

## The Impact of Climate Change in the Coastal Areas of Bangladesh Affected by Cyclone Bulbul

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### Abstract

Bangladesh is considered one of the country's most at risk to the effects of climate change and its coastal area is most vulnerable. This study tries to explore the experiences of cyclone bulbul affected people living in the coastal areas of Bangladesh. This study was conducted in the cyclone Bulbul affected Shymnagar Upazila of Satkhira District. Primary data collection was done using Focus Group Discussion and then a thematic analysis approach was used for analysis. Five core themes emerged from the analysis and they are, firstly, demographic, socio-economic and livelihood of the respondent; secondly, perceptions and information about climate change and salinity; thirdly, salinity and water supply; fourthly, impact of salinity on living beings with special reference to human beings; and finally the adaptation in facing salinity intrusion (in soil and water resources) caused by climate change. Findings show that the impact of climate change has serious consequences on the livelihood patterns of the affected population and on their overall health status. As a result, a number of health's related diseases have been identified in the research area due to salinity such as diarrhea, dysentery, high blood pressure, gastric, skin problems etc. It also impacts to agricultural crops, fisheries and biodiversity. The study focuses to identify the overall impacts of those sectors. The possible measures area selection of salt-tolerant crops, rain water harvesting, regular support from NGOs as well as government to maintain Pond Sand Filter (PSF), construction of Bank Sand Filter (BSF), provide Reverse Osmosis (RO) plants, exploring suitable layers for tube-wells.

**Key words:** *climate change; impact; coastal areas; Bangladesh; cyclone Bulbul.*

### Introduction

Climate change is one of the major global challenges. Science has shown that recent climate changes have had widespread impacts on human and natural systems ((European Union, 2015). The long-term impacts of climate change are temperature rise due to global warming, sea-level rise, salinity intrusion, drought, heat waves, cold waves, etc. Cyclone Bulbul entered Bangladesh on 9 November, 2019 through the Sundarbans in Khulna around midnight, after making landfall at Sagar Island in the southern part of India's West Bengal. It then continued crossing Shatkhira and adjoining South West part of Khulna

division until early dawn. (The Daily Star, 11 November, 2019) and the wind speed was between 100 and 120 kph when the cyclone hit Sundarbans. However, it eventually weakened as it moved northeast. (The Daily Star, 11 November, 2019). The radio telegraphic signal Save our Souls (SOS) forms reveal that the cyclone hit coastal areas and heavily damaged the district of Shatkhira where water logging become the most prominent and visible damage. Other districts that suffered less severe damage included Potuakhali, Bagerhat, Bhola, Borguna and Khulna. So far the cyclonic destruction resulted in the

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loss of seventeen lives, out of which eleven people died from trees falling on them. The cyclone also damaged houses, crops, fish enclosures and embankments. (The Daily Star, 11 November, 2019). The coastal belt of Bangladesh surface water resources, like rivers, ponds and canals, are most susceptible to contamination by saline water intrusion (Abedin *et al.*, 2014; Werner *et al.*, 2013). Climate change is liable for intensifying this problem, which also has adverse health consequences, such as greater prevalence of hypertension and cardiovascular diseases (Hoque *et al.*, 2016). High salt intake is a major risk factor for increased blood pressure (Mustaris and Karim, 2012). Approximately 20 million people in Bangladesh are at high risk of hypertension due to the intrusion of saline water caused by climate change (Rasheed, *et al.*, 2016). The financial life of coastal population has been affected by climate change due to a lack of job opportunities, some families the heads of the households are leaving the village and migrating to different cities to maintain household expenses (Russell *et al.*, 2016). Similar findings are shown in another study by Guha-Sapir *et al.* 2006 where Tsunami affected unemployment in Tamil Nadu. Climate change affected the livelihood pattern and job security of fishermen in Coromandel Coast of New Zealand (Srikanthan, 2013). The impact of climate change will be felt by different parts of the world and by different people; poor countries like Bangladesh are going to be worst hit. For example, research by Furberg *et al.*, 2011 on Sami population shows that rapidly changing unstable weather patterns affect their living patterns. Furthermore, studies by Adebo and Sekumade (2013); Adeniyi *et al.* (2013) and Guha-Sapir *et al.* (2006) suggest that women and children tend to be the worst affected. Additional

