SIGNIFICANCE OF EMBANKMENTS BREACHING IN SOUTHERN BLOCKS OF SOUTH 24 PARGANAS DISTRICT, WEST BENGAL

Hirak Sarkar
Research Scholar
Department of Geography
The University of Burdwan, East Badhaman, India

Abstract: The embankments in Southern Blocks of South 24 Parganas District, West Bengal protect the ecological as well as cultural resources from the tidal inundation have been breached frequently caused by physical, climatic, biotic and several other factors. Such breaching of the embankments severely damaged the bases of subsistence of human life and the species-rich unique estuarine ecosystem of the Sundarbans. The human settlement in the Bengal delta has been only possible due to the reclamation of the premature land by embankment construction and deforestation. But the cultural landscape of the region has been threatened by the breaching of those man-made impediments due to tidal ingression and other hydro-meteorological hazards like cyclones and storm surges. The human settlements and the economic bases of subsistence such as cultivable land, fisheries and sources of drinking water have been severely affected due to the ingression of saline water during breaching which leads to loss of human life and property; displacement of poor rural folks from their native places, destined to move elsewhere in destitute condition without any economic wealth and security. The natural and cultural ecosystem of the Southern Blocks of the District namely Sagar, Kultali, Basanti, Patharpratima, Gosaba and Namkhana have experienced the devastating impact of embankment breaching. The study, therefore, aims at coming across the solutions of the problems of embankment breaching in the area and formulation of better planning and mitigation strategies so that the ecology as well as the economy of the concerned area have become protected from the tidal erosion and inundation.

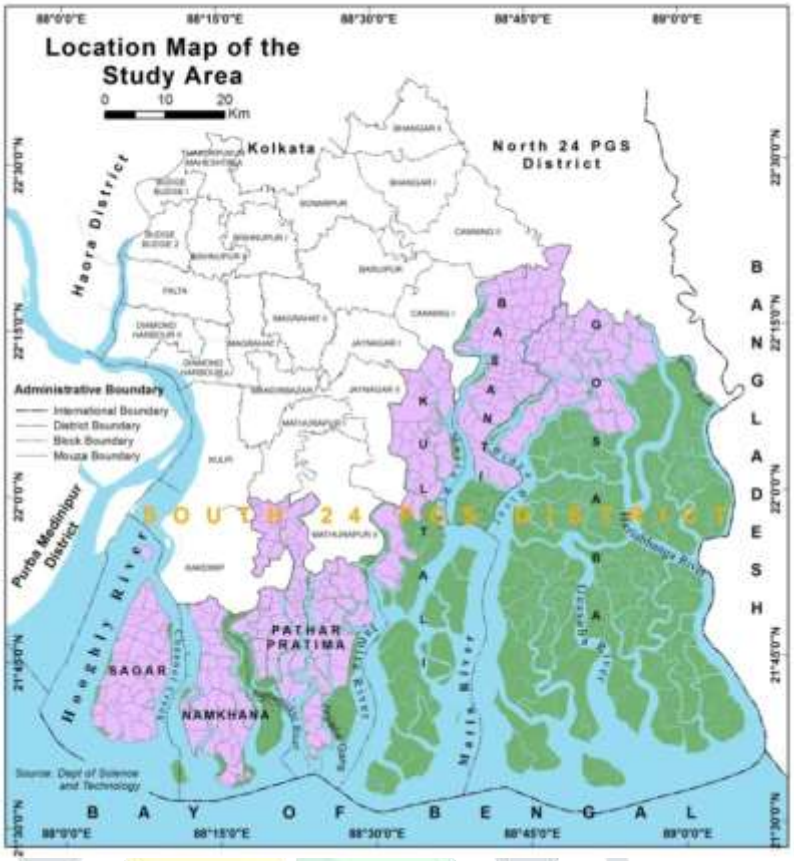
Key Words *- Sundarbans, Bengal Delta, Eco-Sensitive, Estuarine Ecosystem, Embankment Breaching, Vulnerability*

INTRODUCTION

Construction of embankments on rivers is an example of human intervention to natural process. In the deltaic plain of West Bengal, embankments on tidal rivers were made to protect agricultural fields and settled areas from tidal surges. It can be seen as transformation of natural ecosystem into cultural ecosystem. The impediments are crucial for sustenance of human habitation of some parts of South 24 Parganas District of West Bengal, the area under review, and it is evident that breaching of those embankments is detrimental to that cultural ecosystem. The saline water that enters into the agricultural fields makes the soil unusable to yield crops for at least five years and directly damage the agro-ecological system. The focus of the present study is centered upon the investigation into the questions whether the breaching of embankments in the riverine tracts of most southern island blocks of South 24 Parganas District have resulted any ecological, economic and social impact upon the human communities more dependent upon this unique estuarine ecosystem in one hand and to find out the possibilities that whether such impact could be reduced by any suitable alternative management systems on the other hand.

THE STUDY AREA

The South 24 Parganas District has been considered as the area under study. The District is situated at the southern most fringes of the State of West Bengal. It is predominantly a deltaic region formed mainly by the continuous deposition of silt carried down by the Ganga-Brahmaputra system. The administrative components of the District include 5 Sub-Divisions: (i) Alipore *Sadar*, (ii) Baruipur, (iii) Canning, (iv) Diamond Harbour and (v) Kakdwip. The District is composed of 33 Police Stations, 29 Community Development Blocks and 7 Municipalities. The study area extends from 21°29′00″ North to 22°26′15″ North Latitude and 88°03′45″ East to 89°04′50″ East Longitude. The major part of the District being covered by the Sundarbans region in the south and large Municipalities on the north and west, major emphasis have been given on six specific Blocks namely Kultali (Baruipur Sub-Division); Namkhana, Pathar Pratima (Kakdwip Sub-Division) and Sagar and Gosaba Basanti (Canning Sub-Division) mainly where the embankments are breaching is concentrated and their most evident.



GEOGRAPHIC SPECIALTY

The area under review is an active delta and a land of marshes formed mainly by the continuous deposition of silt carried down by the Ganga-Brahmaputra system over the gentle continental shelf of the Bay of Bengal for thousands of years. The study area has several numbers of islands of the Sundarbans which are presently under cultivation but the water levels of the surrounding river remain periodically higher above the reclaimed lands. Innumerable channels and tidal creeks fed the area and the embankments made on the natural levees prevent the areas from flooding. During high tidal surge, flood inundation takes place and tidal channels are shifted by natural phenomena like deposition, erosion, river capture and by human interventions like early reclamation of the immature or juvenile floodplains of the interdependent interfluves and extension of settled culturable areas. Any estuarine ecosystem of the world experience similar phenomena.

RATIONALE FOR SELECTION

The area has been facing a great transformation both in physical and socio-economic characteristics. Establishment of the impediments and purposive clearance of forests with reclamation of immature deltaic land may be marked as prelude to the separation of nature and culture. Embankments are the walls against the way of natural process. But after such separation, embankments proved as the only protector to the once established mosaics of cultural ecosystems. These ecosystems are vulnerable to the surges of sea water brought in by tides and cyclones, causing breaching of embankments in various scale. The larger section of the people belongs to the marginal community practicing subsistent economy with very less or no surplus income living on the land literally marginal in location and marginal in productivity too. Thus the marginal people living on marginal land at marginal location are unique to be treated as rationale for selection.

