impacts of cyclone and their own adaptive techniques against these impacts. PRA was used to find out indigenous techniques of adaptation to various impacts by using three tools, i.e. key information discussion, group meeting and interviewing. Questionnaire survey was conducted systematically in six markets named CDSP Bazar, Tuhin Market, HASI market, Bandartila Bazar, Ocher Bazar, Namar Bazar (Nijhum Dweep Bazar) (Figure 1). A total of 90 respondents from 9 wards (10 respondents from each ward) were interviewed ignoring repetition. Markets were selected for collecting data because most of the people gather at night in market.

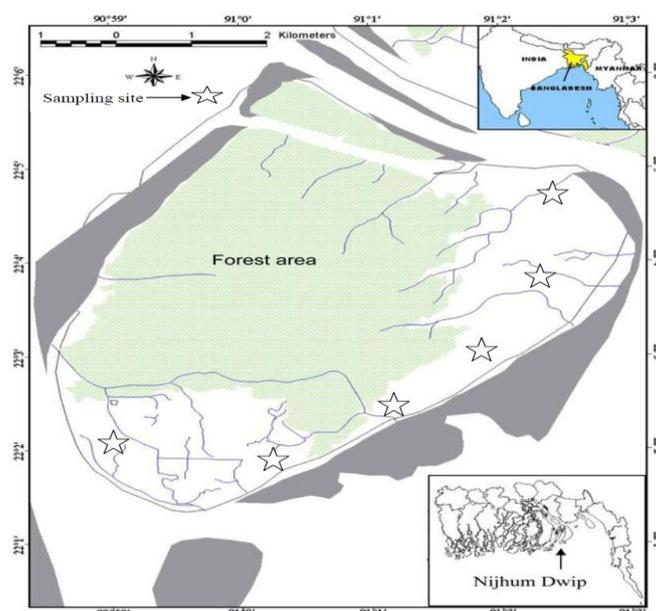


Figure 1: Map of Nijhum Dweep showing six sample sites (Source: Ifterkhar and Takama 2007 after CDSP III)

RESULTS

Impacts of cyclone

People perceived that health related impacts such as Skin diseases, Diarrhoea, Malaria, Dysentery and Cholera were broken out after a cyclone in these areas. Among these diseases, occurrences of skin disease was maximum (76.7%) while lowest was Cholera (32.2%). Among the respondents, 98 % and 97% people thought that water salinity and soil salinity were increased due to various hazards respectively and 87% people thought that biodiversity were decreased especially deer due to cyclone *Aila* (2009), (Table 1) . About 76% people lost their house due to cyclone 1991 and 2009 and 72% people thought that their income level decreased due to cyclone *Aila*.

Table 1: Impacts of last two cyclones on Nijhum Dweep

Impact categories	Occurrences due to cyclones	Percentage(n= 90)
Health related impacts	Skin diseases	76.7
	Malaria	63.3
	Diarrhea	70.0
	Cholera	32.2
	Dysentery	38.9
Ecosystem related impacts	Soil salinity intrusion	96.7
	Water salinity intrusion	97.8
	Biodiversity loss	87.8
Shelter related impacts	Destruction of houses	75.6
Income related impacts	Income reduction	72.2

Damage caused by two major cyclones in Nijhum Dweep

Maximum loss occurred in case of livestock (USD 1630 per household) and minimum loss occurred in case of fish (USD 1020 per household) due to last two devastating cyclones (Table 2). Total human loss of respondents was 54 people in both 1991 and 2009 cyclones.

Table 2: Total damage caused in two major cyclones (29th April, 1991 and 25th May, 2009) per household in Nijhum Dweep (N=90)

Categories	Loss in 1991 and 2009 per household (in USD)
House	1200
Livestock	1630
Crops	1000
Fish	1020
Total	4850

Notes: 1 USD= BDT 69

Change in occupation

Cyclones had an adverse effect on occupation of the local people of Nijhum Dweep. Occupational change towards fishery was increased (12.2%) after the cyclone '*Aila*' in 2009 while farming as an occupation was decreased dramatically (-13.4%). It was also found that the number of day laborer was increased to about 2.3% due to this cyclone (Table 3).