studies by Devkota *et al.* (2014); Kendrovski and Spasenovska (2011); Davies *et al.* (2009) and Bhuiyan and Khan (2011) also show how these groups are suffering from health problems because of climate change. In disaster times, children and babies lack the capacity to escape from the hazard. In a study of 1991 Bangladesh cyclone, for example, children and older people died more disproportionately than others in the population (Chowdhury *et al.*, 1993). Bangladesh is considered to be highly vulnerable in the context of climate change. It is frequently at the mercy of the forces of nature, especially water from the sky, land, and sea (Kabir *et al.*, 2014). The climatic conditions of Bangladesh are influenced by a number of global and regional scale factors. These factors include geographical location, the effect of North-South continental scale atmospheric pressure gradient (terrestrial to oceanic), the influence of the jet stream stretched from South East Asia to Northern Africa on the monsoon wind system, changes in the solar albedo due to land use, land cover change in the region and its impacts on wind pattern, and fluctuations in the terrestrial and sea surface temperature (Islam and Neelim, 2010). Cyclones and storm surges recently became catastrophic events for the coastal people and indirectly for many people in the country. The recent cyclonic storm Bulbul has greatly affected farmers in Satkhira, particularly those in Shyamnagar, Assasuni, Kaliganj, Sadar, and Tala upazilas, flooding vast amount of fish enclosures and crops in its wake (Dhaka Tribune 15 November, 2019) and 14% of the entire land harvested in the country was affected by the cyclone Bulbul (MoA, 12 November, 2019) and Bangladesh lost Tk 263 crore in crop yield in 16 districts from cyclonic storm Bulbul that swashed across the country (MoA, 12 November, 2019). According to the Global

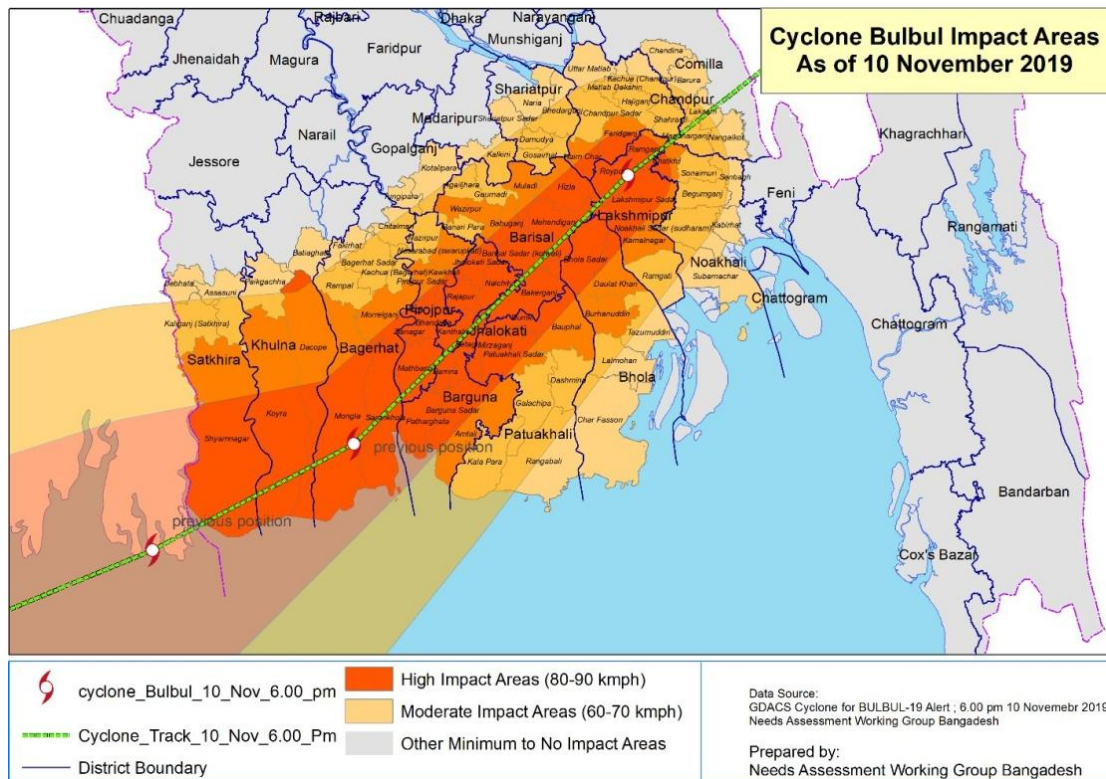
Disaster Alert and Coordinating System (GDACS), around 3.56 million people in the districts of Barguna, Jhalokathi, Patuakhali, Pirojpur, Bagerhat ‘medium’ to ‘high’ and Khulna and Satkhira district ‘high’ to ‘very high’ risks due to Cyclone Bulbul (International Federation of Red Cross and Red Crescent Societies, 9 November, 2019). Farmers had to face serious problems as they were not prepared for such an event in the affected areas. Recurrent floods with increased intensity in the future under the changing climate system remains an enormous challenge for the largest community and livelihoods of the country.

Sea level rise caused by the rapid melting of glaciers, ice caps and other factors might change both the geographic and topographic history of the country in the future. This study emphasizes observations on the effects of climate change in the coastal areas of Bangladesh affected by cyclone Bulbul. Considering the present situation of Shymnagar Upazila of Satkhira District the main objectives were: a) to know the impacts of salinity intrusion on drinking water and crop production in the study area; b) to find out the impacts of salinity intrusion on fisheries and biodiversity.