OBJECTIVES

The objective of the proposed research work is to enter into the exercises regarding identification of the natural and anthropogenic factors and processes responsible for decay and breaching of the

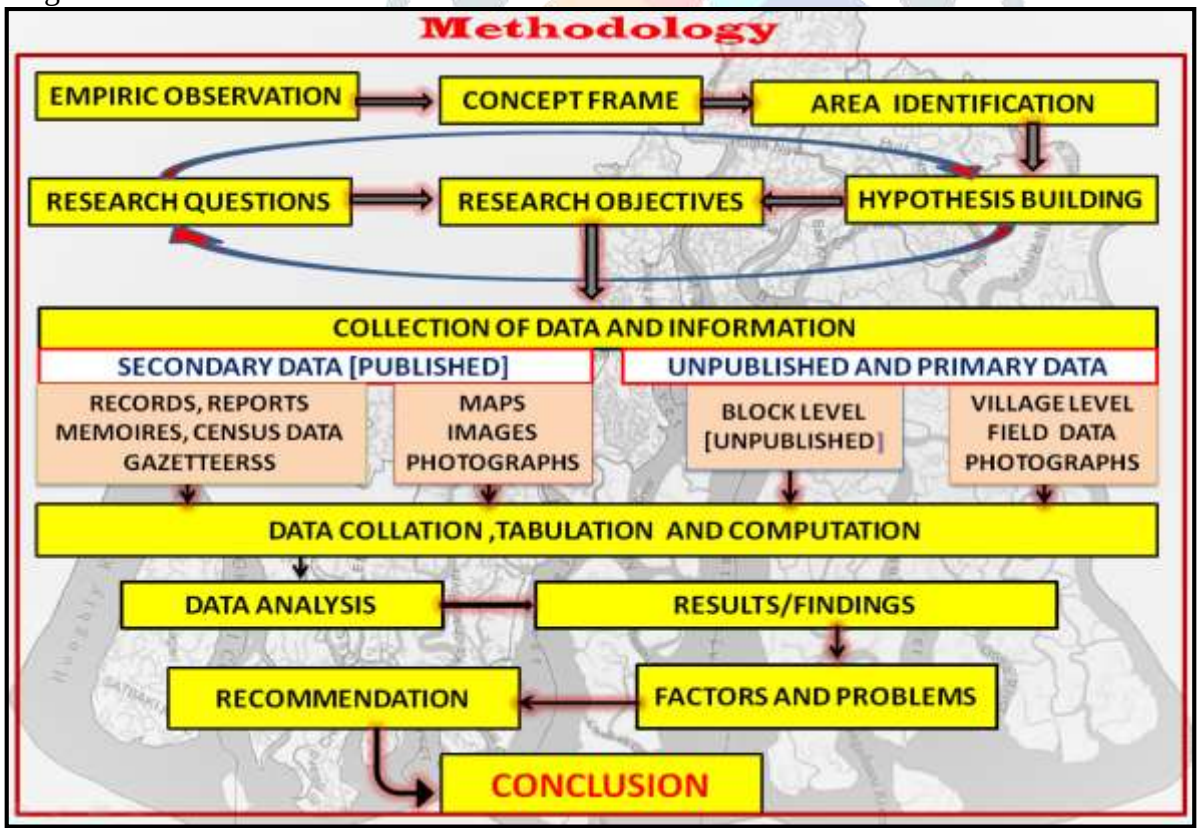
embankments once engineered to protect the life and resources in various parts of the district located on the active delta region significantly influenced with mangrove forests, to probe into the impacts of decay and breaching of those embankments on physical and human ecological aspects of the selected area and to formulate an eco-friendly management plan on the basis of observation and available data.

DATABASE

A study on perspectives of the significance of embankments breaching should not depend only on some statistical information but also some qualitative information to be derived from facts, reports, records, even from oral interviews. The data and information have been collected from different sources which are secondary and primary in nature as well as some of the information are published while some are unpublished. Secondary information have been collected mainly from different records, reports, drafts, gazetteers, maps, images, books and journals relevant to the work. The primary data collection is considered as the important basis for the whole research work. has been collected through detailed field survey on embankments and households. Data also have been collected in the form of oral interviews of the officials of the *mouzas* and responses gathered from communities copping with embankment vulnerability.

METHODOLOGY

The study incorporates some informative and empiric aspects related to the time, space and people. The principle methodological start to the enquiry has been to frame a purposive structured questionnaire schedule through which empiric data and information has been collected concerning physical, economic and human ecological issues and questions. The data and information so collected have been verified in comparison with the information gathered from secondary sources. The data tabulated and rearranged have been computed applying relevant quantitative techniques and necessary graphs and tables have been drawn to establish the hypothesis. The information thus restructured has been analyzed and final remarks have been made on the basis of analytical interpretation with definite methodological steps shown on the diagram.



