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CONVERSION OF MANGROVE FOREST TO SALINE DESERT: A CASE STUDY OF CHAKARIA SUNDARBAN AREA

Shafiul Alam*

Abstract: The coastal areas of Bangladesh cover more than 32% of the total landmass facing a critical problem due to several factors such as the environmental pollution, shrimp and salt farming, demolishing natural resources, deforestation and unplanned land use. Most land use changes occur without a clear and logical planning with any attention to their environmental impacts. The main aim of the present study is to evaluate the applicability of remotely sensed data as a tool for land use mapping and environmental change monitoring of Chakoria Sundarban area. The natural and socio-cultural environment of Chakoria has significantly been altered during the last two decades. The Chakoria Sundarban area at the mouth of Matamuhuri river has now been totally destroyed by shrimp culture and salt farming. The World Bank and The Asian Development Bank played a vital role for the destruction of the mangrove forest. They completed aquaculture project in Chakoria Sundarban region by destroying mangrove forest. Due to rapid land use change the environment of the study area has changed.

Key words: Environmental change, Land use change, mangrove forest, shrimp farming, Chakaria Sundarban, Bangladesh.

Introduction

Trees were once the main cover over most of the land surface in all over the coastal areas of Bangladesh. Now a days, very little of the original forest remains except from Sundarban mangrove forest. More than 30-50 percent of the total production of forest comes from this tidal forest. With the rapid expansion of commercial shrimp culture, the land use pattern of the southeastern region of Bangladesh is gradually changing from cropland agriculture to shrimp farms and from forestland to shrimp farms. (Karim, 2000).

Once upon a time Chakaria Sundarban was covering 21,000 acres originally (Gain, 1999). But at present this mangrove forest has been totally destroyed

by shrimp culture and salt farming. This forest has totally been destroyed during the last two decades. Some patches and bushes about 450 acres are left today. Government, Asian development Bank and World Bank are mainly played vital role for destroying the mangrove forest (Gain 1999). The destruction of mangroves and the rapid expansion of shrimp farms and salt beds have generated environmental problems.

At one time, when the Chakoria Sundarban was dense and live with tigers, deer, wild cats, wild boars, foxes, monkeys and reptiles, the life of the brave people living close to it was full of joy and challenges. But now in the deserted Chakoria Sundarban animals or birds are rarely seen.

The overall aim of this study is to monitoring micro-scale environmental change due to the rapid change in land use practices. Some specific objectives are:

1. To identify land use change pattern by using satellite image.
2. To identify the environmental change during last 27 years.
3. To study the role of institutional factors for environmental change in Chakoria Sundarban area.

Study Area

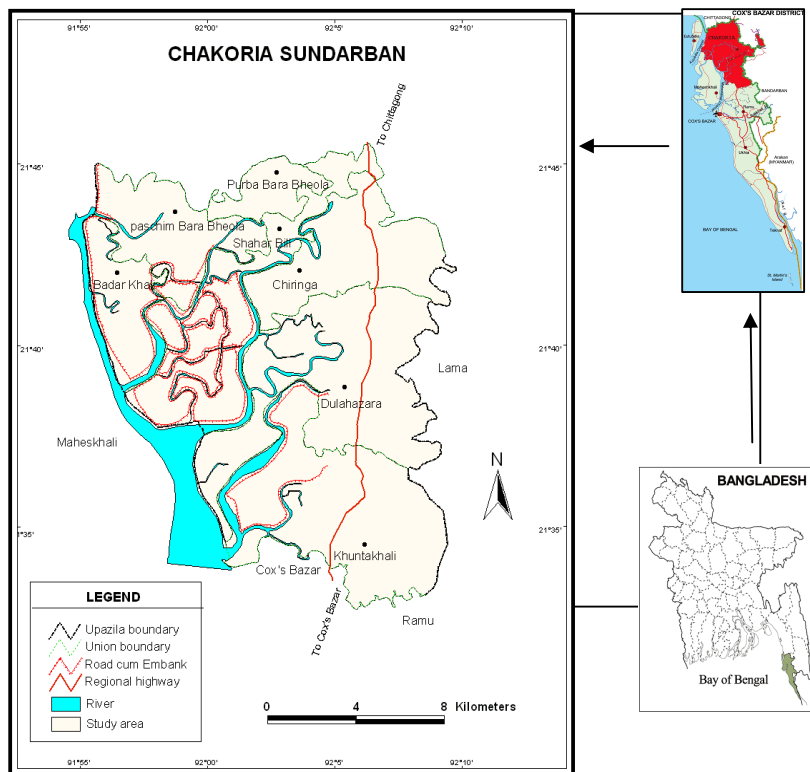
Land use of any place, particularly in coastal areas, is conditioned by a variety of natural and socioeconomic factors, such as soil, topography and geomorphology, hydrodynamics and fluvial conditions, climatic factor and bio-diversity. For any sustainable coastal development planning and management, physical environmental conditions, demographic, socioeconomic and cultural context are to be considered. (Islam, 2001) However, hardly any systematic effort has yet been made at Chakoria coastal belt to investigate micro-scale environmental change due to the rapid change in land use practices. The Chakoria Sundarban is preferred as the study area because of its environmental features which are changing rapidly

