Climate change influence water use pattern in south-west coastal belt of Bangladesh

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Abstract: The southwest part of the coastal area in Bangladesh is to be identified as environmental handicap by both climate change and non-climatic drivers. The water resource sector of the coastal region would most likely be affected significantly due to anticipated changes. The research tries to identify the present status and probable impacts of climate change on changing water use scenario in the transition zone of fresh water and brackish water. Necessary data were collected through questionnaire survey and Focus Group Discussions (FGD) in December, 2012. A total of 100 households were surveyed in the presence of both male and female from five types of drinking water source user namely Protected pond, Pond Sand Filter, Rainwater harvesting, Tube well and Supply water.The survey was conducted to 30 up age group and equal numbers of respondents were selected from each source user. About 49% of peoples are literate and 29% of people are engaged in open water fishing in the Sunderbans. During monsoon 87% of people use rain water for drinking purpose while in other seasons of the year they use pond sand filter and protected pond water while before Aila, Sidr 51% people were use protected pond water. In 90% of household women involved drinking water collection and 65% of households directly consume water from sources. About 80% of households use rain water for cooking in monsoon and 60% of households use pond water in others seasons of the year. Most of the households use pond water for bathing, washing, sanitary purpose, irrigation, fish cultivation and fish processing but most of them use river water for shrimp cultivation. Except rain water harvesting and water supply system most of the water sources in the coastal region were affected by natural disaster at different levels. This study will helps policy makers to find out alternative water source for coastal people.

Key wards: Climate change, Water use pattern, Coastal belt, Impact of natural disaster

Introduction

Bangladesh is considered as one of the most vulnerable countries in the world as per as the climate change and sea level rise concern (IPCC, 2007). It is severely affected by climate change due to its geographical location, hydrological influence of monsoon and regional flow patterns, high rainfall during monsoon while little in the dry season, extreme temperature with scanty rainfall, saline water intrusion, catastrophic natural disaster etc. It is estimated that climate change could affect more than 70 million people due to countries geographical location, high levels of poverty and high dependency on natural resource (UNDP, 2008). Cyclones and associated surges combined with sea level rise poses a grave threat of inundation of coastal region with saline water and consequent salinity intrusion in surface and ground water resources which besides destruction of crops and other biodiversity will create acute drinking water problems(Rana *et al.,* 2001). The water resource sector would most likely be affected than others due to climate changes (Ahmed, 2005).The detection of arsenic and iron in ground water in Bangladesh has imposed a serious threat to the prime source of safe drinking water. As well as the salinity in the coastal area of Bangladesh has also imposed a serious threat to the sources of safe drinking water (Uttran, 2003). The World Health Organization and the Food and Agriculture Organization recommend consuming maximum five

grams of salt per day with food and drinks. But people of this salinity-affected region take up to 16 grams of salt just by drinking water (Roy, 2013). In the coastal area of Bangladesh three factor's increase the salinity level several times than previous. Bangladesh discovered the tremendous economic potential of the shrimp export markets to Europe, Japan and the US and well-heeled Bangladeshi capitalists (with political backing) acquired many of the coastal areas behind the polders for shrimp aquaculture, forcing out the farmers and replacing the paddy fields with the saline water enclosures (Finan and Timothy, 2009). In 2007 and 2009 two very catastrophic cyclones named *'Sidr'* and *'Aila'* hit the coastal region with water upsurge resulting huge salt water intrusion by breaking earthen dyke and almost all the cultivable land is inundated by salt water (Rahman and Sampson, 2009). The upstream reduction of natural water flow is contributing to increasing level of salinity problem in coastal areas of Bangladesh. Both water and soil salinity has increased in an alarming rate during he last couple of decades. Nowadays, saline water becomes the only means of potable water (Basar, 2012).