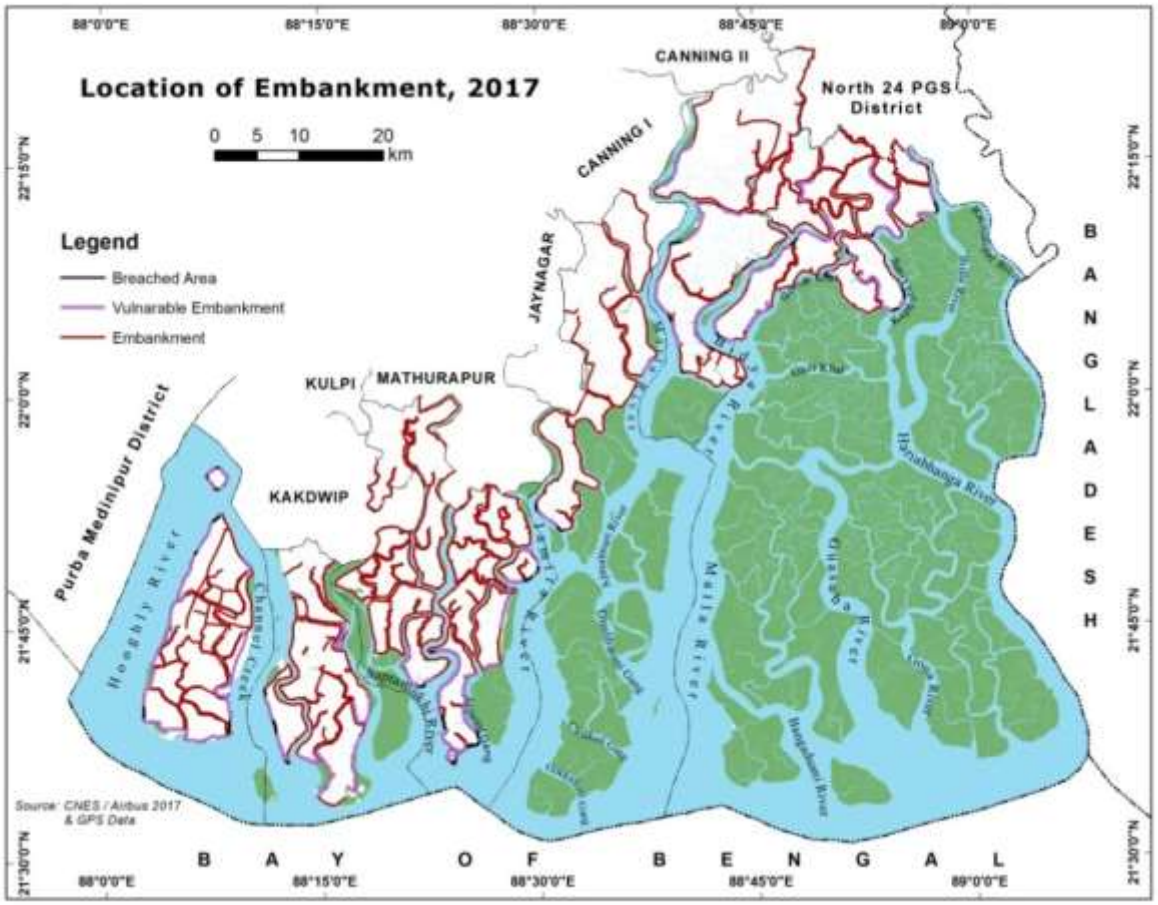
IMPORTANCE AND UTILITY OF EMBANKMENT

Universally river embankments may be considered as a critical infrastructure for local benefits which they offer in the form of flood protection. The embankments have been constructed to protect

productive agricultural lands during the monsoon season from excessive flooding and rural settlements from tidal inundation. Along with the protection, these embankments have provided good road communication and options for movement to sale agricultural produce at nearby markets and expected to contribute towards improvement of the overall socio-economic condition in the coastal areas. The importance of those embankments in the life of the local people of the area has been synonymous to lifeline.

LOCATION AND ORIGIN OF THE EMBANKMENTS

The early settlers have made attempt to protect the agricultural fields and rural settlements from ingression of saline water by raising embankment on the banks of the tidal creeks. These embankments were mainly raised to a certain height by the local people with the help of the local landholders in the past. But the construction of embankments was not done in a planned manner. Dearth of technical knowledge and foresight has made the problem more complex. However, the entire responsibility of the maintenance of embankments has been rendered to the Government with the abolition of *Zamindari* system in 1955. The



Sundarbans Development Board has taken the responsibility of the development of the area since March 1973. The Board put more emphasis on the improvement of the drainage system of the area to drain out the excess water. The construction of sluice gates to serve the above mentioned purpose was started in 1975-76 by the authority. According to the Report of the Department of Irrigation and Waterways, Government of West Bengal (2017), Patharpratima Block embraces the highest length of embankment, followed by the Gosaba Block and Kultali Block has the lowest length of embankment among the six selected Blocks of the study area. The map shows the location of the embankments in the area under study. It is evident from the diagram that the length of embankment is increased in Patharpratima, Kultali and Gosaba Block from 2000 to 2017 and decreased in Sagar, Namkhana and Basanti Block from 2000 to 2017.

NATURE OF EMBANKMENTS FAILURE

The nature of embankment failures is quite complex. Heterogeneity of materials within the dike body or the subsoil results in a failure only if a definite limit of outside influence is exceeded. But nevertheless it is possible to identify four main categories, which affect the stability of a dike system.

Type A: Solution and mud flow

The soils of the dikes are heterogeneous and undergo differential solutions. Stratification of the soil layers also plays a very important role. The permeability of the dike body determines the velocity of percolation of water through the dike and therefore its stability too. This can be seen as solution breaching most frequent on the sides and top of the dykes.

Type B: Wash out

The type is the solution wash furnished by corrosive forces of water currents during forward and retreating tides, therefore related with the velocity of the currents of the tides. The river side wall therefore becomes narrow in breadth, and the thinned out part of the dike is breached easily.

Type C: Over topping

This type of embankment breaching is resulted with strong and wide upsurge of tide water mostly during the time of cyclonic storms. Sudden and quick rise of the water level in the river flows with force over the top of the embankment and is accompanied with quick solution and removal of the top soil. The height of the quickly recedes and the overtopped gap expands rapidly on both ends.

Type D: Slump breaching

This is most frequent on walls faced directly by strong tides. Initially the open wall facing the river or the bay is attacked by the high and strong waves of tide water accompanied with strong gush of storms. The attack erodes the wall almost vertically and as a result, the base of the impediment wall becomes weak that cannot bear the load and falls down straight to the water side. The gap in the wall created by such type is widened and deepened quickly and salt water flows in within a very short time

Table: Embankment Breaching in the Study Area

Blocks	**Reasons for Breaching**
Basanti	Scouring
Gosaba	Tidal bores
Kultali	Weakening, rain cuts, breach, scouring and fishery
Namkhana	Erosion and tidal bores
Patharpratima	Erosion and tidal bores
Sagar	Tidal bores

Source: Disaster Preparedness and Response Plan, South 24 Parganas, Govt. W.B.

IMPACTS OF EMBANKMENT BREACHING

The term 'impact' refers to the action of one object coming forcibly into contact with the other. Impact on its own implies an influence or effect on virtually anything, given its context. Impact can be identified as physical as well as human, economic or social, yet in essence all impacts are virtually social because the ultimate effects are faced by the communities or the societies which have either benefitted or suffered economically due to the effects of different hazards. Since all groups do not have the same bases or combinations of economies, they have suffered differentially, gained differentially or have been compensated differentially by alternative development in the form of extension or improvement in agriculture or opportunities in allied fields of secondary and tertiary service. The breaching of embankments in the area has resulted a number of impacts upon the economic, social and cultural systems followed by the local people. Table contains a list of direct and indirect impact evident on physico-cultural environment caused by embankment breaching.

Reduction in Vegetative Cover

The major jungle products of the area are different kinds of wood, such as *sundari* and *pasur* used for planks and house posts, *kipra*- used for rafter for thatched roofs, *bein* is used for house beams, *hental* for the wall and garments, *keora* for planks. The other essential vegetations which have been used by the inhabitants of the area are *gango, khalsi, babla, golpata, gab* etc. and the medicinal plants like *anantamul, golancha* and *nata* found in this region (Hunter, 1998: 23-24). It has been identical from the study that in case of breaching the embankments are ruined, which causes loss of the above mentioned valuable vegetations. Embankment breaching also has a direct impact on the vegetations which cannot tolerate saline

water. In case of breaching in the embankments the saline water infiltrates into the innermost part of the area under review, make hindrances to sustain the vegetative cover which are fresh water feeder.

