Khulna University Studies **Special Issue (SESB 2010): 57-72: June, 2010**

RESEARCH ARTICLE

LAND USE PATTERN AND SOCIO-ECONOMIC CONDITION OF THE *SUNDARBANS* ADJACENT COASTAL AREAS OF BANGLADESH

Md. Firoz Ahmed[1*], Anowara Khanam[1], Dr. Mohammed Ziaul Haider[1]
Mohammad Sayadur Rahaman[2]

[1] Economics Discipline, Khulna University, Khulna, Bangladesh.
[2] Chemistry Discipline, Khulna University, Khulna, Bangladesh.

Abstract: This study addresses the changes in land use pattern and corresponding socio-economic conditions of the people living in the *Sundarbans* adjacent coastal areas of the south-west Bangladesh. *Shayamnagor* of Satkhira, *Dacope* of Khulna, and *Sarankhola* of Bagerhat districts are considered as the representative areas of the three parts namely west, north and east *Sundarbans* on the basis of the geographical location. The land use maps of 1996 and 2004 are analyzed to observe the changes in land use pattern in the study area. The analysis finds changes in land use pattern in the study area over the time period. Salinity intrusion, unusual rainfall and other climate factors contribute to change land use pattern. The people in the coastal areas are linked with these climate factors for their livelihood. Illiteracy, income discrimination, health hazard, educational hazard, and employment status are the socio-economic indicators used in this study. There is a downtrend in the employment status form 1980's to the current period. The employment rates were 70%, 56.8% and 44.5% in *Dacope*, *Sarankhola* and *Shayamnagor* respectively in 1986, which has decreased to 52.7%, 50.8% and 42.9% in 2003 respectively. Decrease in agricultural production, destruction of the *Sundarbans* and migration are the negative consequences of changes in land use pattern. The Focused Group Discussion (FGD) responders of the study area claim that they are now worst sufferer due to the proximity to the coastal areas and the changes in climate compelling them to diversify their land use and cropping pattern for maximizing their short run personal benefits.

Key words: The *Sundarbans*, Salinity, Land use, Cropping pattern, Socio-economic conditions

Introduction

Bangladesh is one of the most vulnerable countries to climate change. The changes have affected coastal ecosystem and mangroves including the *Sundarbans*. The *Sundarbans* is the largest tidal mangrove forest in the world. This mangrove forest covers Khulna, Bagerhat, Satkhira, Patuakhali and Borguna districts. The coastal zone adjacent to the Sundarbans is diversified due to geographical location, vulnerabilities, and opportunities. This diversified nature has lead to conflicting land uses, and conversion of agricultural cropping patterns.

The people living in the coastal area have been facing vulnerabilities, such as, threat of cyclone and storm surge, land erosion, flood and salinity intrusion. The increasing level of salinity intrusion, incursion of sea water into coastal soils, frequent flood and cyclone are threats for the coastal ecosystem. The sea level rise due to global climate change makes the area more vulnerable. This situation is very alarming for natural resource management as well as for future generation.

[*] Corresponding author: <firozecon@gmail.com>

DOI: https://doi.org/10.53808/KUS.SI.SESB.2010.57-72-ss

The occupational status of the people living in coastal region adjacent to the *Sundarbans* varies. Economic condition of these people varies due to the diverse nature of occupation. Most of the people living in adjacent to the coastal area are dependent on agriculture for their livelihood. The climatic factors directly influence them. The people of the coastal area suffer more compared to other areas of the country during natural hazards. Crop production declines due to changes in climatic factors, such as, salinity intrusion and unusual rainfall. People of the study area are now cultivating their land by matching with the changes in climatic factor and variation of seasonality. Few years ago the land was fallow in winter season but now they are cultivating *aus* and *robi* crop. The socio economic condition of the people in the study area is not good. The housing structure of *Shayamnagor*, *Sarankhola*, and *Dacope* are not good at all, most of the houses are *kutcha*. They also have problem of safe drinking water, very few people have access to electricity and a majority of the people use non-sanitary latrine.

Materials and Methods

Study area: This study covers three regions, namely *Shayamnagor*, *Dacope*, and *Sarankhola*, which are adjacent to the outside of reserved boundary of the *Sundarbans*. The *Shayamnagor Upazila* is situated in Satkhira district which is adjacent to west part of the *Sundarbans*. The *Dacope Upazila* is situated in Khulna district and it is adjacent to northern part of the *Sundarbans*. And the *Sarankhola Upazila* is adjacent to the eastern part of the Sundarbans which is situated in *Bagerhat* district. These three districts represent the south west region of Bangladesh.

Data Collection: This study has used both the secondary and primary data to address changes in land use and livelihood patterns adjacent to the *Sundarbans* coastal area. The land use maps produced by Soil Resource Development Institute (SRDI) are used as the secondary source in addition to published books, journals and annual reports. The study also uses the Focus Group Discussion (FGD) approach to collect primary data on the socio-economic conditions and the status of livelihood.

The FGDs cover three places, namely *Sarankhola*, *Dacope* and *Shayamnagor*, adjacent to eastern, northern and western parts of the *Sundarbans*, respectively. The FGDs tried to trace out various land use activities, changes in livelihood pattern and overall socio-economic conditions due to the changes of climate variables over the time. The places differ from each other due to their spatial variation. This study considers the land use activities of the three different regions adjacent to the *Sundarbans*, mainly on the basis of the published land use maps of SRDI in two different time periods (1996 and 2004). The changes in land use activities of the areas are traced out by the land use maps. The maps (Fig. 1) of 1996 and 2004 (2nd and 3rd land use map of Bangladesh) show the variations of land use pattern in two time periods for the three regions.

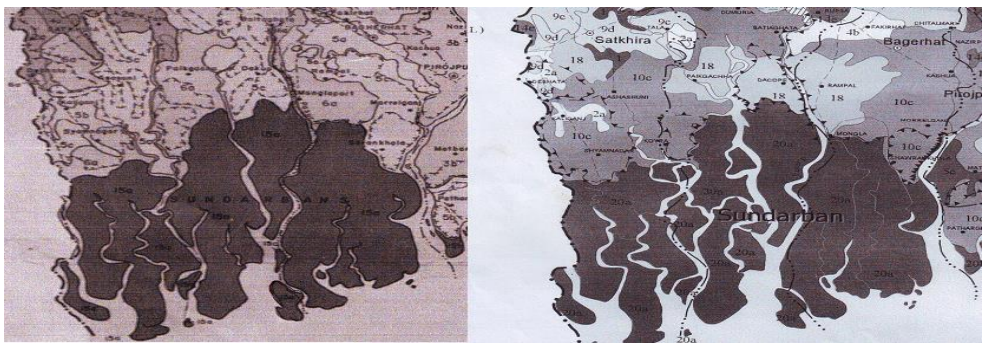


Fig.1. Comparison (L 1996 and R 2004) between the land use activities in the south-west coastal region of Bangladesh (SRDI, 1996, 2004)

.