The surface water of the coastal area is sulphate-chloride dominated (Rahman *et al.,* 2000). During dry season the main source of drinking water were ponds which were specially conserved for drinking purposes (Ahmed, 2002). Because of the existence of bacterial contaminants (i.e., pathogens) in surface water, rural

people have been using underground water from shallow aquifers since the 1970s (Tsushima, 2001). However, the prevalence of arsenic was observed in shallow tube well water in 1993 (Ahmed *et al.,* 2002). PSF is an alternative technique to purify pond water and has high efficiency in turbidity, color and Bacteria removal (Ahmed *et al.,* 2000) (Rahman *et al.,* 2001). Rainwater harvesting system is a sustainable community based safe water option to mitigate arsenic problem (Jakariyaet *et al.,* 2003).In most part of the country, people normally can have access to rainwater for about 6-8 months. However, the rainwater is not available throughout the year and need preservation for the yearlong use (Ahmed, 1999). From the research it was found that before Aila/Sidr, about half of the population drink Pond Sand Filter water and one-fourth drink pond water. The cooking water sources of three-fourth of the population were Pond water (Karim *et al.,* 2005). But in recent years, due to increasing salinity level, most of the people use rain water and Pond Sand Filter water for Drinking and Cooking Purpose.

Materials and Methods

The study was conducted in Shyamnagur Upazila in Satkhira district, which is an offshore area located closed to the world largest mangrove forest Sundarban at the south-west part of the country. There are 12 Unions (lowest administrative unit) of the Shyamnagur Upazila of which Gabura (22° 17 ´ 16 ´ ´ N to 22° 13 ´ 12 ´ ´ N latitude and 89 ^{o} 14 ´ 53 ´ ´ E to 89 ^{o} 18 ´ 69 ´ ´ E longitude) and Munshigang union (21° 36 ´ N to 22^{0} 24 ´ N latitude and 89^{0}E to 89^{0} 19 ´ E) have been selected as study area. The survey was conducted in six villages of Gabura and 7 villages of Munshiganj Union that are along the coastline. Respondents were selected in random stratified sampling method. In the coastal area people use five types of drinking water sources namely protected pond, PSF, RWHS, supply water and tube well and equal numbers of respondents are randomly selected from every drinking water source user. Finally one hundred households were surveyed in December 2012, at the presence of both male and female. The survey was conducted upon 30 up age group. Before preparing the final schedule a draft interview schedule was developed and pre-tested to gain new information. Finally, a set of items were listed and grouped in the logical sequence, so that the coastal people could answer easily.

The final schedule includes questions on the socio-economic characteristics, scenario of sector wise water use pattern, impacts of climate change and extreme weather events on water sources. Some information was also collected from Focus Group Discussion (FGD).

Results and Discussions

Selected characteristics of coastal people

The results on the selected characteristics of the respondents are shown in Table 1. Education ranged from 0 to 9 (Parvez and Akter, 2009) with the mean 2.69 and standard deviation of 1.715. Majority of the respondents (37%) had no education and 14% had non-formal education. In addition 19% people completed primary level, 14% class eight, 8% SSC and only 8% above HSC (Table 1). In Shyamnagur upazila 48.6% people were literate and 51.4% people were illiterate (BBS, 2011). The educational status of the coastal area is low due to poverty (GED, 2009). The mean age of the respondents were 48.67 (±11.794) and a large number of respondents (30%) fall in 40 to 49 age group. Among the rest 22% were 30-39 age group, 18% 50-59 age group, 23% 60-69 age group and 7% were more than 70 years age group (Table 1). The average monthly income of the respondents was 4035.35 (± 2333.487) TK. About 39.3% of respondent had an income 5001 to 7000 TK and 38.1% had an income of 3000 to 5000TK(Table 1). The family size of the surveyed households ranged from 2 to 13 with average of 5.05 and standard deviation 2.143. The current study shows that 64% small family followed by 30% medium and 6% large family (Table 1). The average monthly income of surveying households were 9812.94 (±6391.636) TK. About 29% of households had income of >11000 TK while 22% had 5001 to 7000 TK and 17% had 9001 to 11000 TK. In case of monthly household expenditure the percentage was same. The average monthly household's expenditure was 6149.33 TK with standard deviation 3285.915 (Table 1).