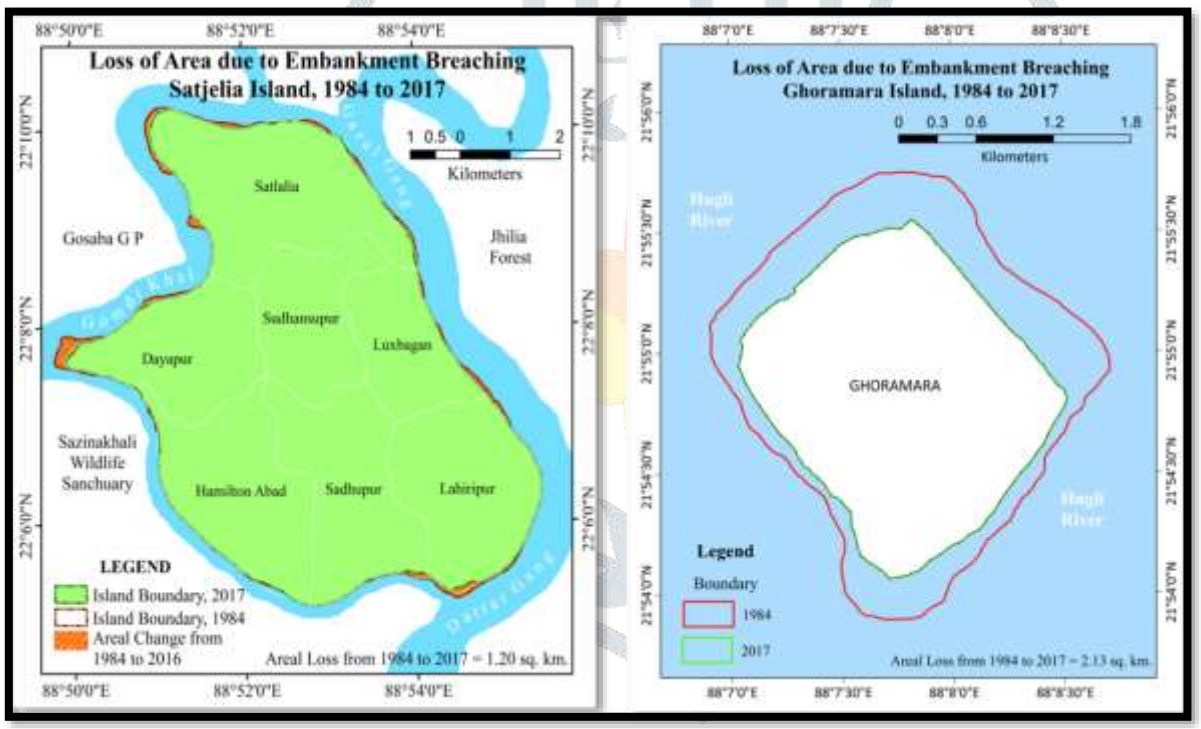
Loss of Wetlands

A number of wetlands have been formed in the study area beside the river banks and also besides the shorelines, amongst them some are salt water feeder and some are fresh water feeder. It is evident from the field observation that most of the wetlands have been situated beside the embankments. These wetlands are being degraded by the embankment breaching. Whenever there is breaching in embankment the salty water infiltrates into the fresh water wetlands hampering the ecological balance of the wetlands. Sometimes these wetlands are silted up by the clayey water of the rivers and oceans which have been infiltrating by the breached areas in the embankments.

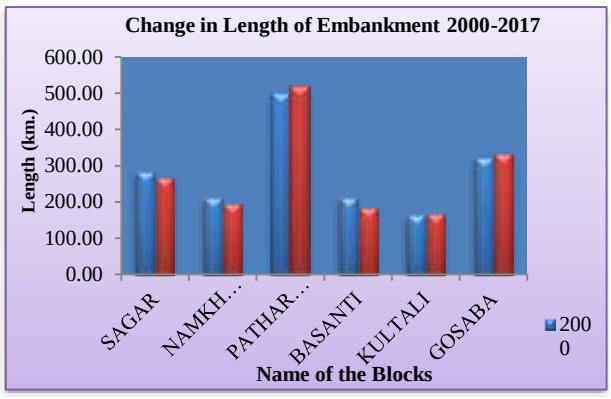
Loss of Land Area

1.20 km^2 land are removed in the Satjelia Island from 1984 to 2017 due to the influence of embankment breaching whereas the lost area is 2.13 km^2 in the case of Ghoramara Island. Maximum area is lost in the Mousuni Island (3.64 km^2) owing to breaching and 1.79 km^2 area is lost in the Jharkhali Island in the period 1984 to 2017. The following maps depict the land loss area.

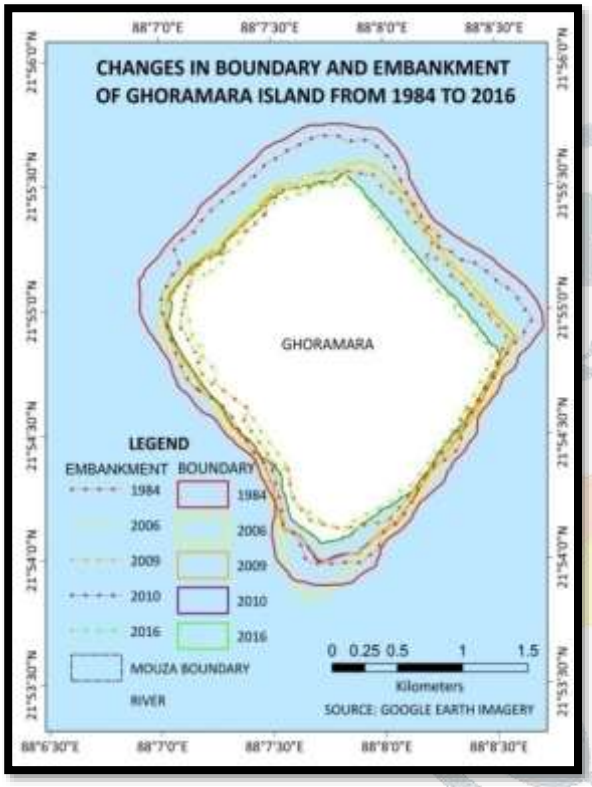
The frequent events of breaching with tidal erosion have reduced the area of the Ghoramara island. The size of the island has gradually shrunk up to 45 per cent due to severe erosion that poses a threat to the local human