Results

The land use activities in coastal regions adjacent to the *Sundarbans* have changed during last several decades**.** The ultimate impacts of climate change and variability have fallen on livelihoods of the people depending on natural resource. In the coastal area, it is seen that the people are directly/indirectly dependent on the natural resources. Agriculture is one of the most sensitive sectors to climate change (Cline, 2007). A majority of the people living in the study area are dependent on agriculture for their livelihood. Moreover, a large percentage of people of the coastal belts are directly dependent on the *Sundarbans* for their livelihood. They are extracting the resources from the mangrove forest and depleting resources to maximize their personal benefit and meet up their individual demand.

Land use pattern of the Sundarbans adjacent areas: A dramatic change in land use activities in the areas adjacent to the *Sundarbans* has taken place in last two decades. The land use maps of SRDI of two different periods show a variation in the cropping pattern in the areas adjacent to coast. In the early 1990s, fallow-fallow-transplanted *aman* (T.*aman*) and fallow-shrimp-T.*aman* were practiced as main cropping patterns in *Shayamnagor*. *Robi* crop-fallow-T.*aman* was cultivated as secondary land use activity (Table 1). Where as, in the early twentieth century, fallow-fallow-T.*aman* was mostly cultivated. Besides, *boro*-T.*aman*, shrimp-T.*aman*, shrimp-fallow-T.*aman*, fallow-sesame-T.*aman* and betelvine are additions in cropping pattern (Table 1).

Table 1. Changes of land use pattern over the time period (SRDI, 1996, 2004)

Place	Main land use		Partial land use	
	1996	2004	1996	2004
Shayamnagor	Fallow-Fallow-T.*aman*, Fallow-shrimp-T.*aman*	Fallow-Fallow-T.*aman*	*Robi* crop-F-T.*aman*, Fallow-Fallow-T.*aman*	*Boro*-T.*aman*, Shrimp-T.*aman*, Shrimp-Fallow-T.*aman*, Fallow-Sesame-T.*aman*, Betelvine
Dacope	Fallow-Fallow-T.*aman*	Shrimp-T.*aman*	*Robi* crop Fallow- T.*aman*	Shrimp-Fallow, *Boro*-T.*aman*
Sarankhola	Fallow-Fallow-T.*aman*	Fallow-Fallow-T.*aman*	*Robi* crop Fallow- T.*aman*	*Boro*-T.*aman*, shrimp-T.*aman*, Shrimp-Fallow-T.*aman*, Fallow-Sesame-T.*aman*, Betelvine

The SRDI land use map shows a little variation in production pattern in 1996 in the three different places of the study area. In *Shayamnagor*, the single crop was dominant and shrimp were cultivated with the local T.*aman*. The *Dacope* was also dominated by the single crop and T.*aman* was their main corp. In case of *Sarankhola*, T.*aman* was dominant. *Robi* crop was cultivated as the secondary crop in the three places.

The cropping pattern in the three places has changed over the time period to maximize people's interest and to cope with the environment. The land use map of 2004 shows some changes in the land use activities of the three representative areas of the *Sundarbans* (Table 1). Shrimp cultivation with T.*aman* has been added in *Dacope* and shrimp of *Shayamnagor* has been stopped as their main cultivation. Shrimp with T.*aman* is now their partial cropping pattern. It is also seen that cultivation of *boro* with the local *aman* has been started in the study areas. In case

.

of *Sarankhola*, it is seen that shrimp cultivation has started with the local T.*aman* in year 2004. The recent land use map (of 2004) also shows that some new agricultural product, such as, betel-vine and sesame are introduced in *Shayamnagor* and *Sarankhola*.

By comparing the cropping pattern of the three places on the basis of two land use maps (land use map of 1996 and 2004), a significant change in land use activities is found in the cropping varieties. During the ninetieth decade, *Dacope* and *Sarankhola* were concentrated mainly on the cultivation of single crop and it was fallow-fallow-T.*aman*. However, the cropping pattern of *Shayamnagor* slightly varies compared to the rest two areas (Table 1). The cropping pattern has been changed for the three regions over the time period. In 2004, there have been changed in the secondary crop and *Dacope* has introduced shrimp farming in a large extent due to increased salinity in the river and to maximize their short run benefit. Due to the salinity intrusion over the time period, the shrimp cultivation has increased in the coastal zone of Bangladesh. And some new crops have been introduced in the areas. In 2004, the secondary crop has changed significantly and the people are changing their cropping pattern to cope with the environment. For this reason, double crop and in some cases triple crop in a year are introduced in these areas with diversified agricultural production.

The FGD responders also support the changing land use activities. The people of the *Dacope Upazila* are now trying back to the rice cultivation from shrimp cultivation. In the early period (before 1980's) most of the areas of *Dacope*, *Shayamnagor* and *Sarankhola* were under rice cultivation. But with the passage of time and for the increased salinity of land and river water, they were tending to cultivate shrimp (Table 2). The data shows that salinity intrusion has induced wide land area coverage for shrimp farming in three districts. People are introducing the culture of both rice and shrimp in the same land. They are trying to cultivate double and even triple crop in a year to meet up their increasing demand.

Table 2: Shrimp Farming in the Study Area (BBS, 2007)

Area	Year	Total Area of Shrimp Farming (ha)	Shrimp Catch (M. ton)	Other Fish Catch (M. ton)	Total Catch (M. ton)
Khulna	1999-2000	29,551	13,594	6,590	20,184
	2003-2004	51,921	18,015	9,605	27,620
	Change (%)	76%	33%	46%	37%
Satkhira	1999-2000	29,544	12,645	8,420	21,065
	2003-2004	48,320	15,039	7,248	22,287
	Change (%)	64%	19%	-14%	6%
Bagerhat	1999-2000	47,710	23,617	7,300	30,916
	2003-2004	59,421	24,547	12,181	36,728
	Change (%)	25%	4%	67%	19%

Recent cropping pattern: In recent time, the cropping pattern is changing and people are now practicing multi-cropping pattern in a year in the same land to increase their production for meeting up their daily needs with the increasing population which is also supported by the FGD responders. The people are now cultivating double or triple crops.

.

Total cultivable land in *Dacope* is 29,147 hectares, of which, 675 hectares cultivable land remain fallow (AEO, 2010). Rice, water melon, vegetables are the main cultivable crops of the area. October to February is *robi* season when *boro*, vegetables, pulses are cultivated (Table 3). March to September is *khorip* season which is suitable for fish, *aus* rice, *ropa aman* and vegetables production.

Table 3. Seasonal cropping pattern in *Dacope* (AEO, 2010)

Robi (October to February)	*Khorip* 1 (March to June)	*Khorip* 2 (July to September)
Boro	Fallow	*Ropa aman*
Boro	Fish	Fish
Boro	*Aus*	*Ropa aman*
Vegetables	Fallow	*Ropa aman*
Pluses	Fallow	*Ropa aman*
Vegetables	Vegetables	Vegetables

In *khorip*II (July to September) season, *ropa aman* is the dominating crop. Land used for *boro* production in *robi* season is used for *aus* production from March to June and used for cultivation of *ropa aman* or fish production from July to September. Vegetables are dominating throughout the year. Pulses are cultivated only in *robi* season but these lands remain fallow during March to June.

In *Dacope*, land is used not only for the cultivation of only one type of crop but also for multi-crops which are suitable to the changing environment. Recently water melon cultivation has become profitable in *Dacope* which was not cultivated in the area earlier. Production of water melon was the highest in year 2009 (Fig. 2). Vegetables production in both summer and winter seasons are now flourishing. In addition to *ropa aman*, people of *Dacope* are concentrating on *boro* cultivation.