Table 3: Occupational change due to cyclone Aila on 25th May, 2009

Occupations	Before cyclone (%)	After cyclone (%)	Change (%) ^a
Only Farming (agriculture +Livestock rearing)	25.6	12.2	- 13.4
Only Fishing	48.9	61.1	+12.2
daily labors only	4.4	6.7	+ 2.3
Both Farming and Fishing	7.8	10.0	+2.2
Both Farming and Business	4.4	2.2	- 2.2
Both Farming and labor	5.6	4.5	- 1.1
Others (Service, teaching etc.)	3.3	3.3	0.0

^a symbol '+' indicates increment of occupational change and '-' indicates declination.

Effects on water sources

Changing of water use pattern was one of the worst effects of cyclone 'Aila' on local people of Nijhum Dweep. Tube-well as a source of drinking, washing, bathing and cooking water was increased after this cyclone. On the other hand, pond as a source of cooking water decreased dramatically after the cyclone (Table 4).

Table 4: Change of water use patterns after the cyclone Aila on 25th May, 2009

Uses of water	Source of water						Change (%) ^a		
	Before cyclone (%)			After cyclone (%)					
	Pond	Tube well	Pond/tube well	Pond	Tube well	Pond/tube well	Pond	Tube well	Pond/tube well
Drinking	6.7	84.4	8.9	1.1	95.6	3.3	-5.6	+11.2	-5.6
Washing	80.0	10.0	10.0	70.0	16.7	13.3	-10.0	+6.7	+3.3
Bathing	90.0	3.3	6.7	64.5	23.3	12.2	-25.5	+20.0	+5.5
Cooking	96.7	1.1	2.2	45.6	40.0	14.4	-51.1	+38.9	+12.2

^a symbol '+' indicates increment of occupational change of water use pattern and '-' indicates declination.

Vulnerability and indigenous techniques of adaptation practiced by the coastal people

Among various vulnerabilities intrusion of salinity, destruction of physical infrastructures, water borne diseases and their consequences were notable (Table 5). To overcome these vulnerabilities they apply some techniques e.g. raising land for avoiding soil salinity, ground water utilization, occupational shifting, cultivating traditional paddy varieties, medicinal plants, planting cyclone protecting tree species around the houses etc.

Fast growing tree species

Tree species play a major role in the protection of resources and life in coastal areas. 82% people prefer *Albizia saman* as a fast growing tree species in their plantation programs followed by *Albizia procera* (11%) and *Cocos nucifera* (7%) for plantation establishment (Figure 2).

Table 5: Vulnerability and indigenous techniques of adaptation practiced by the coastal people

