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Research Paper

Physico-chemical assessment of water bodies and Socio-economic analysis from the coastal belt of Chittagong

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Abstract
The coastal zone of Chittagong is receiving waste and industrial effluents owing to the industrialization and population growth. The physico-chemical parameters pH, temperature, dissolved oxygen, total dissolved solids, salinity of water bodies near the coastal belt of Chittagong provides valuable information on the quality of water. From the coastal belt of Chittagong, six areas (Banskhali, Anowara, Bandar, Sagorica, Vatiary and Kumira) were selected and studied during March-April 2016. The researcher revealed the water bodies was still conducive since most of the physico-chemical parameters investigated fell within the tolerable limits. Moreover, present socio-economic status was also investigated through the coastal belt of Chittagong

Keywords
Coastal belt of Chittagong, Physico-chemical assessment, Climate change, Natural hazards, Socio-economic status, Livelihoods

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1. INTRODUCTION

Water is the main resource for food supply and prime tool for household and industrial applications. The water comprises up to two-thirds of the human body. Water quality is defined in terms of the chemical, physical and biological contents of water. The quality of coastal water varies with the seasons and geological areas. Moreover, water quality changes with the discharge of pollutants to the environment causing pollution of sea water and nearby water bodies in the coastal zone. The aquatic environment with the quality of water are responsible to control of health, disease, productivity as well as related to the national socio-economy (EuropeanCommission, 2002).

There was no serious pollution problem until industrialization started as FAO (2012) concluded. In recent years, industrialization has started through the coastal belt of Chittagong. Taken together, continuous monitoring of that area is given prime importance to the researcher. Physico-chemical are one of the important water quality monitoring tools as any disturbance of these parameters may impose detrimental effect to the living organisms (G.W et al., 2015; Kabir and Naser, 2011). It is worthwhile to mention that any physico-chemical disturbance of the water health ultimately effect the national socio-economic status of the country.

Over the past few decades, Bangladesh has experienced severe climate induced natural hazards especially in the eastern coastal part of Bangladesh. According to UNDP, Bangladesh is no one vulnerable country in terms of cyclone and the 6th most vulnerable country in terms of floods (Siddique et al., 2010). Climate change further intensifies the vulnerability in recent year. As elsewhere in the world, the number of occurrences of disastrous events over the past decade or so has indeed increased dramatically in the low-lying delta (coastal area), which not only has negated her development stride but also her relentless efforts to improve quality of lives millions of her poverty stricken people. Historically the country has been subject to a variety of water-related natural hazards, mostly in the forms of flood, cyclone, storms surge, river bank erosion, drought and salinity intrusion (Ahmed and Mirza, 2000; Karim et al., 1990). A large number of recent analyses suggest that such hydrological hazardous events are likely to be aggravated due to climate change (Ahmed, 2005; Reazuddin et al., 1997; Huq et al., 1996).

Ever since the global concerns have been raised about the adverse impact of climate change, the climatologists and scientists have already recognized Bangladesh as one of the most vulnerable country. The reason is obvious as it is highly vulnerable, even under no-climate change, due to many factors including its disadvantageous location, flat and low-lying topography, high population density, rampant poverty, chronic inefficiency regarding institutional aspects and poor state of economic development. The magnitude of vulnerability would just increase manifold due