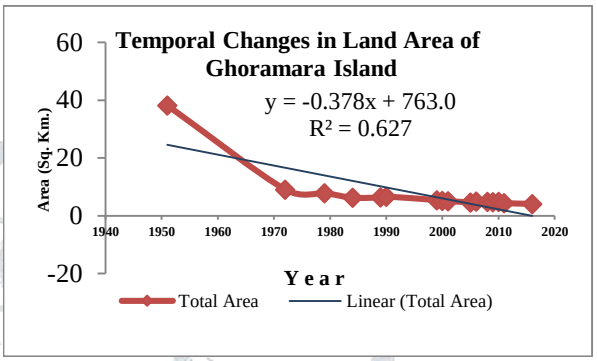


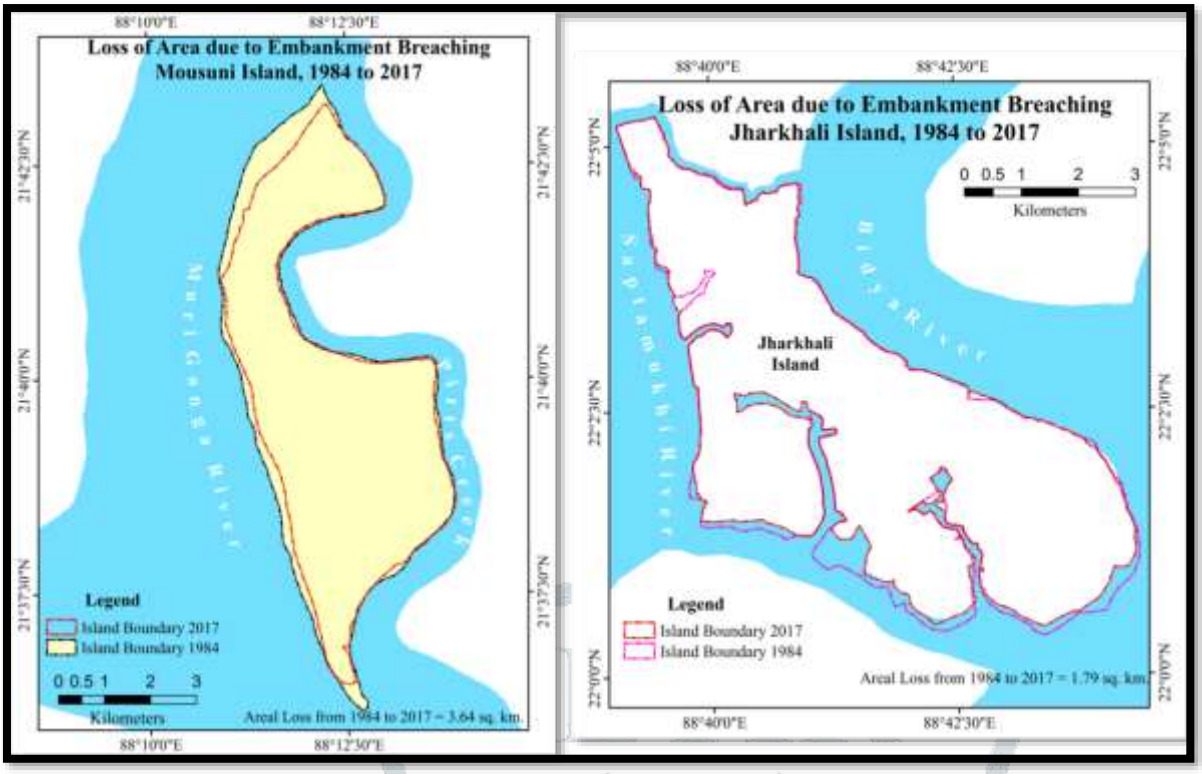
communities (Bhattacharjee et. al., 2011). The shoreline of Sagar Island was shifted in between 1851-1887 and the Ghoramara Island became detached from it (Roy Chowdhury and Sen, 2013). The Lohachura *Char* has been completely disappeared by the combined effects of tidal erosion and embankment breaching caused by the tidal surges. During the same period, the neighbouring island of Suparibhanga *Char* has also been engulfed by the raging sea. The net area of the island has been reduced from 38.23 km in 1951 to 4.12 km. in 2016. The following maps and figure show the scale of



gradual reduction of land area and annual rate of accretion and erosion of this island.