Categories	Vulnerability	Adaptation
Agricultural crops	<ul style="list-style-type: none"> ➤ Soil salinity ➤ Flood and water logging ➤ Destruction of standing of crops ➤ Disease and increase pest infestation ➤ Reducing cultivation opportunity due to higher salinity 	<ul style="list-style-type: none"> ✓ Cultivation of salinity tolerant traditional paddy varieties and applying zinc fertilizer ✓ Introducing raised seed bed in high lands ✓ Adopting crop cultivation considering the changes in weather ✓ Using cow dung as pesticide ✓ Adapt to alternative income opportunities
Fishing	<ul style="list-style-type: none"> ➤ Reduction of scope of freshwater aquaculture ➤ Flood ➤ Attack by sea pirates 	<ul style="list-style-type: none"> ✓ Domestication of saline and brackish water fish species ✓ Trapping by net ✓ Collecting token by giving tax
Health	<ul style="list-style-type: none"> ➤ Breeding ground for mosquito due to decomposition leaf-litters ➤ Mosquito bit ➤ Malaria ➤ Diarrhea, Cholera, , Dysentery etc. 	<ul style="list-style-type: none"> ✓ Clearing the homestead areas ✓ Sweeping out with twigs of <i>Casuarina equisetifolia</i> and mosquito-net for children even in day time ✓ Receiving treatment from village doctor ✓ Used leaf juice of <i>Dalbergia sissoo</i> and <i>Bombax ceiba</i>
Water supply	<ul style="list-style-type: none"> ➤ Water salinity ➤ Debris in water ➤ Bad odor and toxicity due to animal decomposition 	Water purification tablet given by NGOs <ul style="list-style-type: none"> ✓ Shifting of water source
House	<ul style="list-style-type: none"> ➤ Displaced and destroyed by cyclone and storm surge 	<ul style="list-style-type: none"> ✓ Planting cyclone protecting species such as <i>Cocos nucifera</i>, <i>Casuarina equisetifolia</i>, <i>Acacia nilotica</i>, <i>Swietenia mahagoni</i> etc. surrounding the homesteads ✓ Making house through raising ground ✓ Repairing by collecting logs and twigs from forests
Income	<ul style="list-style-type: none"> ➤ Lowering the income ➤ Reducing the employment opportunities 	<ul style="list-style-type: none"> ✓ Shifting in occupation ✓ Loan taking from NGOs or Government for alternative jobs
Infrastructure	<ul style="list-style-type: none"> ➤ Damaged embankment or roads 	<ul style="list-style-type: none"> ✓ Community based construction of embankments or roads
Weather	<ul style="list-style-type: none"> ➤ Weather forecasting signals 	<ul style="list-style-type: none"> ✓ Using radio and Television; volunteers serve the people in remote areas
Energy	<ul style="list-style-type: none"> ➤ Lighting, cooking, mobile charging etc. 	<ul style="list-style-type: none"> ✓ Using high voltage generator and kerosene ✓ Solar energy trapping

Cyclone protecting tree species

Among the respondents, 28% opined *Cocos nucifera* as the priority species of cyclone protecting tree species followed by, *A. saman*, *A. nilotica*, *C. equisetifolia* and *S. mahagoni* for the protection of their houses from extreme natural calamities (Figure 3).

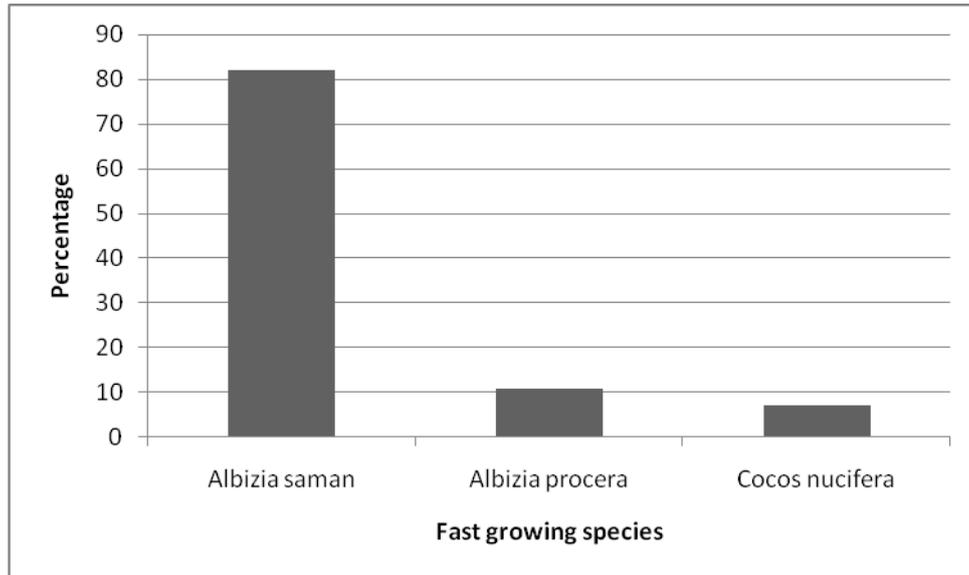


Figure 2: Three fast growing tree species popularly planted in mainland of Nijhum Dweep