The Chakoria Sundarban areas located in Chakoria upazilla Cox's Bazar District, Bangladesh. The area is the most extended plain landmass located between 21°35'N to 21°48'N latitude and 91°57'E to 92°05'E latitude. Chakoria is bordered by the Matamuhuri-Harbang khals is the north, the confluence made Khal at the south, the Cox's Bazar-Chittagong highway in the east and the Maheshkhali Channels in the west.

The climate and rainfall distribution of the area is of tropical nature dominated by the southwest monsoon of the Indian Ocean.

* Department of Geography and Environmental Studies, University of Rajshahi, Bangladesh.

Map 1: Study Area



Source: LGED, 1994

Data and Method

The research is designed to investigate the extent of physical and environmental changes related to or caused by the shrimp cultivation and salt farming over time. With a view to achieving and fulfilling the objectives, Data was collected from both the primary and the secondary sources. Land use survey was also conducted to collect relevant primary data from the study area.

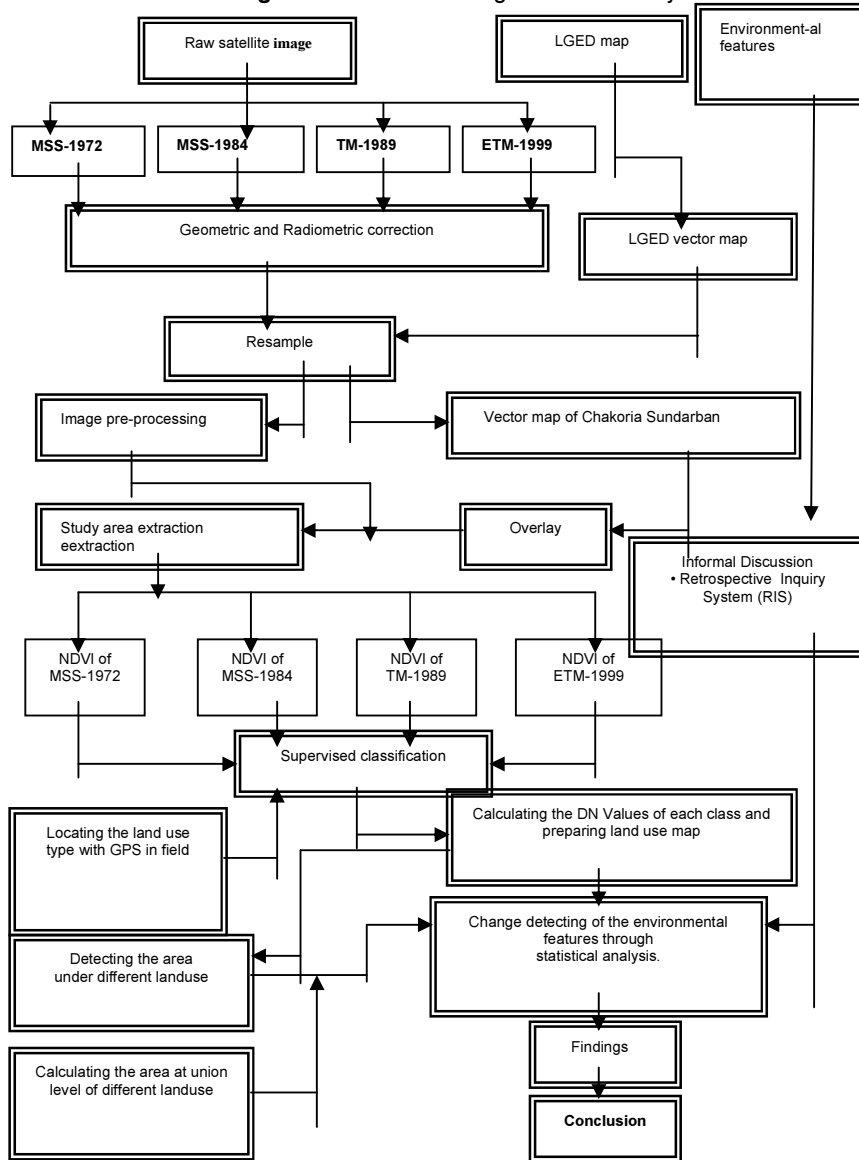
Secondary information was collected from different sources such as: i) Bangladesh Bureau of Statistics (BBS), ii) published and unpublished reports and documents of relevant government and non-government organizations, iii) reports/ maps from Soil Resource Development Institute, Department of