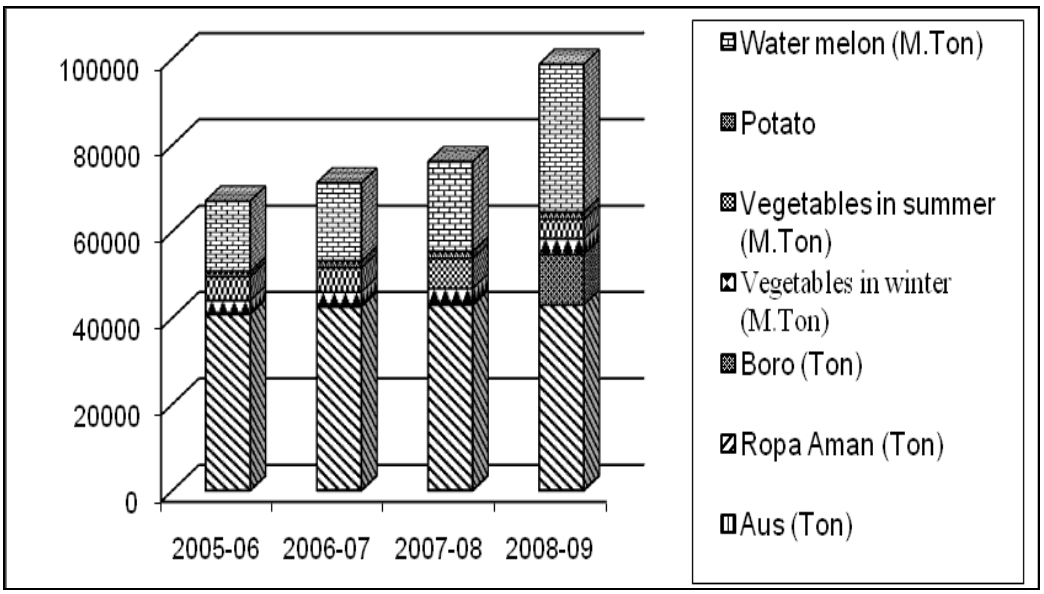


Fig. 2. Recent cropping scenario in *Dacope*

In *Shayamnagor*, 38,570 hectares of land is cultivable of which 24,890 hectares is net cultivable land (AEO, 2010b). In the late ninetieth decade, both local and *ufshi* (a local variety) *aman* paddy were mostly cultivated in *Shayamnagor* (Fig. 3). But this tradition is gradually changing. Cultivation of local *aman* is now shrinking. Only *ufshi aman* production is insufficient to meet food demand of increased people. For the very reason, the people of *Shayamnagor* are trying to cultivate *boro* and a significant portion of cultivable land in *Shayamnagor* is used for *boro* production.

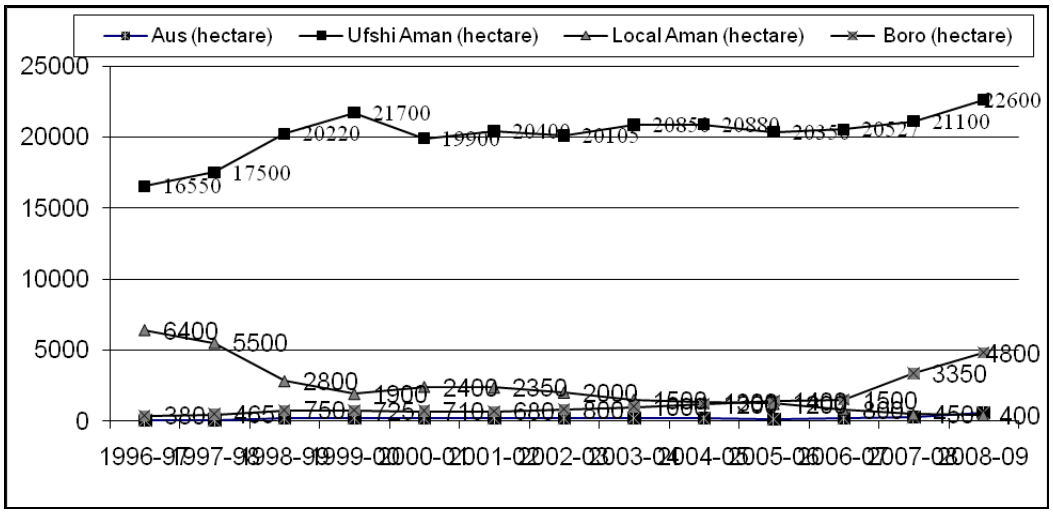


Fig. 3. Trend of cropping pattern in *Shayamnagor*

In *Shayamnagor*, not only paddy but also varieties of crops are produced. *Boro*, potato, vegetables, and pulse are *robi* crops, where as, *ropa aman* is cultivated in *khorip* season. Vegetables cultivation is dominating in current period (Fig. 4). Vegetables can grow in slightly wetted land which is found in *Shayamnagor*. Moreover, vegetable gardening on floating beds is a recent agricultural practice in some parts of *Shayamnagor*. Significant portion of cultivable land is used for potato cultivation. Besides, water melon, wheat, onion, garlic are additions to cropping pattern in *Shayamnagor*.

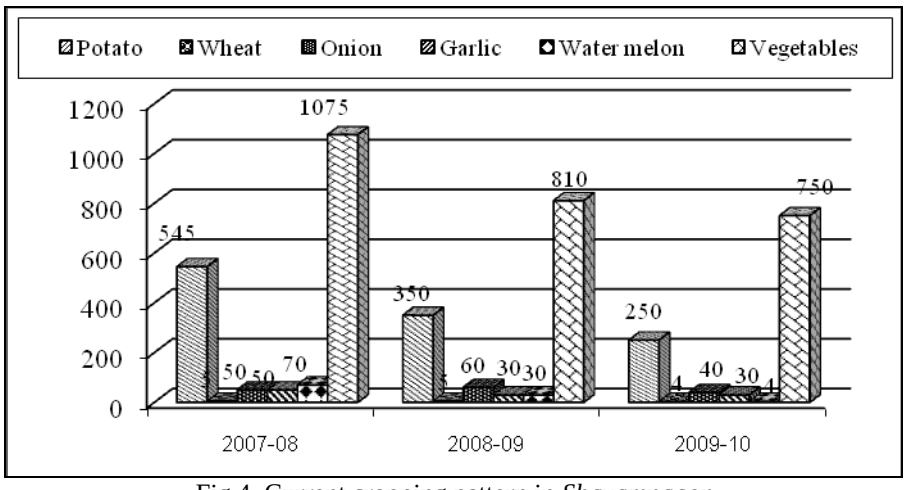


Fig 4. Current cropping pattern in *Shayamnagor*

.

Crop cultivation pattern is also changing in *Sarankhola*. In the ninetieth decade fallow-fallow-T.*aman*, was commonly practiced. But now in addition to *aman*, varieties of *robi* crops like *ropa aus*, *boro*, vegetables, pulse, and potatoes are cultivated in 9,402 hectares crop land (AEO, 2010c). However, 38 hectares cultivable land remains fallow in the area to date.