### **Background of Coastal Zone of Bangladesh**

Coastal zone of Bangladesh is geomorphologically and hydrologically dominated by the Ganges Brahmaputra Meghna (GBM) river system and Bay of Bengal. The coastal zone of Bangladesh covers an area of 47,201 km<sup>2</sup>, 32% of the country, being the landmass of 19 districts (Figure 1) that are Jessore, Narail, Gopalganj, Shariatpur, Chandpur, Satkhira, Khulna, Bagerhat, Pirozpur, Jhalakati, Barguna, Barisal, Patuakhali, Bhola, Lakshmipur, Noakhali, Feni, Chittagong, and Cox's Bazar (Abu *et al.*, 2003). Depending on geographic features, coastal zone of Bangladesh consists of three parts, (a) The eastern zone, (b) The central zone, (c) Western zone. Many of the coastal inhabitants are poor, and the population is exposed to both natural disasters and man-made hazards. Climate change driven events like sea level rise, cyclone, storm surge, coastal

inundation, salinity intrusion and land erosion are main the natural disasters (Iftekhar, 2006; MoWR, 1999). The total amount of salinity affected land in Bangladesh was 83.3 million hectares in 1973, which had been increased up to 102 million hectares in 2000 and the amount has been raised to 105.6 million hectares in 2009 and continuing to increase (Mahmuduzzaman *et al.*, 2014). With 50% of the land less than 8 m above sea level, and a coastline of some 600 km, coastal flooding is a common problem (Flooding Forecast, 2017). Bangladesh is especially vulnerable to tropical cyclones with around 718,000 deaths from them in the past 50 years (Ubydul *et al.*, 2011). The future vulnerability in the coastal region of Bangladesh will be significantly higher than present condition (Uddin *et al.*, 2018).



**Source:** Remote Communications Outlet (RCO) Flash Update 11 November, 2019

Figure 1 Impact areas of Cyclone Bulbul on coastal regions of Bangladesh

## Materials and Methods

The study was conducted in the Satkhira district is located in southern part of Bangladesh. The district is surrounded by a complex river network consisting of Kobadak, Sonai, Kholpatua, Morischap, Raimangal, Hariabhanga, Ichamati, Betrabati and Kalindi-Jamuna. The area of Satkhira district is 3,858.33 sq km with a population of over 2 million. Annual average temperature varies from a maximum of 31.6°C to a minimum of 21.4°C and annual rainfall is 1,742 mm. Average literacy rate is 30.35 percent (male 39.7 percent and female 21 percent). The main occupations are agriculture, fishing,

pisciculture, agricultural laborer, wage laborer, commerce, industry, transport, service, etc. Most of its flood ridges were washed away and people are faced with the daily difficulty of tidal sea water engulfing their land (Daily Sun, 10 November, 2019). The study was conducted in the four villages namely Shaura, Faisamari, Jelekhali and kloser under the Gabur union and three villages of Kamalkathi, Khutikatha and Jhapa under the Padampukur union of Shymnagar upazila of Satkhira District. Data were collected during the period of 15 November to 10 December 2019 using interview schedule. A

systematic research procedure was maintained to avoid possible bias. The study villages were selected on a discussion with the local experts and in consultation with local government institutes and vulnerable communities. The selected villages were most affected in the study upazila. The survey questionnaire was prepared in a peer review process to make it consistent with the subject and local issues. The focus group discussions and informal discussions with the community members were used to collect information and compare with the survey data. Appropriate participants for the focus group discussions were selected from the questionnaire survey. Data and information given by the respondents was gathered carefully during the survey period. Open-ended questions were used to collect the data. In this way, quality of data was confirmed in every steps of the survey. Thus total 100 respondents were surveyed in seven villages' under the two unions in the study area. The head of the household/family was given priority to answer to the questions. Due to absence of the head, another senior person of the family was considered to respond. Sometimes elder respondents answered the question in presence of all members of the family. In many cases, they all discussed before responding to some questions. The

questionnaire was prepared to collect the relevant information and data from the study locations. The following four themes are the data analysis. The first theme of the questionnaire emphasized on the demographic, socio economic and livelihood of the study unions. The second theme focused perceptions and information about climate change and salinity problems. The third theme considered the salinity and water supply (state trend and loss) due to source of water in different period, extreme event like cyclone Bulbul affected sources of drinking water, while using the pond or PSF. The final or fourth theme covered the impact of salinity on living beings over the last twenty years caused by extreme events. Two FGD was conducted into the two study unions. Each FGD included 8 to 10 respondents (male and female). The FGDs were conducted with farmers and NGO workers. In one cases, some local knowledgeable persons were present in the group discussion. At the end of the FGDs, a draft paper was prepared with key messages from the discussions. The researcher carefully went through the descriptive responses given by the respondents to each question in order to understand the meaning they had communicated in the focus group discussions.