Geography and Environmental Studies of Rajshahi University, Society for Environment and Human Development (SEHD).

Satellite images are considered to be the most common data source for extracting land use and land cover of an area. In this research, landsat image of different years (1972, 1984, 1989, 1999) have been used for land use mapping and change detection.

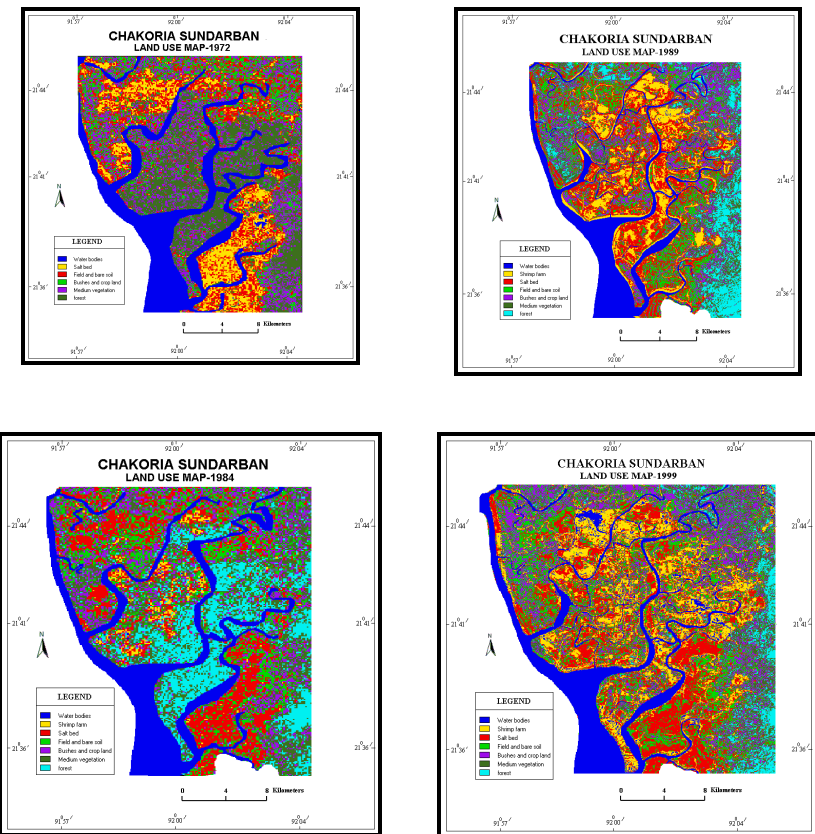
Normalized difference vegetation Index (NDVI) and False Color Composite (FCC) images have been used to categorize the vegetation and identify land use pattern. Based on the variations in reflectance patterns found in the FCC images 22 train areas have been selected. Later the terrain areas have been located using GPS and land use patterns have been detected. Finally supervised classification is used to identify the land use pattern. NDVI images are used to identify vegetation category because before 1980 the main land use type in this study area was mangrove forest. Normalized difference vegetation Index is suitable for vegetation identification but not suitable for general land use classification. So, False Color Composite (FCC) is used to identify general land use pattern like shrimp farm, salt bed, bare soil. Using the DN value range from the curve different forest and land use type in the image has been detected.