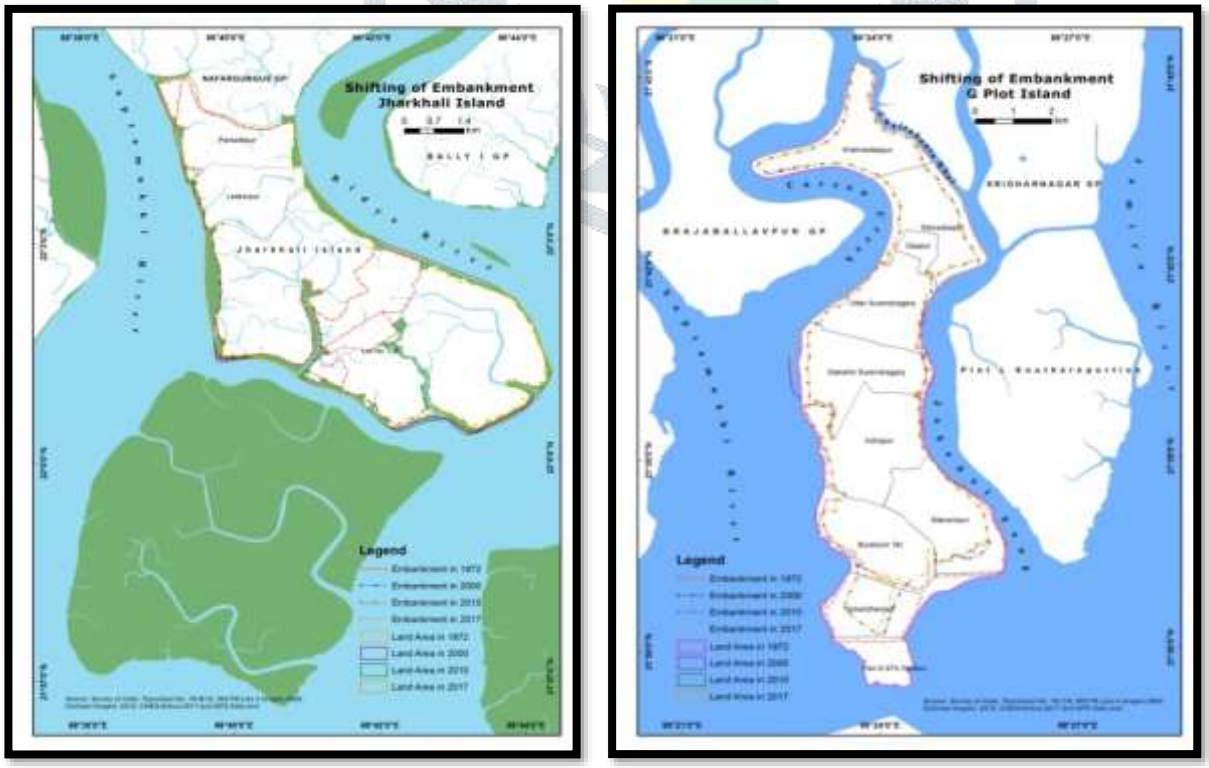




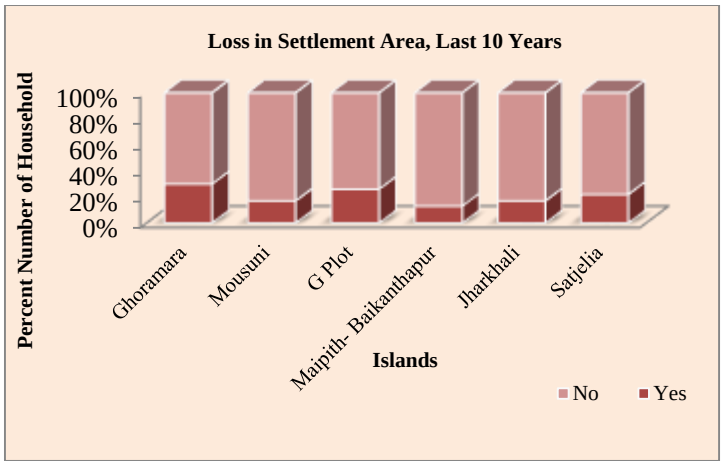


Shifting of Bank Lines

Embankment breaching is one of the major natural calamities of the area under study, which took place in almost every year. Shifting of river bank line is a natural process, sometimes it erodes one bank and sometimes it builds the other bank. It causes change of the river courses. The resultant impact of that breaching is decrease in the area of the reviewed islands. Map shows shifting of embankment and land loss of the selected Islands.



Loss in Settlement Area



The harshest impact of embankment breaching is the loss of settlement that makes the inhabitants more vulnerable to live a plunge life. Breaching of embankments drives the inhabitants to leave behind them except bearing the losses. They never change location of their settlement before the breaching takes place as they have little earnings that never allow them to replace their houses before it totally collapses. The people settled upon the embankments are more vulnerable to the breaching.

It is evident from the field study that Ghoramara Island of Sagar Block is most vulnerable to embankment breaching. It is clear from the diagram that 33 per cent families of Ghoramara Island have lost their homes due to embankment breaching whereas Maipith-Baikunthapur Island of Kultali Block lost 13 per cent of the total number of households. Medium loss is seen in Mousuni Island of Namkhana Block, Jharkhali Island of Basanti Block, Satjelia Island of Gosaba Block and G Plot Island of Patharpratima Block, accounting 17 per cent, 17 per cent, 22 per cent and 26 per cent of the total households respectively.

It is evident from the field survey that 69 per cent of the households have lost more than 0.10 acre of land and 8 per cent households have lost less than <0.05 acre of land in Maipith-Baikunthapur Island as a result of embankment breaching It is also observed that Ghoramara and Mousuni have lost 42% and 41% of inhabited land which accounts >0.10 acre respectively.

Table: Households facing Loss of Settlement Area by Embankment Breaching, Last 10 Years

Name of Blocks	Name of Islands	Households facing Loss of Settlement Area (Per cent)	
		Yes	No
Sagar	Ghoramara	33	77
Namkhana	Mousuni	17	83
Patharpratima	G Plot	26	74
Kultali	Maipith- Baikunthapur	13	87
Basanti	Jharkhali	17	83
Gosaba	Satjelia	22	78

Source: Field Survey, 2017

Table: Loss in Settlement Area due to Embankment Breaching, Last 10 Years				
Name of Blocks	Name of Islands	Loss in Settlement Area (Per cent)		
		< 0.05 acre	*0.05-0.10 acre*	>0.10 acre
Sagar	Ghoramara	24	33	42
Namkhana	Mousuni	6	53	41
Patharpratima	G Plot	23	50	27
Kultali	Maipith- Baikunthapur	8	23	69
Basanti	Jharkhali	18	47	35
Gosaba	Satjelia	18	50	32
Source: Field Survey, 2017				

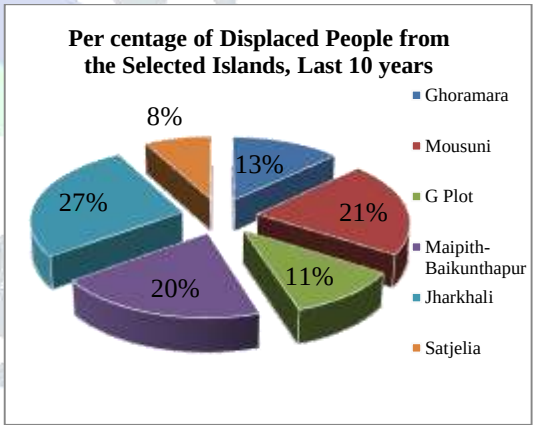
It is also evident that Ghoramara Island, G Plot Island, Satjelia Island and Jharkhali Island have experienced 24%, 23%, 18% and 18% of land loss, accounting less than 0.05 acre respectively. Medium loss of land (0.05-0.10 acre) is seen in Mousuni Island, G Plot Island, Satjelia Island and Jharkhali Island which accounts for 50 per cent.

Increase in Environmental Refugees

Throughout the world the problems of environmental refugees are one of the most burning issues at this time. Environmental refugees are those people who could no longer gain a secure livelihood in their homelands because of drought, soil erosion, desertification, deforestation and other environmental problems, together with the associated problems of population pressures and poverty (Myers, 2002: 609-613). It is evident that when there is breaching of embankments the resultant phenomena is the displacement of some people as their homes have been destructed. The people have to leave their place of origin and have to take shelter in camps made by different govt. and no-govt. agencies after the breaching.

It has been observed from the diagram that Jharkhali Island ranks first (27%) and Satjelia Island (8%) ranks last in terms of displacement of people owing to embankment breaching. Mousuni Island and Maipith-Baikunthapur Island ranks next to Jharkhali Island as they account for 21 per cent and 20 per cent of displaced people respectively in last 10 year.

Table: Percentage of Displaced People, Last 10 years		
Name of Blocks	Name of Islands	Per cent Number of Displaced People, Last 10 Years
Sagar	Ghoramara	13
Namkhana	Mousuni	21
Patharpratima	G Plot	11
Kultali	Maipith- Baikunthapur	20
Basanti	Jharkhali	27
Gosaba	Satjelia	8
Source: Field Survey, 2017		



Vulnerability to Women

Women in the Sundarbans commonly experience many disadvantages with embankment breaching. They have to work harder for a livelihood but have less control over income and assets. At least 50 per cent of the women here are anaemic due to pregnancy, lactation and inequitable food distribution within families. About 58 percent girl children are underweight and 18 per cent malnourished. There has been a sharp rise in the number of women marginal labourers, from 6-10 per cent, between 1991 and 2001 and 12-22 percent after *Aila*. During flooding of embankment breached situation forced women to work harder to secure food, water and energy for their homes. Girls are more likely than boys to drop out of school to help their mothers with these tasks and because of early marriages (Ghosh, 2012: 87-94). According to Geeta Jana, a residents of Mousuni Island have stated that, " after embankment breaching in 2011 she had lost her home, but she hadn't gone to rehabilitation centre with her three daughters being stay on trees for 15 days, for privacy concern and also for political discrimination."

SUGGESTIVE MEASURES

Some suggestions have been stated to formulate vulnerability mitigation strategies and to ensure a balanced nature-culture ecosystem in the deltaic South 24 Parganas District to mitigate the impact of embankment breaching. An attempt of multidisciplinary approach in such formulation has been made below on the basis of the discussion with experts from diverse fields and knowledge of the local people who are the real stakeholders of the results of the embankment breaching.