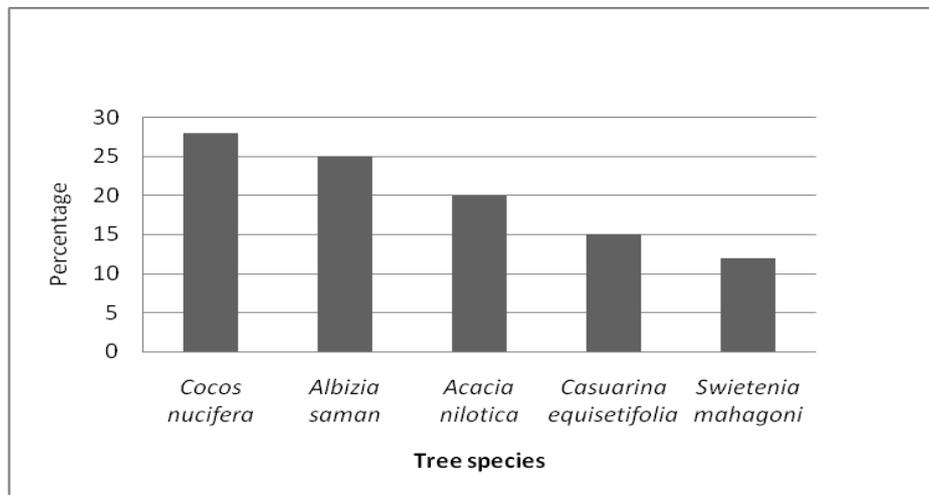


Figure 3: Cyclone protecting tree species popularly planted in mainland in Nijhum Dweep

Rehabilitation program of the cyclone victims

For rehabilitation program of the cyclone affected people, maximum victim (45%) took loan money from money lender, 10% from NGOs, while 25% people were self-dependent in rehabilitation programs of their households after hazard (Figure 4). This study also revealed that governmental organizations (GOs) involved actively (21%) for rehabilitation of the cyclone affected people of Nijhum Dweep.

Saline tolerant paddy varieties

People were cultivating saline tolerable local Amon varieties such as Rajasyle (70%) and Kajolsyle (25%). Only 5% people were cultivating HYV to adapt with cyclone impact on agricultural crops (Figure 5).