Production of *ropa aman* is the highest in *Sarankhola* (Fig. 5). Vegetables production is gradually increasing in this region. Cultivation of water melon is totally absent in *Sarankhola*. Cultivation of sugarcane, wheat and pulse has potential possibilities.

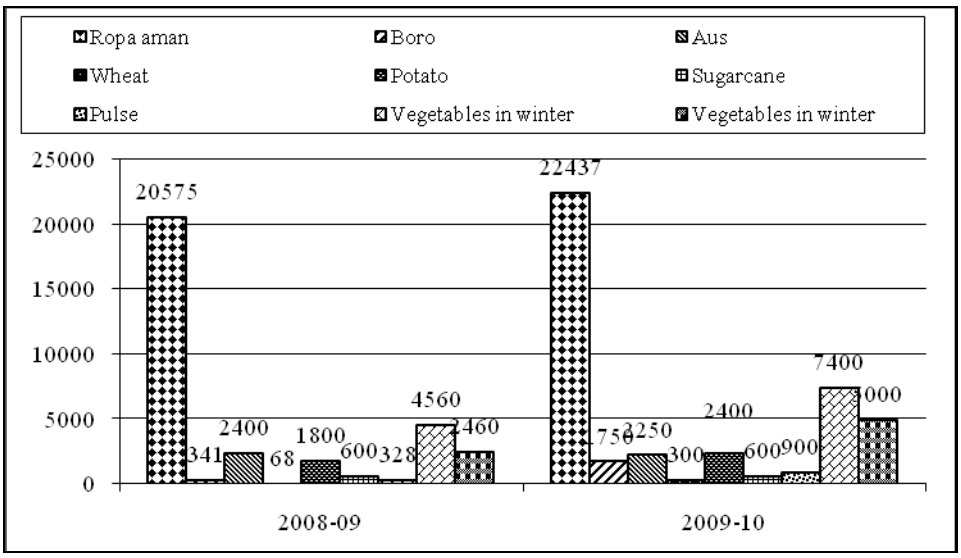
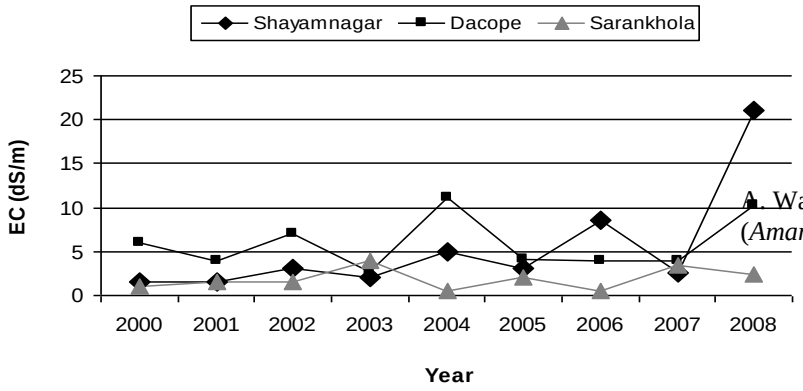


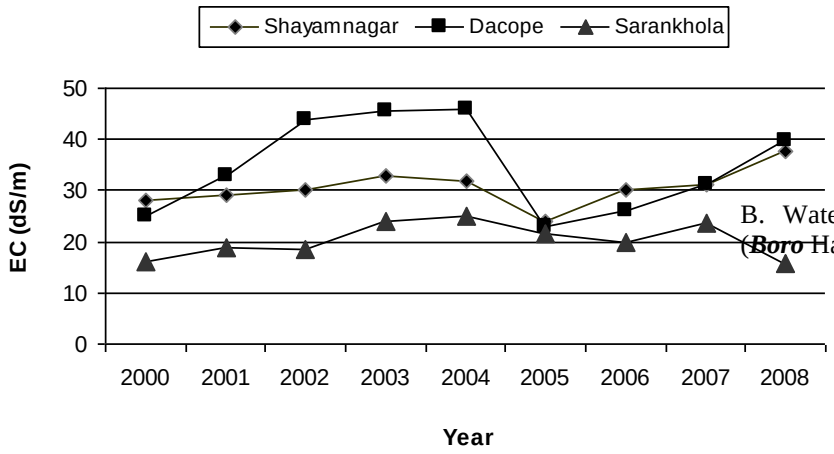
Fig. 5. Current cropping pattern in *Sarankhola*

Causes of changes in land use pattern: Some climate variables are mostly responsible for the changing cropping pattern of the coastal area. The changing pattern of climate variables has changed the land use activities of the *Sundarbans* adjacent area.

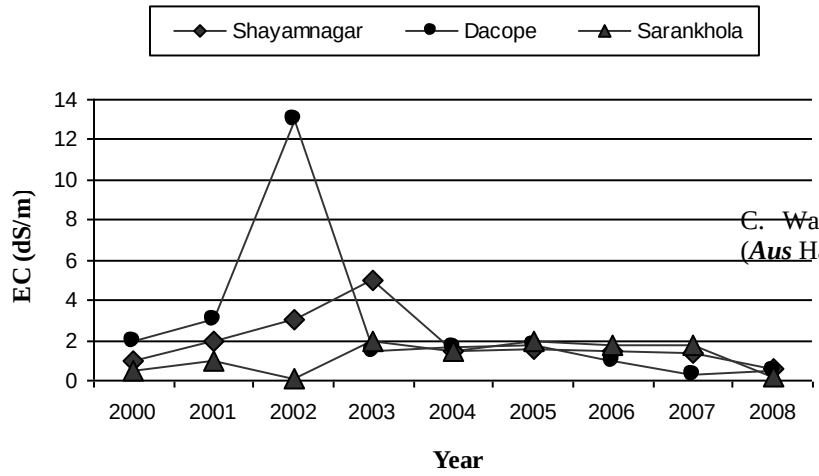
Increased soil and water salinity: Salinity ingress causes an increase in soil salinity, especially when farmers irrigate their lands with slightly saline surface water at the beginning of the low flow period (Shamsuddoha and Chowdhury, 2007). SRDI (1997) reported that, soil salinity levels in the south of Khulna and *Bagerhat* ranged between 8 to 15 dS/m during the low flow season. It is also reported that, some regions of the southern Sundarbans are known as 'non-saline in the pre-*Farakka* period' have began to develop soil salinity during the low flow seasons of 1980s. The anticipated sea level rise would produce salinity impacts in three fronts: surface water, groundwater and soil. Increased soil salinity due to climate change would significantly reduce food grain production. According to the Fig. 6 & 7, it is clear that salinity intrusion in the coastal area is very seasonal. In the rainy season (June-October), intrusion of saline water is minimal due to extreme flow of fresh water, but in the dry season, especially in winter, saline water goes up gradually. SRDI (2008) database states that the salinity intrusion in coastal areas of Bangladesh has increased over the time period (Fig. 6 and 7A-B). In the study area, it is seen that the western part of the Sundarbans is highly saline and the eastern part is low saline area and *Dacope* (northern part) is moderately saline area. The Figures illustrate that both temporal and spatial variations in salinity level are seen in the study area. According to the FGD responders, currently some parts of their lands are not being utilized for crop production, mostly due to increase in salinity and the situation would aggravate further under a climate change scenario.