Occupation of the respondents

The present study reveals that large numbers of respondents (29%) depends on open water fishing in Sundarbans and 17% were business men. Among the rest 12% were farmer, 9% day labour, 9% Households work and 6% service respectively. Negligible amount of people were engaged in doctor, transport sector, house hold farming and construction sector.

Table 1. Percentage distribution of the respondents by socio-demographic characteristics (n=100).

Selected Characteristics		Frequency	Percent	Mean	SD
Education	Illiterate	37	37.0	2.69	1.715
	Only signature	14	14.0		
	Primary	19	19.0		
	Class eight	14	14.0		
	SSC	8	8.0		
	HSC	5	5.0		
	BSc & MSc	3	3.0		
Age (years)	30-39	22	22.0	48.67	11.794
	40-49	30	30.0		
	50-59	18	18.0		
	60-69	23	23.0		
	>70	7	7.0		
Monthly income of respondents (TK)	<3000	8	9.5	4035.35	2333.487
	3000-5000	32	38.1		
	5001-7000	33	39.3		
	7001-9000	8	9.5		
	9001-11000	3	3.6		
Family size	Small (2-5)	64	64	5.05	2.143
	Medium (6-8)	30	30		
	Large (above 8)	6	6		
monthly income of households (TK)	<3000	4	4.0	9812.94	6391.636
	3000-5000	14	14.0		
	5001-7000	22	22.0		
	7001-9000	14	14.0		
	9001-11000	17	17.0		
	>11000	29	29.0		
Monthly expenditure of family (TK)	<3000	4	4.0	6149.33	3285.915
	3000-5000	14	14.0		
	5001-7000	22	22.0		
	7001-9000	14	14.0		
	9001-11000	17	17.0		
	>11000	29	29.0		

Table 2. Occupational patterns of people in coastal region of Bangladesh(Field survey, 2012)

Occupation	Percentage
Day labor	9
Farmer	12
Transport sector	1
Service	6
Business	17
House hold work	9
Farming	1
Fisherman	29
Others	8
Doctor	3
Wood smith	1
Constructor	1

Present and past scenario of drinking water use pattern

The present study shows that in monsoon most of the households (87%) were used rain water for drinking purpose and only 10% of households used Tube well water. During post monsoon almost equal numbers of respondents were used rain water (19%), protected pond water (20%), tube well water (20%), PSF water (21%) and supply water (20%) for drinking purpose. The current study also shows thatin pre-monsoon and dry season about 29% of households were used pond sand filter water for drinking purpose and equal number of households (20%) used tube well water, protected pond water and supply water while only 6%

households used rain water. But the scenario was different before Aila, Sidr. The study shows that for drinking purpose 51% householdswere used protected pond water and 33% used pond sand filter water and 13% used tube well water (Figure, 1).Moinuddin (2004) conducted a study to find out the threat to drinking water security in the coastal zone and found that the coastal zone was under arsenic problem. He also found that different water treatment options and alternative options was tried to adopt in Government and Non-Government Sectors. Rain Water Harvesting System (RWHS) and Pond Sand Filter (PSF) system were the most acceptable alternative source of drinking water.
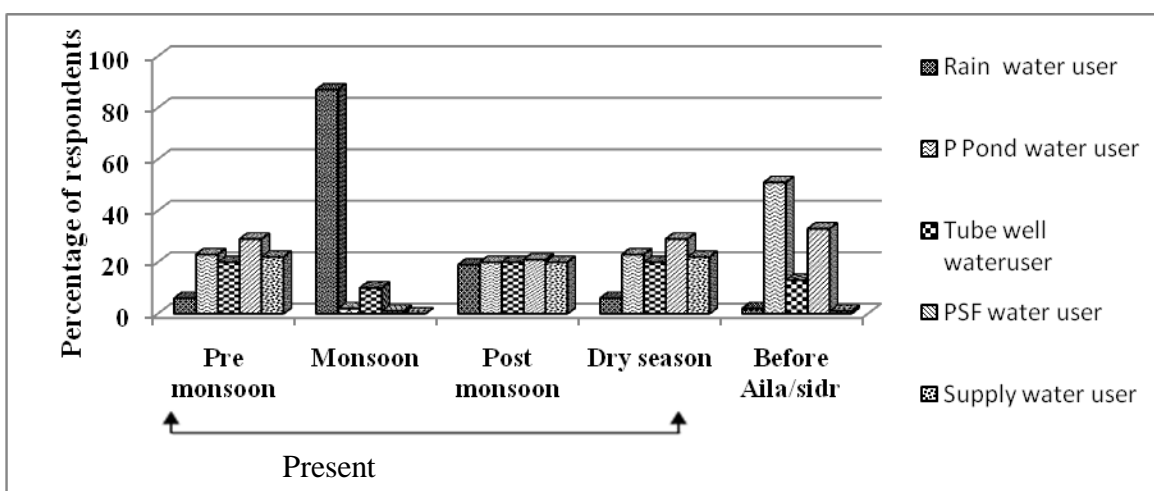