To compare the land use types and environmental changes between 1972 and 1999, perceptions of local farmers of the study area have also been considered. This attempt of Retrospective Inquiry System (R.I.S.) was processed depending on the local people's memory reflections. Informal discussions have been made with key informant, such as local teachers, service holders, NGO personnel, Gher owners, and Gher-laborers. Discussions on changing socioeconomic scenario were also carried out with different persons in the local power structure including traditional and modern power elite like *Mat bars* (village heads), Chairman/members of Union Parishad (lowest tier of local government), school teachers etc. Questions on the changing pattern of livelihoods were asked to local youths, boatmen, women, day labour, petty traders, the artisans, the lathials (musclemen) etc.

Figure 1: Schematic diagram of the study**Results and Discussion****Land Use Pattern**

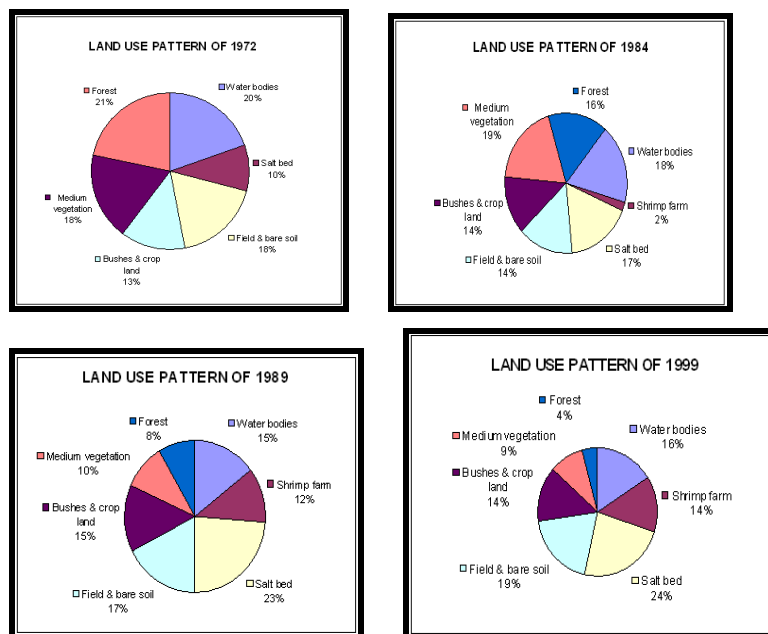
Ground truthing, Calculating DN value from NDVI images and Considering the nature and diversity of land uses, seven major land use categories are identified in the study area, which are:

1. Water bodies, 2. Shrimp farms, 3. Salt beds, 4. Field and Bare soil,
5. Bushes and cropland, 6. Medium vegetation, 7. Forest