## Results and Discussion

### **1<sup>st</sup> theme: Demographic and Socio-economic Profile of the Study Area:**

The questionnaire survey under the study area was the combination of different aged group. Out of total respondents, 96% were men and 4% were women. Besides, 96% were married and 4% were unmarried. About 34% respondents were between 20 to 40 years old. About 34% of the respondents were over 50 years of age. Of the total

respondents, 23% were literate, 43% were completed primary education (class I-V), 20% had junior education (class VI-X), SSC, HSC, Graduate and post graduate were found 6%, 4%, 3% and 1%, respectively. The study shows that more than 90% households owner has a small piece of land. Almost all households in the study area involved in fisheries practices. Overall, 70% of fishermen go to sea to catch fish.

Moreover, farming is great challenge for all the study unions due to scarcity of safe surface or ground water. About the access to drinking water, nearly 80% households collect water from the pond while 15% from the Pond Sand Filter (PSF). This figure shows that approximately 100% households depend on pond for drinking purpose. Among the two study unions, a few people (nearly 5%) of Gabura and Padampukur collect water from Very Shrouded shallow Tube well (VSST) where layer from can be found only at 32 ft down from the ground

level. During FGDs, most of the informer told that more than 95% people of the Gabura and Padampukur Union depend on the ponds for drinking water. The coastal area of Bangladesh is mostly vulnerable to the harmful effects of climate change and climate variability issues. Some factors including salinity intrusion caused by extreme events (e.g. Cyclone and Storm surge) and slow onset processes (Sea Level Rise) are aggravating the impacts on almost every sector including agriculture and drinking water supply.

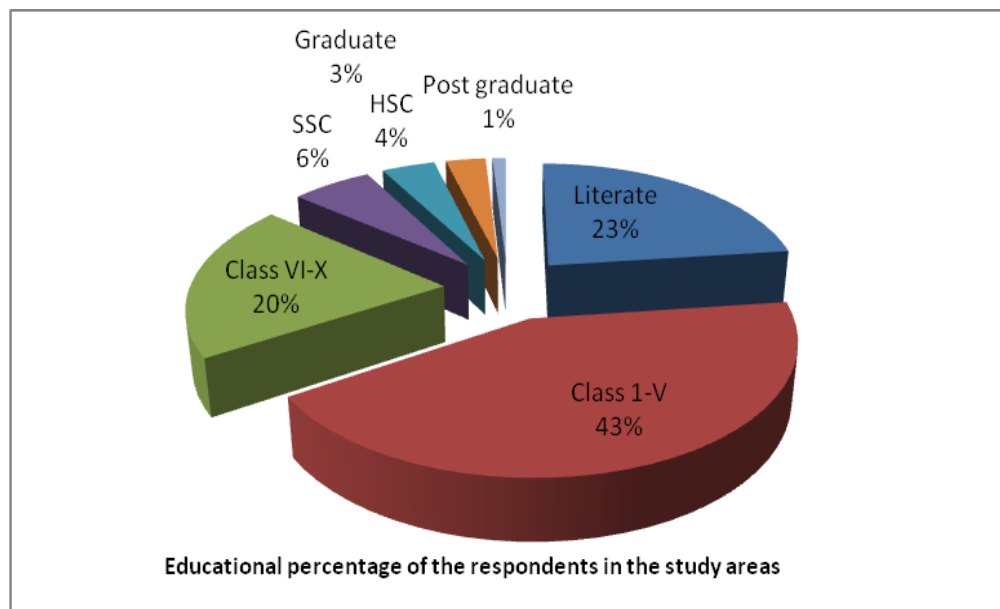


Figure 1 Educational percentage of the respondents in the study areas

### Second theme: Livelihood and Vulnerability

**Sources of Income:** The main sources of income are catching fish (55%), agricultural (25%), remittances (15%) and other sources (5%). It indicates that fishing, rice cultivation and remittances are the most common income sources of the study households.

### Gender and Inequality

The households of the study area think that the impact of salinity intrusion will affect men and women differently. It is mainly because of the level of exposure and different job of men and women at the family activities. It is found from the answer given by affected men and women. A few male respondent from the study area told, "We are losing rice and other

production due to salinity intrusion in the agricultural field which is directly affecting our income”. And the another women told, “I have to walk at least 2 km everyday especially during dry season to collect drinking water from the pond/PSF in which

the salinity level is low. She also said that sometimes it takes more than 2 hours which affects domestic works and taking care of small kids. Moreover, most of the women are concerned about water borne diseases and social security.