A. Water Salinity Level (*Aman* Harvesting Period)



B. Water Salinity Level (***Boro*** Harvesting Period)

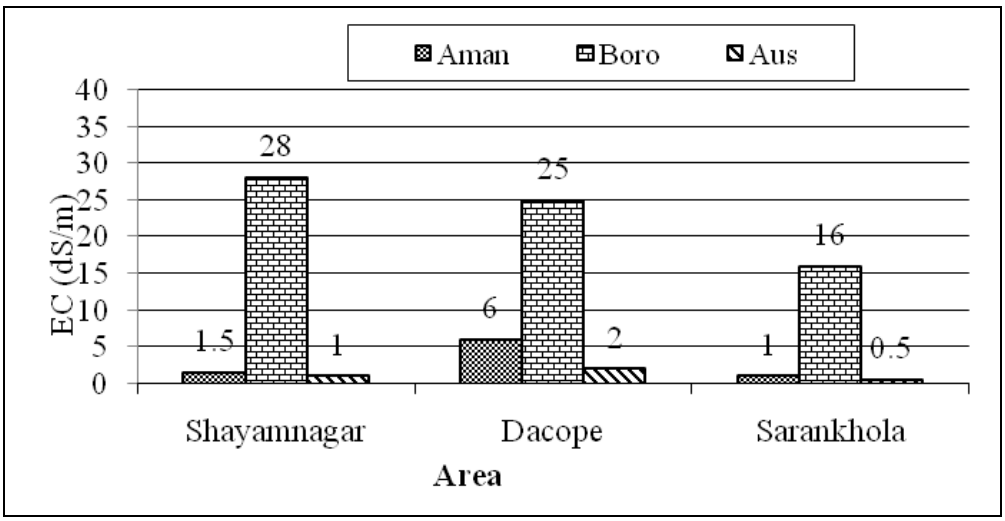


C. Water Salinity Level (***Aus*** Harvesting Period)

.

Fig. 6 (A, B & C). Water salinity level in the study area (in different cropping period) (SRDI, 2008) and Haider *et al.,* 2009)

A



B

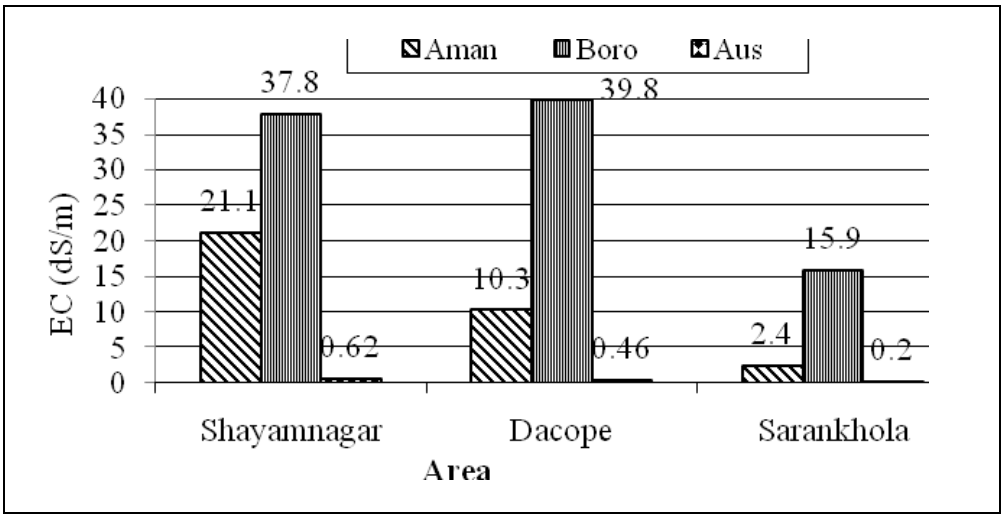


Fig. 7 (A and B). Water salinity level in the study area (Year 2000 and 2008)

Rainfall: Rainfall, a climate variable affects the agricultural production. Excess and scanty of rainfall hinders the production process. The people can not cultivate their land on time. The most remarkable change of rainfall is the change in duration of rainy season. It was found that there would be excessive rainfall in the monsoon (*aman* season) causing flooding and very little or no rainfall in the winter (*boro* season) forcing low productivity. This behavior of rainfall affects agriculture sector and livelihood. Due to heavy rainfall in a short span of time (mainly in *Aman* season), there is a water logging problem and the cropping pattern is changing. There is a huge variation of rainfall over the time period in the study areas (Table 4 and 5). Form the FGD of

Shayamnagor, it has been pointed that the people of this area cannot cultivate paddy in time of rainy season due to the heavy rainfall, where as they are cultivating *boro* (December-April). They have failed to cultivate their land in the recent past *aman* season due to the heavy rainfall and water logging. The people of *Dacope* and *Sarankhola* are also suffering from the problem of heavy rainfall in a short period. Heavy and unexpected rainfall impedes food grain production.

Table 4. Variation of the total rainfall (mm) over the time period (BWDB, 2005).

Place	Total rainfall in a year (in millimeters)											
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Shayamnagor	1575	2142	1727	1616	2002	1683	1903	1737	2033	1982	2001	1872
Dacope	1471	1816	1994	1710	1756	1629	2594	1496	1978	1853	2061	2111
Sarankhola	1881	1975	2548	2614	2031	2538	2324	1819	3080	2366	2189	3381

Table 5. Monthly average rainfall (mm) from 1996-2007 (BWDB, 2005)

Places	Monthly average rainfall (in millimeters)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Shayamnagor	9.8	31.2	51.6	94.9	171.7	290.5	364.7	283	323.8	199.2	25.8	4.0
Dacope	8.7	22.0	37.0	65.8	178.6	318.5	381.0	285.8	346.7	186.0	39.2	3.4
Sarankhola	10.5	16.8	51.9	99.4	239.8	429.9	480.4	358.2	365.3	300.6	37.8	5.1

Cyclone and flood: The cyclone and the frequent flood are deterring the smooth and traditional agricultural production. The inundation and intruding salinity are interrupting traditional practices in the Sundarbans (Huq and Ayers, 2008). The cyclone accompanied with torrential rain and devastating tidal surge causes havoc to lives and property in the cyclone path, and the environment in the affected area. In November 2007, the tropical cyclone Sidr, with a 100 mile long front covering the breadth of the country and with winds up to 240 km per hour, hit Bangladesh (Huq and Ayers, 2008). From the FDG of *Shayamnagor*, it is evident that recent cyclone and the tidal surge (*Aila*) have destroyed their cropping land, livestock, fishes, agricultural properties. Production decrease, inundation of land and ponds by saline water, and loss of houses are some other impacts of the natural disasters. They have ranked cyclone as the most responsible factor for their vulnerability. And due to flood over a longer time, they can not cultivate their land.