Figure 2: Land use Map

Source: Landsat MSS-1972, TM-1984, MSS-1989, ETM-1999

Figure 3: Land use patter from 1972 to 1999



Source: Landsat MSS-1972, TM-1984, MSS-1989, ETM-1999

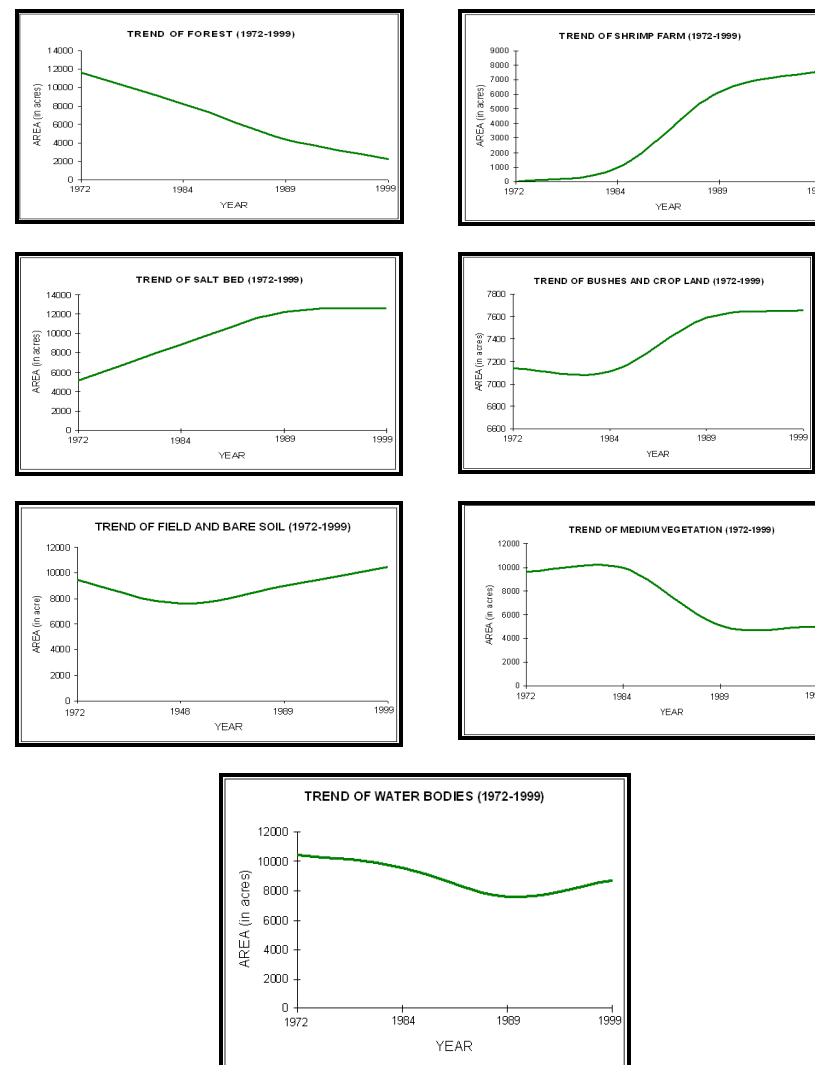
In 1972, forest cover area was 11572.77 acres in the study area. This land use covered 21% area of the total land use. Mangrove forest was the major land use type of the study area. In 1984, Forest cover area was 8242.89 acres. This land use covered 20% area of the total land use. In 1989, forest cover area was 4396.67 acres. This land use type covered 8 % area of the total land use. In 1999, Forest cover area was 2267.86 acres which covered only 4 % area of the total land use. Here afforested trees were included.

Land Use Change Pattern during 27 Years

Consider both the physical and cultural factors affecting the land use changes in the study area. During the 27 years observed periods the major land use changes are as follow:

1. Changes from mangrove forest to shrimp farm
2. Changes from mangrove forest to salt bed
3. Changes from salt bed to shrimp farm (in rainy season)
4. Changes from shrimp farm to salt bed (in winter season)

Figure 4: Change pattern of Land use



Source: Landsat MSS-1972, TM-1984, MSS-1989, ETM-1999

Results from image interpretation and field observation show that in the study area the dimensions of change of different land use types are not same. Here changes have quantified and represented graphically (Figure 4).

In 1972 Chakoria Sundarban was covered with deep mangrove forest. That time major land use pattern was mangrove forest. Day by day it decreased. The main causes of loss mangrove are shrimp culture and salt production. In 1972 total mangrove forest was 11572.79 acres. In 1984 it decreased to 8242.90 acres while in 1989, it was reduced to 4396.67 acres. By 1999, only 2267.87 acres or nearly 4 % of the total land area remained under mangrove forest. During a ground truth in February 2004, only a small area of mangrove forest was found in Chakoria Sundarban, estimated about 200 to 300 hectares.

Shrimp farming mainly starts in this area in 1975 (Gain, 1999). For this reason this type land use was not found in 1972. In 1984, shrimp farm cover area was only 970.79 acres. In 1989 it increased to 6174.33 acres. That time shrimp farm was expanding rapidly. The main cause of rapid expanding shrimp farming area was foreign donations. The main donor was World Bank and Asian development bank. In 1999, shrimp farm cover area dramatically expanded to 7619.53 acres. It is mentionable here that, these shrimp farms cover areas are convert to salt bed area in winter season. In rainy season shrimp farms are increased and in winter season it decreased.

In 1972, salt bed cover area was 5115.42 acres. Where as, in 1984, 1989 and 1999 this type of area was increased and area covered by the same land use type was 8827.03, 12230.94 and 12595.78 acres respectively.