Measures for Protection of Embankments

The embankments to be constructed reconstructed and maintained needs to meet two criteria: "they need to be high enough to prevent overflow and they need to be strong enough to prevent bursts and other forms of damage" quoted from Shri Tushar Kanjilal (2006), the veteran social worker and former member of the Sundarban Development Board. The criteria which have definite effect upon the maintenance and management of the embankments incorporate the following suggestive measures.

- The embankments must be constructed with proper building materials which are adjusted to the local hydrologic regime. They must be strong, solid, all weather proof and most importantly long lasting.
- The embankment must be built on a stable surface. If the embankment that is constructed is strong made of solid materials but the base is weak then there is every probability of failure of the foundation. Thus a stable base is essential for long lasting embankments. The solid base can be assured only when the impediment is constructed at a safe distance from the edge of the river especially if the river banks are not stable and show carvings and slides.
- Clay, silty clay, matured loamy soil has greater cohesiveness than mud. So for embankment construction this type of soil texture will strengthen the structure of embankments.
- The Irrigation Department makes brick pitching to protect the outer slope of the embankments. Brick pitching is expensive enough; low cost earth filling can be followed because it is available resource for repairing the embankments long enough. Earthen embankments needs minimum allotment even for reconstruction the embankments rather than repair works. Brick pitching stripes become unstable and dislocated with the wave currents.
- There is large discrepancy between the design made on the papers during planning and its implementation on real ground. The authority should follow a proper guideline for embankment construction and repair works. The authority itself is sure about its quality and durability.
- The gradient of the landside slope of the embankments towards the basin needs to be less than 2:1 as is advised by construction engineers, the steep walls needs to be avoided because it makes the top overloaded. The soils of the embankments promote natural growth of grasses that helps the soil at hold and the presence of the grass and its roots reduces the salinity of the soil on the slopes of the embankment. Gradually the grass cover of the slope becomes grazing grounds for domestic animals and the hoofs of the animals act as efficient compactors that improve the strength of the embankment as a whole.
- People living near the embankments excavate pond to conserve water for irrigation and other purposes. Reconstruction of embankment becomes necessary whenever embankment breaching takes place and those excavated areas remain closer to the embankments. The ditches and large holes made by local people needs to be filled up by earth filling so that the crest level remains higher than the high water level.
- Protection of embankment requires control of river bank erosion by scientific manner, for which use of local materials are necessary. River bank erosion can be managed by planting mangrove saplings and setting sand bags along the shore.

Measures for Sustenance of Economy

The protection and management of the embankments is conditional to the protection and management of the means of production from land and water. The policies therefore need to be protective to the embankments and natural resources to protect the marginal communities dependent upon the development and management of resources. With this view, the following management can be suggested to secure the economy with an objective to secure the life and livelihood of people of the study area.

- Effective land utilization needs to be done even in the situation when land is under water. Agricultural lands must be protected by embankments, for which the protection of the embankment itself is more necessary. It will help the agricultural land from salt water intrusion during flooding. There is also an opportunity of pisciculture along with paddy compound by this land embankment that reduces in seasonal migration.
- Rain water harvesting should be done so that irrigation water can be supplied for farming. The stored water can also be used for fish culture. Excavation of canal, digging of pond is required for rain water harvesting. This will reduce migration of people into cities.
- Proper construction and operation of sliding gates can prevent inflow of saline water in the interior part of the shallow basin. The flap gate prevents inflow of water when the sliding gate is not closed on time or is left open. The sliding gate should be in a closed position except at months when excess water needs to be drained out.
- Better transport and communication system must be provided so that the people can be evacuated easily whenever they will encounter any natural hazard or flood situation. Increasing number of jetties, up gradation of jetties would facilitate the protection of river banks with preventing erosion in a number of locations.
- Number of flood shelters and cyclone shelters in the surveyed islands must be increased. It is found that shelters are not adequate. People move to schools during flood situation. The schools remain closed during the monsoon season for at least 3 to 4 months. Poor quality food is provided in the shelters and the quantity is also very low.
- Domestic animals are sometimes washed away during heavy flood. Their life is also threatened by natural hazards thus along with human shelters, shelters for domestic animals must be constructed in a comparatively high level of land.
- Plantation of salt resistant crops and plants must be given priority. The examples of salt resistant crops are few species of rice like patnai, balam, valki and nonasal.
- Small scale industries such as bori (cake of pulses paste) making, clay doll making, boutique printing, making of nature based handicrafts preparation must be encouraged in the study area. Govt. must provide loan at a subsidized rate to the rural folk for reducing the pressure on economy.
- Workshops, seminars and other activities can be arranged by Govt. and non Govt. agencies to increase public awareness and community knowledge regarding sustainable livelihood options with an objective of sustenance of economy.
- An integrated approach to planning and management of the Sundarbans mangroves and its cultural landscapes within the large scale of integrated coastal area management programme must be implemented.

Re-stabilization of ecological balance

The study area being a part of the Sundarbans can logically be considered as habitats for various kinds of animals, fishes and plants found along the entire east coast of the country. It is important that the biodiversity of this ecosystem needs to be conserved and its resources be managed efficiently, that will not push the people further into 'ecological poverty' (Agarwal, 2000: 18).

The stress on the mangrove forest resources is increasing due to strong antagonism among the stakeholders and the communities utilising the ecosystem resources. Their socio-economic and cultural values and significance needs to be preserved. In such a crucial situation some analytical on the basis of some findings it may be suggested that a holistic approach to mangrove resource management will be much more suitable than other approaches (Salomons et al. 1999: 21-36). The task of an integrated management approach is to work together. The core objectives of the mangrove ecosystem management is the production of a socially and ecologically desirable resource utilisation and services that will balance mangrove wetlands ecosystem in the coastal area (Islam, 2008: 45-63).

CONCLUSIONS

Summarizing all the discussion, it may be concluded that breaching of the embankments of the area under review have affected the ecology and economy of the people in general and the marginal communities in particular, but the impact are differential in extent and magnitude. The people living close to the tidal

rivers and embankments and reliant more upon the production systems based upon the stable estuarine ecosystem for sustenance are more affected by direct and indirect negative impact of embankment breaching and they need environmental and social justice. The question of differential sufferings needs agreeable, rather, community specific solutions which they may achieve through the plans which embrace their actual needs. Being predominantly an agricultural area with equal importance on pisciculture, people from both professions living in and outside the areas affected, need suitable plan and management to achieve a balanced development of the area. Active participation in the development program by the local people from every stratum of the society is required.