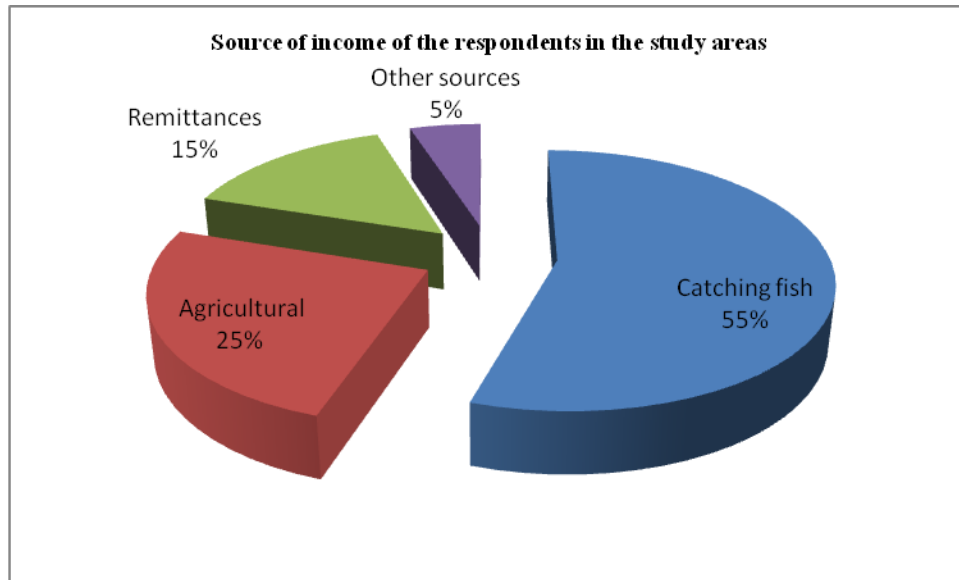


Figure 2 Source of income of the respondents in the study areas.

### **Third theme: Climate Change and Salinity**

**Impact of Climate Change on Temperature and Rainfall:** The household survey shows that the main climate change problems in the study area were temperature rise, erratic rainfall, and change in seasonal patterns, salinity intrusion, high tide, sea level rise, water logging, cyclone and tidal surge, earthquake, river erosion, thunderstorm etc. Most of the respondents told that these problems had been increased after Cyclone Bulbul. Padampukur UP Chairman told that cyclonic storm Bulbul wreaked havoc in my union. The sheer force of the storm uprooted a large number

of big trees. Pucca and tin-shed homes were damaged, and shrimp enclosures and croplands were inundated and roads alike. One man told that we have lost more than 7 people due to cyclone Bulbul. Around 30% respondents told that river water was rising (nearly 5 ft.) from a decade but 20% answered that the land was degrading gradually. Nearly 40% respondents said that every year at least 3 (medium and small scale) cyclones were hitting in this area in the month of March to Jun and as a result of these cyclone, a few fisherman died in every year in the sea. Besides, Earthquake is occurring in the area. Nearly 25% respondents told that owing to Earthquake

our pond water spilled over and a lot of fish left the pond. Most of the informer answered about the trend and severity of extreme events like cyclone and tidal surge were acute problem in this locality. According to Bangladesh Meteorological Department (BMD), the climatic system of Satkhira shows variations in the trend of a 69 years period (1948-2016). Annual average maximum temperature and rainfall shows a slightly increasing trend. But the trend of monsoon rainfall shows an increasing pattern while winter rainfall is slightly decreasing during the period of 1948-2016 (Haque, 2019). Moreover, the days about without rainfall were increasing over the mentioned period. The cyclone Bulbul affected the rice crops and drinking water facilities in the coastal Districts and huge saline water from Sonai, Kholpatua, Morischap, Raimangal, Hariabhanga, Ichamati, Betrabati and Kalindi-Jamuna river entered into agricultural land in coastal area specially Shyamnagar, Assasuni, Kaliganj, Sadar, and Tala upazilas. As a result of this saline water, salts are visible on the agricultural land. The study indicates that all standing crops and vegetables were damaged as confirmed by the local communities in FGD consultation. Most of the ponds were also submerged by the badly effect of cyclone Bulbul. Moreover, many of the PSFs were also fully or partially damaged.

**Trend of Salinity Intrusion:** It is important to note that salinity intrusion not only takes place at the groundwater level but also has been contaminating the surface water. Wherever there is a cyclone like that of Bulbul that occurred in November 8, 2019 a huge extent of the areas had been inundated extensively. The land was flooded, and saline water from the Bay of Bengal intruded the land and merged with the

surface water, hence overlapped with drinking water. The study indicates that due to salinity intrusion agricultural crops and human health are being affected. Nearly 90% of the respondents told that the salinity has been changed in the locality during the last 20 years at high level. Out of the total respondents, 74% told that rice (Aus, Aman and Boro) and vegetables have been the most impacted agricultural sectors by salinity and 44% comment about fisheries which has affected by salinity. They also told that fresh water fish are being affected by different diseases due to salinity. Nearly 75% respondents informed that food and nutrition has been affected in human health due to salinity intrusion and 10% conscious about social security. A few respondents are thinking of ecosystems (Mangrove and Biodiversity) about the over increasing salinity issues. The farmers as well as communities are trying to adapt to the changing patterns with assistance from the related government organizations and NGOs. The government of Bangladesh is providing infrastructural and technological options in both agricultural and drinking water facilities. A number of rice tolerant varieties have been developed due to changing pattern to adapt the adverse impacts of salinity.