Union wise land use change pattern

To monitor environmental degradation exactly, micro level land use pattern change should be observed. In this study area there are seven unions. These are Badar Khaliu, Chiringa, Dulahazra, Khutakhali, Paschim Boro Behola, Purbo Boro Behola and Sahar Bill. All of the unions have six major types land use pattern. Union wise land use change pattern during 27 years have been presented in **table 1**.

Shrimp Culture in Rotation with Salt

Shrimp culture is relatively new introduction in Chittagong district. At present, it is located around Cox's Bazar area, from Bashkhali South to Teknaf, Moheskhal island and in Chakaria Sundarban area. Most of the shrimp culture is taking place on salt drying bed during the monsoon season when salt production is not possible. Salt production was once widely practiced in the Coastal Region but now is mostly in the central area of Chittagong District.

For salt cultivation pond is erected in tidally inundated land with small embankment and the salt water is introduced in the pond during dry season where it is evaporated by sunshine and the crude salt is produced. Some polders in the tidal lands are at present also being used for salt production. For shrimp culture pond is inundated to hold the water to a depth of 3 to 4 ft. Before the construction of Coastal embankment in the region the individual land holders constructed rudimentary embankment to protect their agricultural land from saline water. At that time salt culture was practiced outside this embankment and the area was limited. Due to lack of proper maintenance of the embankment the saline water inundated the agricultural land. Subsequently the low elevated agricultural land with the dilapidated embankment was utilized for salt production. After the construction of coastal embankment, the salt producers living inside the embankment continued to do the business as before by taking seawater through the sluice or cutting the W.D.B. embankment. About 13000 hectares are at present used for salt production.

Table 1: Union Wise Land Use Change

Union Name	Badar Khali		Chiringa		Dulahazra		Khuta Khali		Paschim Boro Behola		Purbo Boro Behola		Sahar Bill	
Landuse category	Changes from 1972 to 1999 (acres)	Change in %	Changes from 1972 to 1999 (acres)	Change in %	Changes from 1972 to 1999 (acres)	Change in %	Changes from 1972 to 1999 (acres)	Change in %	Changes from 1972 to 1999 (acres)	Change in %	Changes from 1972 to 1999 (acres)	Change in %	Changes from 1972 to 1999 (acres)	Change in %
Water bodies	82.30	(-3.23)	58.33	(+2.92)	550.65	(-34.78)	253.64	(-310.69)	148.95	(+1.49)	0	0	128.54	(-31.92)
Shrimp farm	377.53	(+14.82)	622.90	(+31.22)	1385.72	(+18.82)	741.38	(+320.00)	1212.25	(+309.68)	8.21	(+3.65)	2197.32	(+37.48)
Salt bed	508.19	(+19.63)	567.03	(+18.42)	2283.82	(+18.82)	1334.24	(+36.17)	89.87	(+1.97)	11.81	(+5.25)	3861.43	(+24.35)
Field and bare soil	276.35	(+10.85)	51.59	(+2.59)	1482.46	(+12.86)	351.38	(+5.53)	664.02	(-21.74)	76.81	(-34.15)	1008.34	(+18.02)
Banks and crop land	119.06	(+14.67)	241.34	(+12.09)	811.56	(+7.84)	134.90	(+3.66)	154.90	(-5.97)	70.40	(-31.3)	333.51	(-2.65)
Medium vegetation	869.81	(-24.13)	141.19	(+10.71)	499.56	(-34.24)	186.35	(-5.05)	501.89	(-16.43)	38.43	(-17.09)	2162.12	(-17.2)
Forest	322.86	(-32.67)	429.65	(-22.04)	3509.92	20.46	686.65	(-24.71)	281.01	(-9.2)	19.26	(+18.56)	2681.76	(-29.28)

Environmental Degradation

Both salt and shrimp farms are threat to coastal bio-diversity. The problem occurs from two sources: first, expansion of shrimp farms and second, their operation. Mangroves are the breeding ground for a wide variety of fishes, shellfishes, mollusks, phytoplankton, sea turtles, dolphins, lizards, sea grass and other marine lives. The expansion of shrimp farms means the destruction of this natural habitat and gradual loss of bio-diversity.

Depletion of mangrove forest together with the natural reserve forest on highlands have also lead to the extinction of wild lives, such as a variety of birds, deer, monkey and a wide range of other wildlife species from the region.