Fig. 1. Present and past scenario of drinking water use pattern of coastal people. (Field survey, 2012)

Present and past scenario of cooking water use pattern

In pre monsoon and dry season most of the households (60%) were used protected pond water for

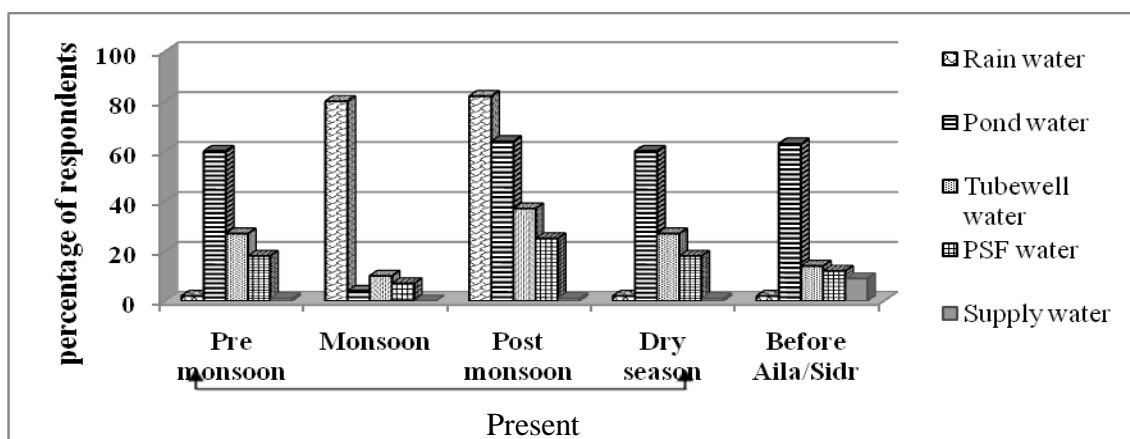coking purpose while 27% used tube well water and 18% used pond sand filter water.

Fig. 2. Information regarding the cooking water source of coastal people in different times. (Field survey, 2012).

But in monsoon 80 percentage households were used rain water for cooking, while few households used tube well water (10%), pond sand filter water (7%) and pond water (4%).Protected ponds were the main cooking water source of large numbers of households (60%) in post monsoon while 27% households used tube well water and 18% used pond sand filter water. The present research shows that before Aila/Sidr Protected ponds were most of the households (63%) cooking water source while 14% used tube well and 12% used pond sand filter water (Figure, 2). Karim et al, 2004 found in his study that 76% people use pond water for cooking purpose while 24% use other sources.