#### **Fourth theme: Impact of salinity on Human Health**

Salinity creates a huge health problem in the coastal areas. As saline water mix with ground water, people are suffering from various kinds of health problem, such as diarrhea, malaria, dengue, kalazar, HIV/AIDS, enteric fever, anthrax, avian influenza, Nipah virus infection, leptosporiasis, acute respiratory infections (ARI) in recent years are alarming. Of them, dengue, malaria, diarrhea, Kalazar has already been referred as climate sensitive



diseases (Confalonieri *et al.* 2007). In addition, cholera is probably a re-emerging infectious disease in the country which is also sensitive to climate parameters (temperature and sun shine) (Wagatsuma *et al.* 2003; Confalonieri *et al.* 2007). Not only through water but also through various kinds of food grain people are getting saline more than they required. The most

vulnerable groups are the pregnant woman and the children. Higher rates of (pre) eclampsia and gestational hypertension in pregnant women living in the southern coast of Bangladesh, compared with non-coastal pregnant women, were hypothesized to be caused by saline contamination of drinking water (Khan, 1993).

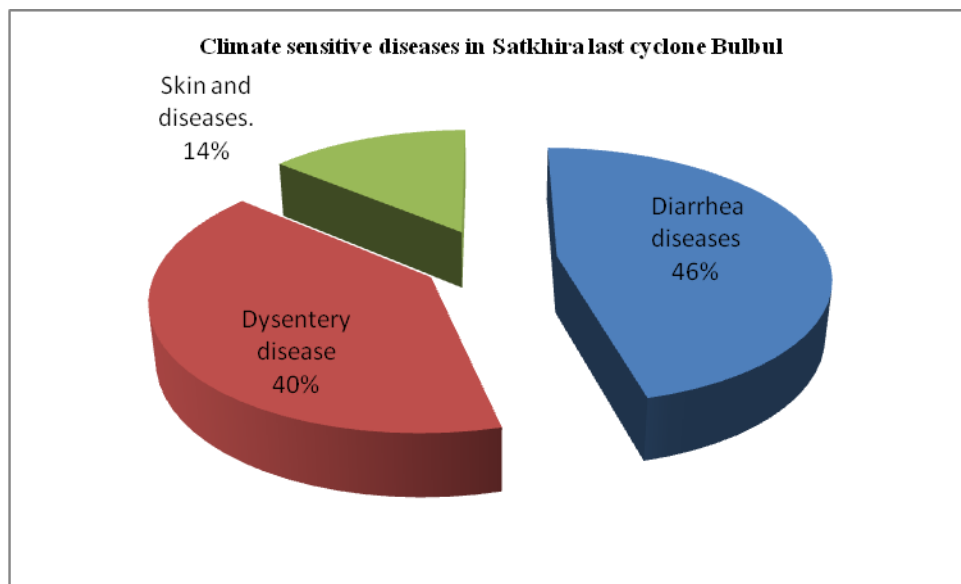


Fig 3: Climate sensitive diseases of the respondents in Satkhira after cyclone Bulbul

It may causes defective new born baby which would be a very negative signal for the future of Bangladesh. Cholera sometimes spread like an epidemic after the disaster such as flood or cyclone due to lack of drinking water and over consumption of saline water. As salinity decreases the crop production, so decreases of food supply brings poverty in this area. As a result mal-nutrition, under nutrition, water borne diseases, food borne diseases and even starvation is also an obvious effect of salinity among the coastal people. The study showed that 46% people had affected by the

diarrhea diseases while 40% people had affected by Dysentery disease and only 14% people had faced skin and other kinds of diseases. The salinity impact in relation to health cannot be ignored because incidences of water borne diseases (e.g. diarrhea and dysentery) have been much higher from the recent past in the study areas. The community believes that the chronic consumption of water directly from the pond has caused severe water borne diseases in all the study unions. It is alarming that at least one member of each of the study families suffer from either

diarrhea or dysentery in every month in the study villages. The community people strongly believed that this impact might have been correlated with salinity intrusion in the sources of water.

**Impacts of Salinity on Agriculture:** The impacts of climate change such as extreme

temperature, drought, and salinity intrusion etc. are also responsible for the declining crop yields in Bangladesh. The salinity intrusion in the coastal area is creating a serious implication for the coastal land that was traditionally used for rice production (Denissen, 2012).