Sea level rise: The impacts of rising sea level include loss of coastal ecosystems, flooding of cities, displacement of coastal inhabitants, and increased vulnerability to storm surges. It must be understood that sea level rise is not an instant disaster like a tornado or a tropical cyclone; rather it is a slow, almost imperceptible process - the cumulative effects of which are enormous. Sea level is currently rising at a rate of 1/10 inch per year (Koshland, 2009). According to NAPA projection, the sea level will rise 14cm, 32cm and 88cm in the year 2030, 2050 and 2100 (NAPA, 2005). Form 1977-98 clearly shows that annual sea level rises at the rate of 4 mm at *Hiron* Point in the *Sundarbans* and the South western Khulna region 5.18mm/year sea level rise is recorded which may reach to 85 cm by 2050. (Shamsuddoha and Chowdhury, 2007). Due to this climate change, the cropping pattern of the coastal zone is changing alarmingly. As it is creating the drainage congestion, water logging is their main concern in time of *aman* cultivation. Currently

.

80%-90% of the land is under the coverage of rice cultivation in *Dacope*. But due to siltation in the river bed, the water logging problem has been worsening. Some of the respondents are not willing to cultivate rice; instead, they are interested to cultivate shrimp again. In *Shayamnagor*, this is a great concern, 80% of the respondents claim that due to this problem they do not want to take risk again by cultivating rice, instead, they want to cultivate shrimp.

Discussion

Consequences of changes in land use pattern: Topography and climate make the coastal region of Bangladesh ecologically vulnerable to destabilizing variations including cyclone, floods, river erosion and tidal surge all of which occur more frequently and intensely than in any other regions of the country. The changes in climate variables are leading serious negative consequences on the livelihood pattern of the people of the *Sundarbans* surrounding regions. According to the FGD, there is a relationship between the changes of climate variables and changes of land use activities which is influencing the livelihood pattern of the people living in the study area. The adverse effects of climate change, climate variability, sea-level rise and associated phenomena such as the increase in the intensity and frequency of hurricanes and other extreme weather events continue to threaten the sustainable development, livelihoods and existence of the coastal zone of Bangladesh.

Over the time period the livelihood pattern of the people adjacent to the Sundarbans area have been worsening. The socio-economic status of the people adjacent to the Sundarbans is not satisfactory at all. In the study area it is seen that changes in land use pattern is the effect of change in climate variable, which also diversified their livelihood pattern. The study findings show that salinity is the root causes of changing the land use pattern. The FGD responders also support this statement.

The people of the *Sundarbans* adjacent areas are worst sufferer for the cyclone and flood and the responders of FGD in *Sarankhola* and *Dacope* claim that cyclone and flood have tend to divert their land use pattern.

Due to changes in climate variables the land use pattern of the south west coastal area is changing, thus the living condition of the people and the socio economic status are changing. Increase of salinity, unusual rainfall and a rise in sea level are creating negative impact on agricultural production, creating migration and more dependency on the *Sundarbans*.

Decreasing agricultural production: Due to the changes of climate variable, the overall agricultural production is decreasing. Bangladesh lost about 0.5 million tonnes of rice annually as a result of floods during the period 1962-1988, which accounts for nearly 30% of the country's average annual food grain imports (Paul and Rashid, 1993). The sea level rise and heavy rainfall create congestion in the drainage system and the people of the study area faces water logging problem in time of *aman* season. Thus, they are getting lower crop yields and even it is seen that they are not interested to cultivate their land in time of *aman* season. The study findings in *Dacope* show that on an average the production of rice is 3-4 mounds per *bigha* of land. This is the result of excess salinity in the water and soil. The FGD respondents of the three places also claim that all climate variables (rainfall, sea level rise, salinity, flood, and cyclone) have declined their productivity of crop in different seasons, which is diversifying their crop production.

Migration of the people: The environmental hazards and destruction of lives of the people are caused by the changes of climate variables. If sea level rises up to one meter by this century, Bangladesh could lose up to 15 per cent of its landmass and up to 30 million Bangladeshis could become climate refugees (Harasawa, 2006). People of this area (Khulna, Satkhira, and Bagerhat) are now homeless due to the frequent flood, tidal surge and cyclone. According to FGD, the people of these coastal areas have a very strong social network with the people of India. A large number of people from *Shayamnagor* are working in many provinces of India, especially after affected by the flood and cyclone. The people of these areas have lost their land due to the river

bank erosion. Thus they are becoming homeless and living elsewhere. They are migrating by losing their property. Moreover, the people of *Dacope* and *Sarankhola* are migrating to other places. Therefore, it can be predicted that the inundation of land would increase the flow of permanent and temporary migration from the study area.

Destruction of the Sundarbans: The *Sundarbans* also offer subsistence to around 3.5 million inhabitants who live within and around the forest boundary (Huq and Ayers, 2008). Climate change will have a detrimental impact on all of the forest ecosystems in Bangladesh, and the *Sundarbans* are likely to be the worst affected (Rahman and Alam, 2003).The climate variable which is destroying the traditional land use pattern in the coastal area is also creating more dependency on the *Sundarbans*. The inundation and intruding salinity are interrupting traditional practices in the *Sundarbans*. The people of *Shayamnagor*, *Dacope* and *Sarankhola* are mostly dependent on the *Sundarbans* for their livelihood, because of their changing pattern of land use. The increased dependency on the *Sundarbans* is the chronological impacts of salinity intrusion (Haider *et al.*, 2009). Although opportunities for shrimp farming have accompanied increasing salinity, shrimp farmers are encouraged to inundate their land with brackish water during times of low salinity, exacerbating damage to the forest cover. Depleting forests in waterlogged and saline areas are putting further pressure on forest resources such as fuel wood and timber, enhancing the rate of forest depletion (Agrawala *et al.*, 2003). People of the adjacent area of the *Sundarbans* are employed in various occupations inside the forest, such as, cutting wood, fishing, and collecting honey and other forest products like *golpata* (large leaves) and hay. Apart from these specific jobs, people from the surrounding villages also depend on the *Sundarbans* for their daily life. Due to their excessive dependency on this large mangrove forest, the forest is destroying.

Socio-economic status of the people: *Shayamnagor*, located in Satkhira district, is the largest *Upazila* of Bangladesh in respect of area, consists of 1,968.24 sq. km. with 313,781 people. *Sarankhola*, the second smallest *Upazila* of Bagerhat district, in respect of population, occupies 756.61 sq. km. with a total of 114,083 people. And, *Dacope*, the second largest *Upazila* of Khulna district in respect of area, consists of 991.57 sq. km. with 157489 people. Illiteracy, income discrimination, health hazard, and unemployment are the common socio-economic issues of coastal districts adjacent to the *Sundarbans*. A downward trend in employment level is found in the selected three coastal districts (Fig. 8). Employment level in these districts was higher during the 1980's than that of the current decade.