Households washing and bathing water source

Washing mainly indicates both cloth and kitchen utensil washing. From the study it was found that at present most of the households (88%) were used general pond water for washing while 10% used tube well water and 2% river water. It was clear from the figure 3 that all the households were used same water source for washing purpose for many years. At present times around 89% of households bathing water source were pond water. Another considerable number (9%) of households were used tube well water and only 2% used river water. The coastal peoples bathing water source were same before & after Aila/Sidr.
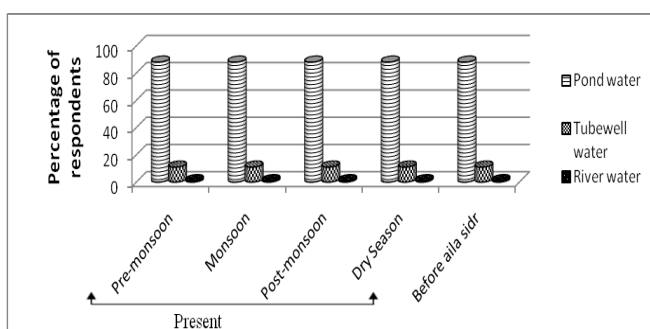
Fig. 3. Performance of different water supply options for domestic purpose in different times. (Field survey, 2012).

Performance of water source for agricultural purpose

This irrigation water includes those that were used in agricultural field. According to the Table 3 there were 64% of people used deep tube well water for irrigation before Aila, Sidr but post Aila, Sidr 61% people used it. At present 39% of people were used pond water for irrigation while before Aila, Sidr 36% people used it for irrigation. At present 88% people were used river water for shrimp cultivation, in those firms' crawfish was cultivated.12%of people used pond water for lobster cultivation. The same percentages of people were used river water and pond for craw fish & lobster cultivation before Aila, Sidr. From the study it was found that brackish water shrimp cultivation is at same level. Fish cultivation mainly indicates fresh water fish cultivation. At present 98% of people were used pond water & 2% rain water for fish cultivation. Actually those were pond water because rain water stored in pond (Figure 4). At present most of the respondents (97%) were used general pond water in fish depots for fish and shrimp processing while only 3% used tube well water. The percentage was same before Aila, Sidr.

Table 3. Irrigation water sources of coastal people. (Field survey, 2012).

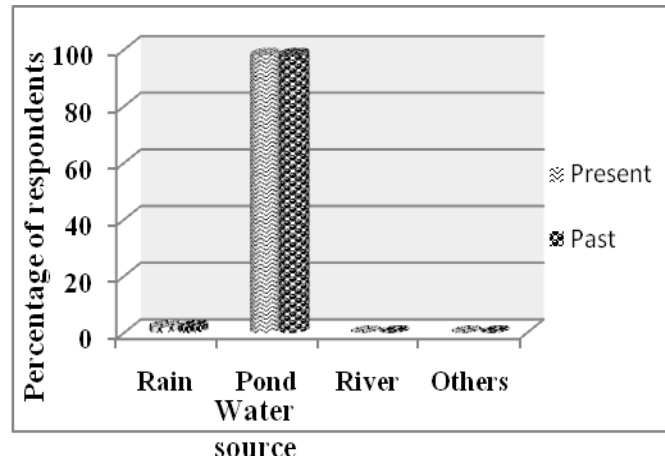| Sources of water	Present (%)	Past (%)
Pond water	39	36
Deep Tube well	61	64

Figure: 4 Water source used for fish cultivation in different times. (Field survey, 2012

Restaurants water source

From the survey it was found that restaurants were not common in the study area. Among the existed 94% were used pond water &only 6% used tube well water.

Present and past scenario of sanitary water use pattern

The present study shows that 91% households were used pond water for sanitary purpose in all seasons and 9% use tube well water. Households were using tube well water for sanitary purpose because it is near the house. The figure 5 shows that the sanitary purpose water use pattern had never been changed over time.
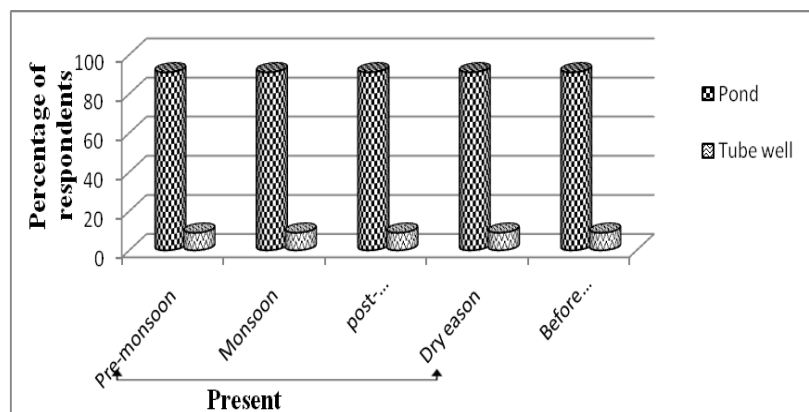