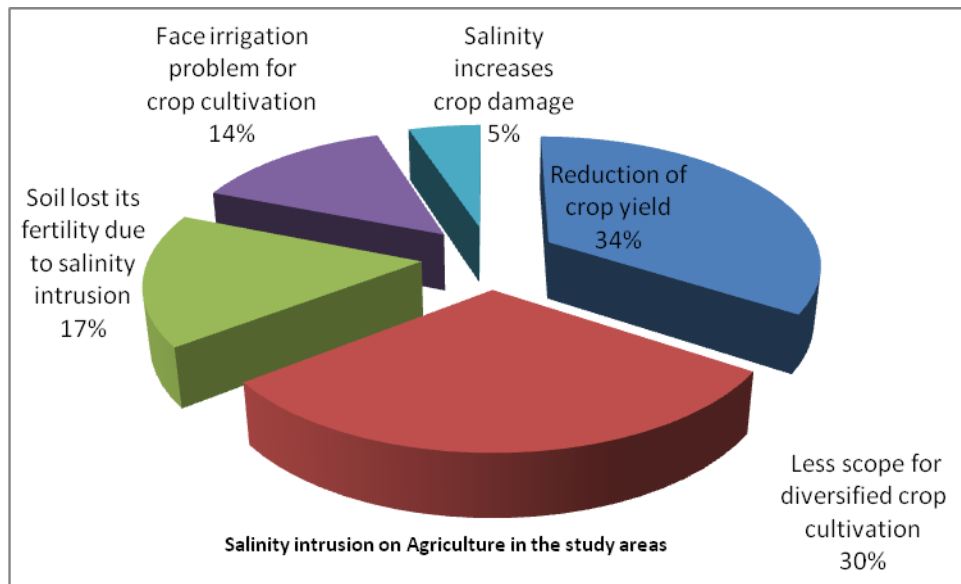


Figure 4 Impacts of salinity on agriculture as perceived by the respondents of the study area

The study showed that agricultural crop production owing to salinity intrusion at the study place. 34% respondents told about reduction of their yield. Besides, 30% respondents said that they have less scope for diversified crop cultivation due to impact of salinity at dry season in the area. On the other hand, 17% people believe that soil lost its fertility due to salinity intrusion. They also told that the salt is visible on the crop field surface during dry season and this occurrence is happening after Bulbul. Besides, 14% people face irrigation problem for crop cultivation during the summer season as the saline water enters into the circumferential canals and the

ground water is mostly affected by salinity in both shallow and deep aquifer. In addition, 5% respondents said salinity increases crop damage, and a few respondents told about salinity create delay cultivation during the cultivation period.

**Impact of Salinity on Fisheries:** Salinity intrusion affects the fish production in the coastal areas of Bangladesh. The respondents' perception is increase in river salinity is likely to change the aquatic ecosystems of coastal Bangladesh. About 25% household members said that they have experienced in saline intrusion water cultivation of fish in the dry season. 28%

said that they have found less production for salinity intrusion and 21% said about less growth of fish due to increasing salinity intrusion. 23% household members said that virus attack the fish because of salinity intrusion and 3% household members said that they found dead fishes due to salinity intrusion. This saline water intrudes in the

inland riverine areas which contribute to the reduction of fresh water bodies. This result is creating even more negative effects on the diversity of fish in the inland riverine areas across the coastal belt in Bangladesh, so they prefer to go for shrimp cultivation which is increasing salinity more and more (Alam *et al.*, 2017).

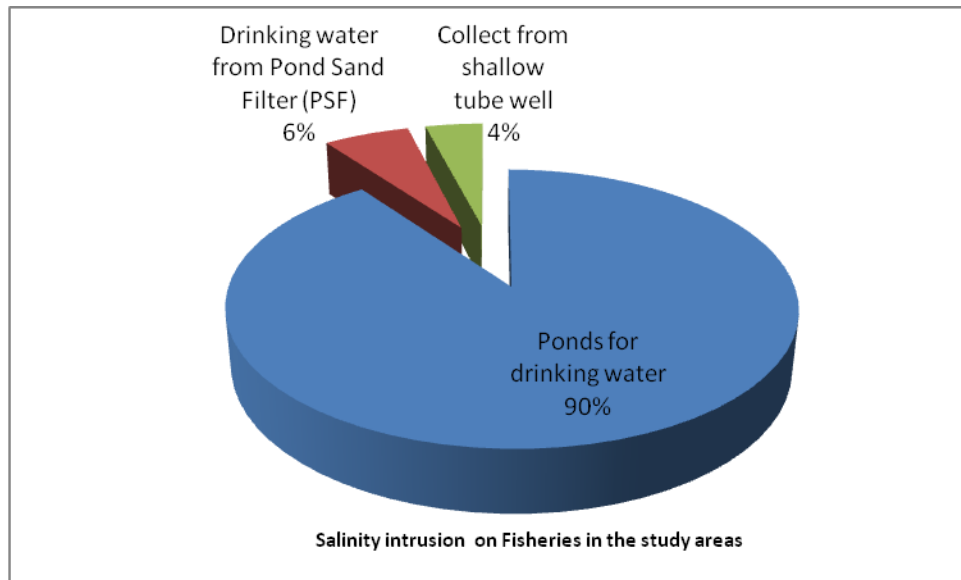


Figure 5 Salinity intrusions on Fisheries in the study areas

#### **Impact of Salinity on Biodiversity:**

Changes in surface water due to temperature and rainfall variations, inundation, and salinity intrusion would cause pressure on the aquatic ecosystem of the study areas. As ecosystem functions and services are affected by super cyclone Bulbul, it would result in reduction of aquatic yields, slow tree growth, changes in seasonal pattern, decreasing fruit trees and a decline in the number of birds. About 45% people said that the growth of the trees are lessening specially, Coconut, Superi and Bamboo tree are diminishing day-by day. On the other hand, about 25% respondents

told that a very few number of birds are seen after cyclone Bulbul. Besides, 10% people told that fruit trees are lessening due increased soil salinity of the study area. About 15% people said that sea level rising and the other 5% people told that seasonal pattern are changing.