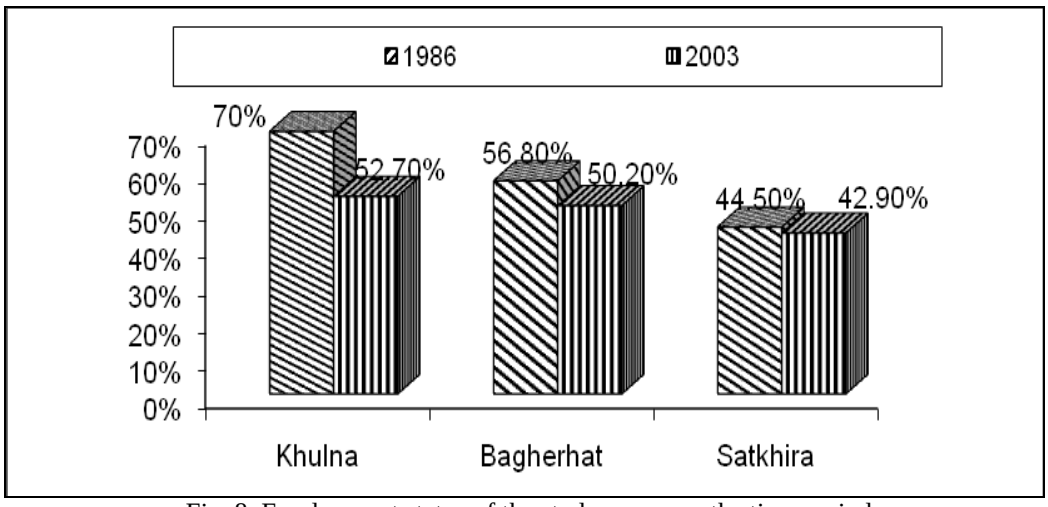


Fig. 8. Employment status of the study area over the time period

.

The people living in coastal region adjacent to the *Sundarbans* are involved in different occupations. Economic status of these people varies due to the diverse nature of occupation. A majority of the people of *Dacope* are engaged in agriculture sector in their own land, In case of agricultural labor, *Shayamnagor* takes the highest position. As most of the people are dependent on natural resources, in time of natural hazards the people of the coastal area suffer more than other areas of the country. Household income of *Shayamnagor, Sarankhola, Dacope* dwellers is largely dependent on agriculture. More than sixty percent residents of *Shayamnagor, Dacope* depends on agriculture (Fig. 9). Businesses and non-agricultural activities are also treated as sources of household income of these regions. To meet excess family expenditures and to add new household income, significant portion of people engage their children as family workers. Due to poverty and the lack of awareness of their parents, children are deprived from the light of education.

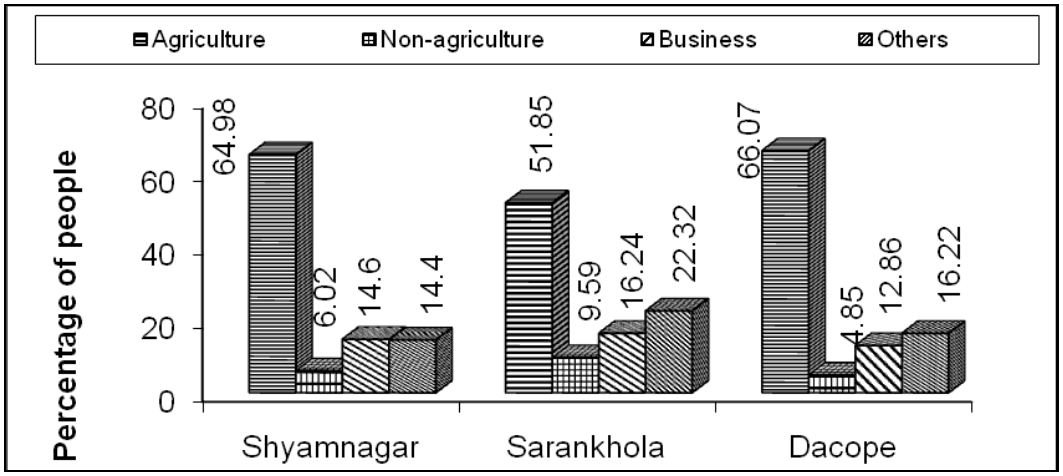


Fig. 9. Source of household income

Kutcha housing structures are dominant in *Shayamnagor, Sarankhola, and Dacope*. Above 80% dwellers of *Shayamnagor, Dacope* and above 70% dwellers of *Sarankhola* have *kutcha* houses. The rest have semi-*pucka* and *pucka* houses. More than half of the residents use pond water for their drinking purpose (Fig. 10). Very few people use deep-tube-well water.

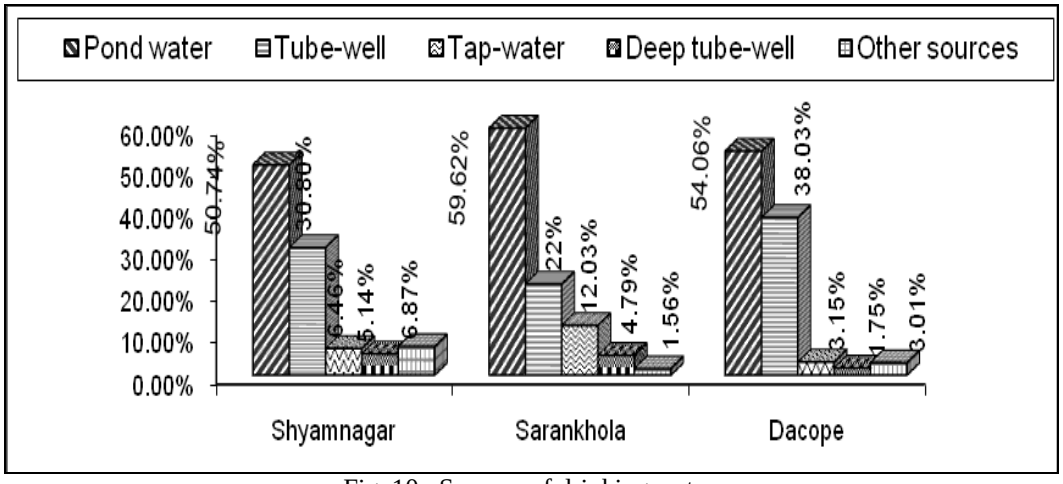


Fig. 10. Sources of drinking water

The use of non-sanitary latrines is the highest in *Sarankhola* (Fig. 11). About 47% and 48% dwellers of *Shayamnagor* and *Dacope* use non-sanitary latrines. Few people use open space. *Kutcha* housing condition, inadequate food supply, insecure drinking water, and unhealthy sanitation condition aggravate health hazard in the areas. Dysentery, Diarrhoea, stomach pain cold and fever are common health hazards. A significant portion of people have no access to electricity in the study area (Fig. 12). Less than 10% residents are reported to have electricity facility.