**Fig. 5. Present and past scenario of sanitary water use pattern in coastal Bangladesh. (Field survey, 2012).**

Person involved in drinking water collection and its purification technique

In Bangladesh perspective majority women (70%) involved in drinking water collection while daughter involved 7%. This result represents that in most of the cases women were related with water hygiene. Only 7% of male and 3% of servant involved with drinking water collection from distance sources (Figure 6). As women involved in water handling, so proper training for women can reduce water bone disease.
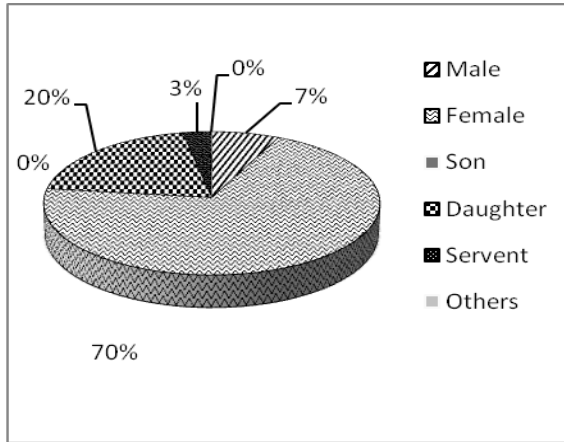
Fig. 6. Person involved in drinking water collection in coastal region (Field survey, 2012).
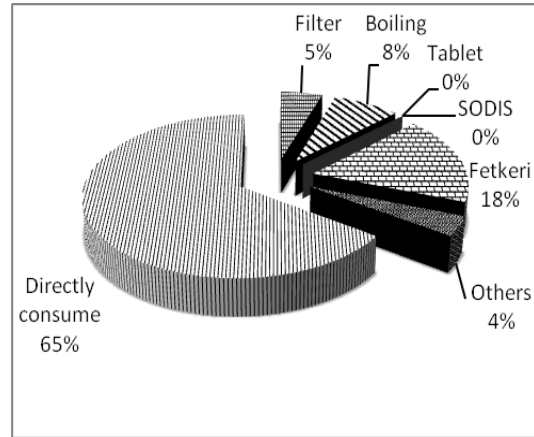

Fig. 7. Drinking water purification materials used by coastal people (Field survey, 2012).

Water purification reduces the possibility of water bone disease transmission. Water purification system was very much poor in the study area. Most of the people directly consume water from sources (65%), filter 5%, Boiling 8%, Fetkeri 18% others 4% (figure 7). An investigation by Neelopal and Ishrat (2010) in another coastal upazila Keshabpur found that 68% directly consume drinking water, 7% boil, 1% filter and 20% use water purification tablet.
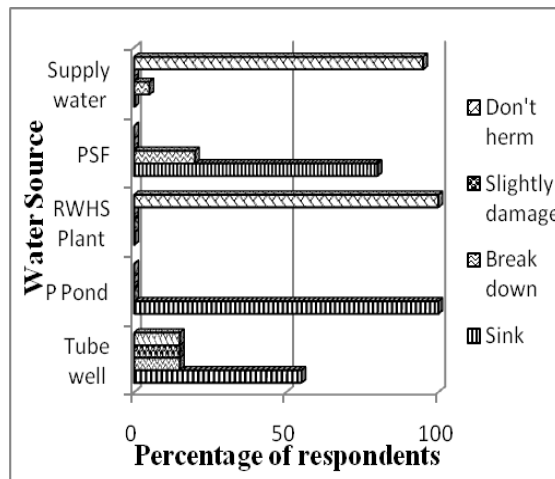
Impacts of natural disaster on drinking water source
Figure 8 state that natural disaster had affected the 56% of respondent drinking water sources. The main water sources of this group were protected pond, pond sand filter and tube well. Another 44% of respondent