#### **Impact of Salinity on Drinking Water:**

After extreme events like as Bulbul, respondents are facing problem in obtaining safe drinking water because of major drinking water sources are inundated or permanently damaged and many water resources are not usable for long time. it appears that more than 90% of the people

depend on the small isolated wetlands or ponds for drinking water, 6% drinking water from Pond Sand Filter (PSF) and other 4% collect from shallow tube well. But most of the households boil the pond water before they drink it. During raining season, the households usually collect rain water for the purpose of drinking. Among

the total respondents, 80% told that due to cyclone Bulbul their drinking water sources were affected and of them 87% informed that the affected drinking water sources was inundated during the mentioned period. Besides, out of the total respondents, 74% told that the pond or PSF which they use for drinking water has no salinity.

Sources of drinking water during last Cyclone Bulbul

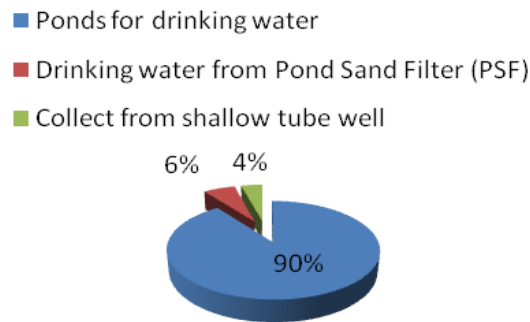


Figure 6 Sources of drinking water after cyclone Bulbul

Among the 80 respondents, most of them collected water from the far area and a few people had to depend on GoB water supply and NGO aid water. The sources of water including ponds, tube-wells, Pond Sand Filter (PSF) were also affected. All of the affected ponds had to adopt a cleaning process for further domestic use.

#### **Final theme: Adaptation in facing salinity intrusion**

During last 30 years, salinity is increasing in our research area and respondents face different kinds of problems from the salinity intrusion. Within the research area, 45% of respondents said that they had migrated from these places for short duration of time

because of salinity intrusion. 36% respondents said that they were not leaving finally but 19% respondents told that they were seeing migration to other household members for months. So, majority people of the research area were trying to cope with salinity intrusion caused by climate change but some respondents migrates for earning money. Maximum people of the research area cannot do anything to deal with salinity intrusion caused by climate change. The current coping mechanisms were not enough to adapt to increased levels of salinity especially caused by extreme events. The poverty, low level of resilience and lack of alternative livelihoods together with such climate induced hazards cause

huge losses for not only study communities but also the people of the whole coast.

There is the issue of increasing sea level rise as well which would be bringing the water line further inwards, hence affecting the coastal area in terms of agricultural productivity, drinking water facilities and also risking other livelihood options and other social securities. The impact of a cyclone will be penetrating deeper into the

land mass, thus affecting the whole coastal region and it is “over 33 million” people will be in a risky position in the near future. One third of the population living in the coast will be severely affected as there is lack of access due to scarcity of safe water sources and proper sanitation facilities. People in the study area suffer from the water crisis and sanitation facilities in this particular season.

### Conclusion

The coastal districts from South West to South East of Bangladesh are vulnerable to climate change and climate variability issues. Some of the districts including Satkhira, Patuakhali, Barguna, Pirojpur, Bagerhuti, Khulna, Barishal (out of 19) are particularly at a higher level of vulnerability probably because of their geographic location and topography. Satkhira, for example, is predicted to be one of the most substantially affected districts in the country because of the proximity of a large portion of its populations to the coast who are dependent on the natural resources base. The local communities may lose alternative livelihoods and income due to the ultimate consequences of climate change. Through the overall observations in the study areas are suffering from a wide range of climate change driven hazards and anthropogenic problems. They will also face challenges in

agriculture sectors seriously hampered due to lack of freshwater for irrigation caused by climate change. Salinity concentration has already put a threat to the crop production and a significant yield loss has already been observed in the dry season which will ultimately affect livelihood, income generation and food security. The people of Satkhira are also critically exposed to disadvantages of non-climatic factors e.g. lack of safe water supply and sanitation, health services, poverty, poor housing and growing population pressure etc. It is expected that the climate change will be the significant barrier for the poverty alleviation efforts and attempts of both government and non-government organizations. Consequences in water and health sectors might be severe in the future in the coastal zone.

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