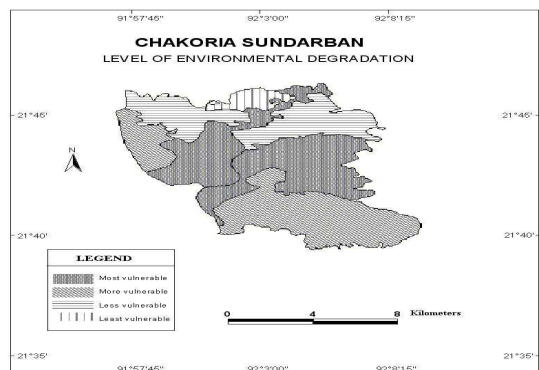
The spectacular growths of shrimp farming over the past 10 to 15 years have significantly changed indigenous social life. Competition between the

traditional farmers, fishermen and commercial shrimp producers has developed a new socio-cultural relationship and have thus resulted many interest groups. At Chakoria, traditionally people collected their fuels from the forest and they are now facing tremendous crisis of wood for fuel. Local fishermen traditionally fishing from the nature have lost their jobs and many of them have either become day labourer or forced to migrate elsewhere or further to seaward, and many to offshore islands. However, a new young group has been evolved who collects shrimp fry from the wild to supply to shrimp farms. Traditional peasant families have also been affected and many farmers have changed occupation to salt production, labour or small business. Shrimp farming did not bring any good to local poor people. Only the rich people who are mainly outsiders and living in cities have the capacity to invest money are getting benefit out of shrimp cultivation. (Khan, 1996)

It is not benefiting either economically in earning foreign currency or ecologically. Shrimp yield per hectare in Bangladesh is far behind than other exporting nations. (Mahmood and Saikat, 1995).

Chakoria shrimp-farming technique is traditional. Between 1992 and 1997, attempts were made to apply semi-intensive and intensive techniques, but due to high production cost and the rate of fish mortality for spread of disease, it has been proved to be nonfeasible. The Acid sulfate soil at Chakoria is not suitable for intensive shrimp farming, with little scope to increase production in future. Acid sulfate soil is a great problem in shrimp farming in Bangladesh coastal belt, particularly at Chakoria (Mahmood and Saikat, 1995). Due to deforestation the most environmentally degraded union of the Chakoria Sundarban area is Sahar bill.

Map 2: Union wise environmental degradation



Source: LGED Map, 1994 and field survey 2005

Institutional factors for deforestation

Asian Development Bank and World Bank has played vital role for deforestation in Chakaria Sundarban. (Gain, 1999) The cutting of mangroves had thus begun with human settlement. However, the rush to cut the forest in the late Seventies and early eighties was unprecedented when Asian Development Bank (ADB) and the World Bank came forward with investment to promote shrimp farming. Both banks have encouraged shrimp farming for export. With the financial assistance guaranteed to promote shrimp farming by the ADB and the World Bank, Bangladesh government decided in 1985 to hand over all forest land suitable for shrimp farming to the Ministry of Land (Gain, 1999). With this government decision, all arrangements for destruction of the centuries old mangrove forest were completed. The ADB funded project was completed in 1986. The shrimp culture project of World Bank was completed in 1993. But, shrimp farming has already been fully destroyed a natural mangrove forest.

Conclusion

By using Geoinformation technique the land use pattern, deforestation and environmental change can be easily identified. Remote Sensing technique is the most effective way to monitor the gradual environmental changes of different years.

Now a days, Chakoria Sundarban has been completely destroyed and replaced by shrimp farms and salt beds. The area looks like a saline desert. Day by day, its environment is decreasing dramatically. The main causes of the loss of mangroves, shrimp culture and salt farming. At present, the ecosystem of the Chakoria Sundarban has been fully destroyed. Some major donor agencies like World Bank, Asian Development Bank are mainly responsible for this destruction. The salinity of the soil is increasing rapidly due to shrimp farming and clear-cut deforestation. The effect of this deforestation is the shortage of firewood, animal food of local people and robbery. In this area, land use is changed seasonally. In dry season, shrimp ponds convert to salt bed, like this in winter, salt beds convert to shrimp farms. Due to deforestation, physically and socially most vulnerable union is sahar bill and at present total Chakoria Sundarban area looks like a saline desert.

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