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REFERENCES

1. Aerts, J. C. J. H., & Heinen, M. (2009). Adaptation cost in the Netherlands: Climate Change and flood risk management. *Climate research Netherlands-Research Highlights*, 34-36.
2. Bandyopadahyay, D. (2000). Can Sundarbans be saved?. *Economic and political Weekly*, 3925-3928.
3. Bandyopadhyay, S. (1997). Natural environmental hazards and their management: a case study of Sagar Island, India. *Singapore Journal of Tropical Geography*, *18*(1), 20-45.
4. Banerjee, A. (1998). *Environment, Population and human settlements of Sundarban Delta.* Concept Publishing Company.
5. Beverly, H. (1873), *Report of the Census of Bengal, 1872*, Superintending Govt. Press, Alipore, Calcutta.
6. Bhattacharya, A.K. (1999). *Embankments as large-scale constructions in the Indian Sundarbans and their impacts on the Coastal Ecosystems*. In D.N. Guha Bakshi, P. Sanyal, and K.R. Naskar (Eds.) Sundarbans Mangal, Calcutta, Naya Prokash.
7. Danda, A. A. (2007). Surviving in the Sudarbans: Threats and Responses-An Analytical description of the life in an Indian Riparian Commons.
8. Danda, A. A. (2010). Sudarbans: Future imperfect climate adaptation report.*WWF India*, 1-36
9. Dash, M. C. (1993) Fundamentals of Ecology Tata McGraw Hill. *New Delhi-373pp.*
10. De, B. (Ed.). (1994). *West Bengal District Gazetteers: 24-Parganas.* KR Biswas, State Editor, West Bengal District Gazetteers, Education Department, Government of West Bengal.
11. Dey, S.L. (1997), *Socio Economic Change in West Bengal: A study of the Sundarban Region*, Shipra Publications, New Delhi.
12. Dhara, S., and AK, D. P. (2016), *Embankment Breaching and Its Impact on Local Community in Indian Sundarban, A Case Study of Some Blocks of South West Sundarban*, International Journal of Innovative Science, Engineering & Technology, 3(2).
13. Dube, S.K. (2006), *Report on Hazard Assessment and Disaster Mitigation for West Bengal due to Tropical Cyclones*, Indian Institute of Technology, Kharagpur
14. Fell, R., Wan, C. F., Cyganiewicz, J., & Foster, M. (2003). Time for development of internal erosion and piping in embankment dams. *Journal of geotechnical and geoenvironmental engineering*, *129*(4), 307-314.
15. Ghosh, A. (2004), *The Hungry Tide*, Harper Coilins, United Kingdom.
16. Ghosh, A. (2012). Living with changing climate-impact, vulnerability and adaptation challenges in the Indian Sundarbans. *Centre for Science and Environment, New Delhi.*
17. Govt. of West Bengal. (2002). *A Revenue History of the Sundarbans: From 1870 to 1920*, West Bengal District Gazetteer, Higher Education Department, Kolkata.

18. Hazra, S., Ghosh. T., DasGupta, R., & Sen, G. (2002). Seal Level and Associated changes in the Sundarbans. *Science and Culture*, 68(9/12), 309-321.
19. Hossain, B. M., Sarkai, T., & Hossain, Z. M. (2010, September). River embankment and bank failure in Bangladesh: a study on geotechnical characteristics and stability analysis. In *Proceedings of International Conference on Environmental Aspects of Bangaledsh (ICEAB10)* (PP. 171-174).
20. Hunter, W. W. (1897). *Annals of rural Bengal*. Johnson Reprint Corporation.
21. Intergovernmental Panel for Climate Change. (2007), *Sea Level Rise due to Climate Change and its Impact upon Coastal Belt.*
22. Islam, M. S. (2011). *Biodiversity and Livelihoods: A case Study in Sundarbans Reserve Forest. World Heritage and Ramsar Site (Bangladesh),* A thesis submitted of the requirements for the degree of Master of Science (M. Sc.) in Management of Protected Areas at the University of Klagenfurt.
23. Jana, D. (2008), *Srikhanda Sundarban* (in Bengali), Deep Prakashan, Kolkata.
24. Kanjilal, T. (1999a), *Ban Kete Basat* (Deforestation for Settlement). In Pathe Prantare (in Bengali), Calcutta.
25. Kanjilal, T. (2005), *Sunderbans: Its Embankments and Related Issues*, Commemorative Volume on Embankments of Sundarbans and related issues, Published by the Organising Committee for Workshop-cum-Seminar on Sundarbans held on July 21, 2005, Kolkata.
26. Mandal, A. K. (2003), *The Sundarbans of India: A development Analysis,* Indus Publishing Co., New Delhi.
27. Miah, M. G., Bari, M. N., & Rahman, M. A. (2011). Agricultural activities and their impacts on the ecology and biodiversity of the Sundarbans area of Bangladesh. *Journal of the National Science Foundation of Sri Lanka*, 31(1-2).
28. Mitra, A. (1954). *The share of wages in National Income*. Institute of soc. Studies.
29. Moitra, D. (2005), *Causes in Embankment Failure in Sunderbans*- A case Study, in a commemorative volume, An Anthology of Articles published on the Occasion of Workshop cum Seminar on Sunderbans, Organisation Committee, Kolkata.
30. Mukhopadhyay, A. (2009). *Cyclone Aila And the Sundarbans: an enquirey into the disaster and politics of aid and relief* (pp. 18-20). Kolkata: Mahanirban Calcutta Research Group.
31. Mukhopadhyay, S.K. (2007), June). The Hooghly estuarine system, NE coast of Bay of Bengal, India. In *Workshop on Indian Estuaries, NIO, Goa, India.*
32. Myers, N. (2002). Environmental refugees: a growing phenomenon of the 21st century. *Philosophical Transactions of the Royal Society B: Biological Sciences, 357*(1420), 609-613.
33. Odum, H.T., & Odum, E.P. (1959). Principles and concepts pertaining to energy in ecological systems. *Fundamentals of ecology. HT Odum EP Odum (editors). WB Saunders Co., Philadelphia, Penn.*
34. O'Malley, L. S. S. (1914). *Bengal District Gazetteers:* 24-Parganas. Concept Publishing Company.
35. Ray, R., Chakraborty, I., & Bhattacharya, N. (2002). A study Among Some "Meendharas" of Sunderbans, West Bengal. *The Anthropologist*, 4(2), 83-89.
36. Roy, A. (2010). Vulnerability of the Sundarbans ecosystem. *Journal of Coastal Environment. 1(2),* 169-181.
37. Rudra, K. (2011), *The Proposal of Strengthening Embankment in Sundarban: Myth and Reality*, mcrg.ac.in
38. Salomons, W., Turner, K., de Lacerda, L. D., and Ramachandran, S. (Eds.). (2012), *Perspectives on Integrated Coastal Zone Management*, Springer Science and Business Media.
39. Sarkhel, P. (2012), *Examining Private Participation in Embankment Maintenance in the Indian Sundarbans*, South Asian Network for Development and Environmental Economics, Nepal, Kathmandu.
40. Sharmila, C. (2014), *Island Subsidence in the Sundarbans- A Myth or A Reality?,* Lap Lambert Academic Publishing, Germany.
41. The Intergovernmental Panel on Climate Change. (2007), *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Cambridge University Press, London.