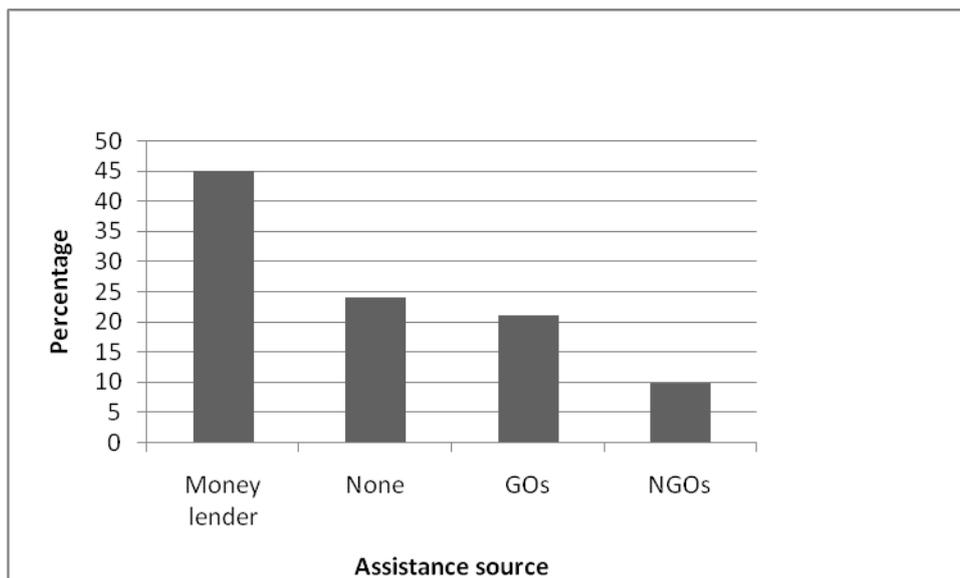


Figure 4: Rehabilitating assistance taken by the cyclone victims from sources

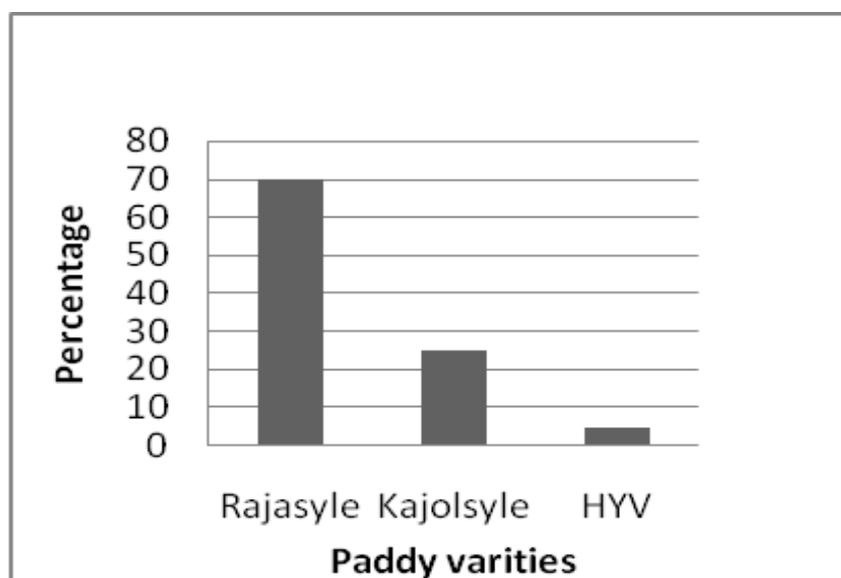


Figure 5: Cultivation of salinity tolerant paddy varieties by people

DISCUSSION

Salinity intrusion was common during cyclone because study area was very near to sea. Skin diseases were the highest during cyclones due to using saline water for bathing and washing. Deer population was reduced in alarming rate because most of them were washed away to nearby char land and a portion of them was died. Livestock loss was highest because 1991 cyclone suddenly hit in night. On the other hand, fish loss was lowest because a few number of people practiced psyculture and maximum fisherman caught fishes from river. Most of the people changed their occupation from farming to fishing because frequent cyclone flooded the agricultural land which increased soil salinity and decreased

crop production. Ground water dependency was increased for drinking, washing, bathing and cooking because pond water turned into highly saline after cyclone.

People raised land and cultivated salinity tolerant and short rotation traditional paddy varieties such as Rajasyle and Kajolsyle (local name). In case of embankment and road destruction, people practiced community based construction. People popularly planted *A. saman* in homestead as a fast growing timber species and cyclone protecting tree species, such as *C. nucifera*, *A. nilotica*, *C. equisetifolia* etc., because these species are highly saline tolerant. For rehabilitation most of the people were dependent on money lenders because they quickly and easily got money from them. Besides this, most of the respondents tried to rehabilitate by their own resources because of avoiding extra interest imposed by different NGOs after lending money from them.

CONCLUSION

Nijhum Dweep, one of the most vulnerable islands due to climate change and consequent cyclones, is located very close to the Bay of Bengal. Several cyclones had attacked this island and destroyed huge amount of property including human life. But, local people are struggled against this climatic extreme event by their own techniques. Considering these, this study was aimed to find out the impacts of cyclones on local communities of this island with their adaptation techniques by using PRA tools. This study found that life loss, skin diseases, salinity intrusion, livestock loss were the most dominant impacts among the communities during and after the cyclones. Besides, there was a dramatic change in the occupation of livelihoods and source of water for various purposes. On the other hand, water sources for various purposes were shifted from pond to tube-well after cyclones. The most popular adaptive techniques were planting wind break, fast growing tree species, practicing multi-occupation and community based constructions. However, people of Nijhum Dweep are well adapted to this destructive climatic event and this experience may be used in other coastal communities of Bangladesh.

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