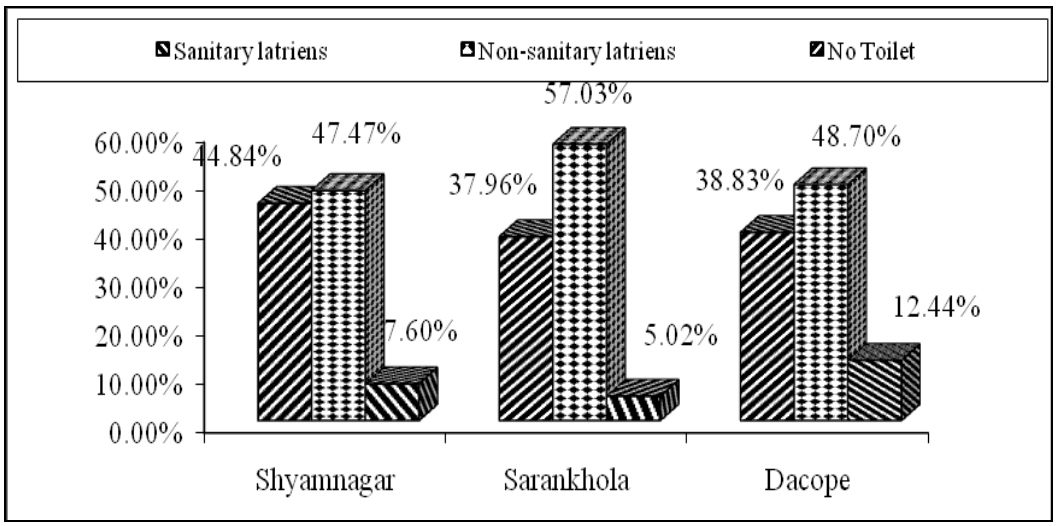


Fig. 11. Sanitation facilities

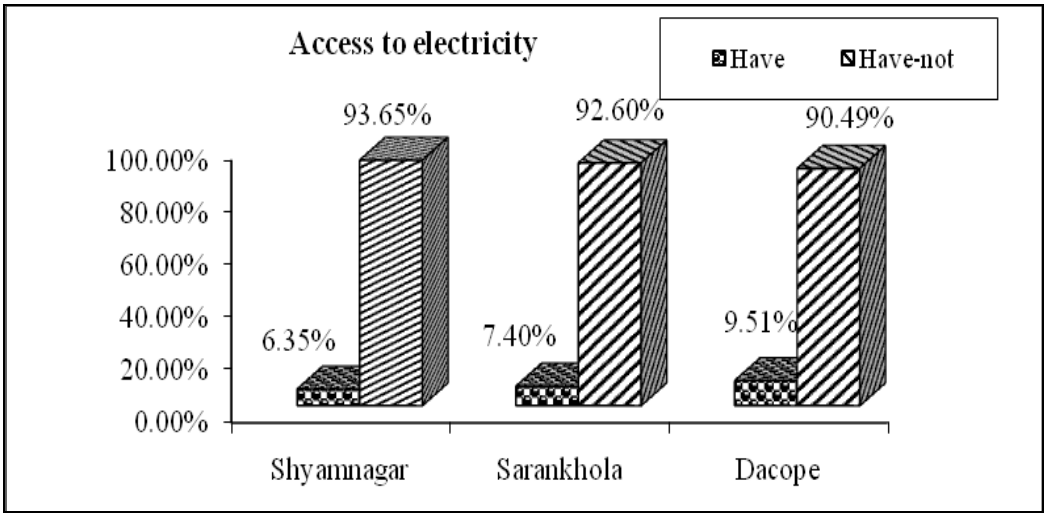


Fig. 12. Access to electricity

Conclusion

The land use pattern of the study area is different from the other regions of Bangladesh for its geo-physical condition. The land use map shows that the land is now used for multi-crops instead of earlier single cropping pattern. The study findings show that there have been changed in the secondary crop. Some regions have introduced shrimp farming due to increased salinity in the

.

river, due to the problem of water logging and also due to the motive of maximizing short run benefit of farmers. The most significant impact of salinity intrusion is the changes in land use activities. Salinity has encouraged or enforced the people to use their land for shrimp farming instead of rice cultivation. Study findings shows that the shrimp farming has increased in recent times. In addition, the frequent flood and cyclone of the coastal area are destroying the cropping land and the cropping pattern is changing over the time period. The inundation and intruding salinity are interrupting traditional practices in the *Sundarbans*. So, the traditional land use pattern in the coastal area is destroying. Permanent or temporary migration and increased dependency on the *Sundarbans* are the sequential impacts of changing land use pattern and conditions in climatic variables. Due to the dependency on the *Sundarbans*, the people of the study area are depleting a larger portion of the forest resources to earn their livelihood. The spread of income inequality, poor health condition, illiteracy, unemployment and shortage of pure drinking water are the common socio-economic features of this region.

References

AEO, 2010. *Crop Production Plan of Dacope Upazila in Khulna District*. Agriculture Extension Office (AEO), *Dacope*, Khulna

Agrawala, S.; Ota, T.; Ahmed, A.U.; Smith, J. and Aalst, M.V. 2003. *Development and Climate Change in Bangladesh: Focus on Coastal Flooding and the Sundarbans*. Organization for Economic Co-operation and Development (OECD)

BWDB, 2005. Bangladesh Water Development Board (BWDB), Government of the People's Republic of Bangladesh, Dhaka

Cline, W.R. 2007. *Global Warming and Agriculture: Impact Estimates by Country*. Centre for Global Development and the Peterson Institute for International Economics, Washington DC

BBS, 2007. *Statistical Yearbook of Bangladesh 2006*. Bangladesh Bureau of Statistics (BBS), Planning Division, Ministry of Planning, Government of The People's Republic of Bangladesh, Dhaka

Haider, M.Z.; Rahaman, M.S.; Khanam, A. and Ahmed, M.F. 2009. Impact of Salinity on Livelihood Pattern: A Study on the South-West Region of Bangladesh. Proceedings on *Climate Change Induced Livelihood Pattern in the South-West Coastal Region of Bangladesh*. Prodipan and Environmental Science Discipline, Khulna University. No. 6: 33-37

Harasawa, H. 2006. Key vulnerabilities and critical levels of impacts on east and southeast Asia. In: *Avoiding Dangerous Climate Change*. Cambridge University Press: Cambridge: 243-249

Huq, S. and Ayers, J. 2008. *Climate Change Impacts and Responses in Bangladesh*. Policy Department Economy and Science DG Internal Policies, European Parliament

Shamsuddoha, M. and Chowdhury, R.K. 2007. *Climate Change Impact and Disaster Vulnerabilities in the Coastal Areas of Bangladesh*

Koshland, M. 2009. *Causes of Climate change*. Marian Koshland Science Museum, www.koshland-science-museum.org/exhibitgcc/causes02.jsp retrieved on August 2

NAPA, 2005. *Final Report of National Adaptation Programme of Action (NAPA*). Ministry of Environment and Forest Government of the People's Republic of Bangladesh, November, 2005

Ahmed M.F; Khanam A; Haider M.Z; Rahaman M.S. 2010. Land use pattern and socio-economic condition of the *Sundarbans* adjacent coastal areas of Bangladesh. *Khulna University Studies* Special Issue (SESB 2010): 57-72

Paul, A. and Rashid, H. 1993. Flood damage to rice crop in Bangladesh. The Geographical Review, 2(83): 151-159

Rahman, A. and Alam, M. 2003. *Mainstreaming Adaptation to Climate Change in Least Developed Countries (LDCs): Bangladesh Country Case Study*. IIED Working Paper

SRDI, 1996. *Land Use Bangladesh*. Soil Resource Development Institute (SRDI), Government of The People's Republic of Bangladesh, Dhaka, Bangladesh

SRDI, 1997. *Soil Salinity in Bangladesh 1996*. Soil Resource Development Institute (SRDI), Government of The People's Republic of Bangladesh, Dhaka, Bangladesh

SRDI, 2004. *Land Use Bangladesh*. Soil Resource Development Institute (SRDI), Government of The People's Republic of Bangladesh, Dhaka, Bangladesh

SRDI, 2008. *Water Salinity in Bangladesh*. Soil Resource Development Institute (SRDI), Government of The People's Republic of Bangladesh, Dhaka, Bangladesh

.