drinking water sources were not affected by natural disaster. Most of them were rain water and supply water user. From the research it was found that all the rain water harvesting plant (100%) and supply water (95%) were not affected by natural disaster. Only 15% of tube wells were safe from natural disaster. On the other hand 15% tube wells were slightly damaged. Another considerable numbers of PSF (20%) and tube well (15%) were break down during natural disaster. In disaster period large numbers of water sources were sinking due to high storm surges. The entire protected pond (100%) and most of the PSF (80%) were sink during natural disaster (Figure 9).
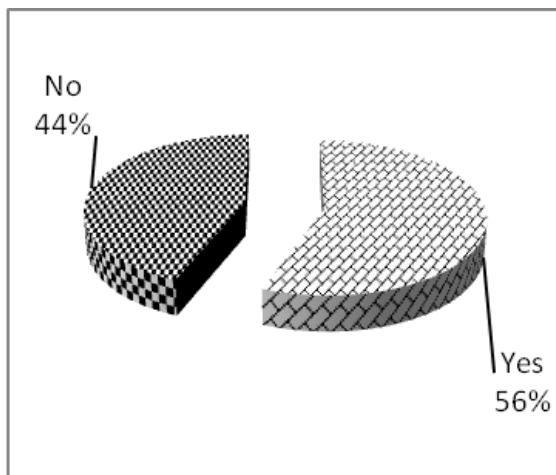
Fig. 8. Respondent's drinking water source affected by natural disaster in coastal region of Bangladesh. (Field survey, 2012).


Fig. 9. Impact of natural disasters on drinking water source. (Field survey, 2012).

Disaster occurred in past ten years

Figure 10 states that large number of disaster strike several times in coastal region of Bangladesh. Some disasters were milestone and occurred in every year.

Most of the respondents said about river erosion (86%), sidr (82%), Storm (82%), tornado (73%), aila (95%), Salinity (96%), drought (73%) and cyclone (96%).
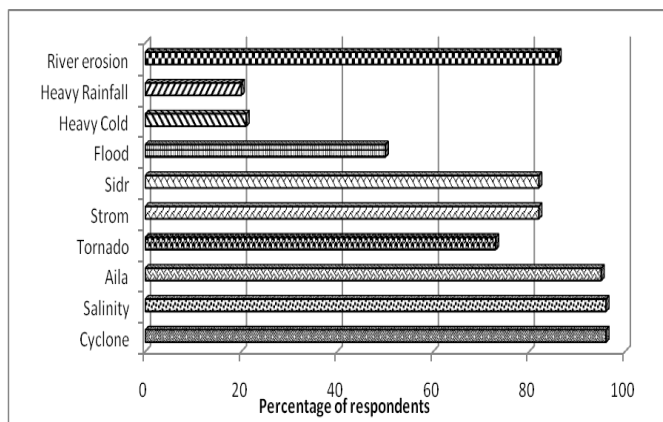
Fig.10. Past 10 years scenario of natural disaster in coastal region of Bangladesh. (Field survey, 2012).

Conclusion

The impacts of climate change in changing people's water use pattern in a coastal area of Bangladesh were assessed through a questionnaire survey. It reveals from the study that most of the people were used rain water for drinking purpose in monsoon, while pond sand filter, protected pond, supply water and tube well were used in other seasons but before Aila, Sidr protected pond was the main water source of coastal people. In most of the house hold women involved in drinking water collection and they consume it directly from the source. During monsoon and post monsoon most of the people use rain water for cooking and pond water in other seasons. From the ancient time people are dependent on general pond water for washing, bathing, sanitary purpose, irrigation and fish cultivation. They use river water only for brackish water shrimp cultivation.

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