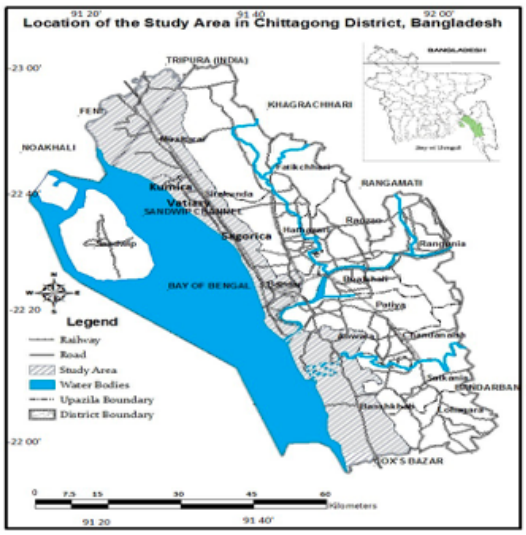

Figure 1. Location of the study area

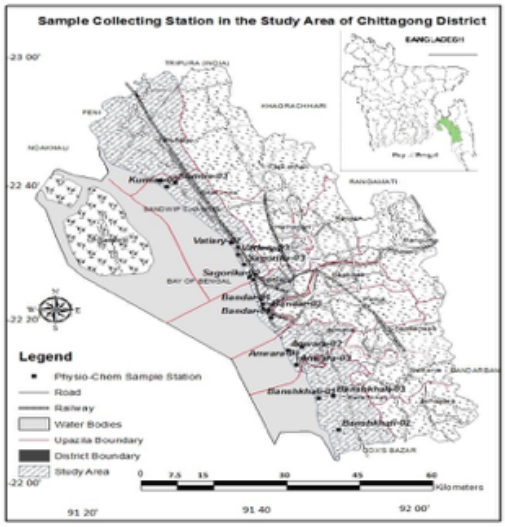

Figure 2. Sample collecting station

to the impacts induced by climate change. Recent studies suggest that all such factors would exacerbate the advertiser for the poor people of Bangladesh under climate change scenarios (Huq et al., 1996; Warrick and Ahmad, 1996).

This study was conducted to observe some physico-chemical parameters of the water bodies near the coastal belt of the Chittagong. In addition this paper also shed light on the impact of climate change on the livelihoods of coastal people which may help government as well as policy maker to formulate policy and implement it to protect coastal people. There few studies on the physico-chemical assessment of the water bodies near the coastal belt of Chittagong of only one or two selected sites, whereas, in our study we investigated the almost whole coastal belt of Chittagong consisting of six areas. In addition, to the best of our knowledge, no study has been carried out with the investigation of physico-chemical analysis of water bodies near the coastal belt in combination with the socio-economic status of the public or workers of the coastal belt of Chittagong.

2. EXPERIMENTAL SECTION

The land area of Bangladesh is approximately 147,570 km^2 and its coastline stretches some 716 km. In the present study, we choose the total coastal belt of Chittagong consisting of six areas. These are Banskhali, Anowara, Bandar, Sagorica, Vatiary and Kumira (Figure 1). The positions of the sampling stations (Figure 2) were accurately located by using a hand held Global Positioning System (GPS) (Raja Reddy and Jayaraju, 2012) and Geographical Information System (GIS).

2.1 Physico-Chemical Assessment

Water samples were used directly for measurement of pH within 5 minutes of collection. Water samples were used for measurement of temperature by thermometer directly (Velsamy et al, 2013). To measure the dissolved oxygen (DO), water samples were collected in narrow mouth glass stopper bottle. Added manganese sulphate solution, alkali-iodide azide solution and conc. sulfuric acid followed by shaking in usual way. Protected sample stored at this point from strong sunlight and measurement of DO by DO meter (Model: YK-22DO) as early as possible. Total dissolved solids (TDS) (ppm) were measured using Portable pen type TDS meter, ECO, TDS-3C (Zhejiang, China). Salinity (ppt) was measured using Portable Salinity Refractometer, 43036 STX-3 (Vee-Gee, China) (Arumugam and Sugirtha, 2014). Noise pollution is one of the silent of all forms of pollutions is measured by a digital read out.

2.2 Socio-Economic Analysis

The study follows both quantitative and qualitative approach. For conducting this study, a semi-structured interview questionnaire has been used to obtain quantitative data from 4 coastal points in Chittagong area that are Banshkhali, Anawara, sitakundu and vatiary. With an aim to arrange this work in a representative manner, 60 samples were selected purposively from the study area. Each man and woman age (15-85) who lives in the selected area are the unit of the study. Statistical analysis used SPSS windows program (version 17.5) to process the data in this work. In addition, to find out the in-depth view and knowledge about climate change and livelihoods of coastal people and to verify the authentic information at least four Focus Group Discussions (FGDs) were conducted in the study area. Relevant information was also collected from secondary literatures including books, journals, annual reports, newspaper and magazines etc.

3. RESULTS AND DISCUSSION

Chittagong the commercial capital of Bangladesh is a reason of concern in recent years. Failure to provide for environmentally sustainable development procedure of the coastal belt of chittagong is an alert to the whole Bangladesh. Take this reason

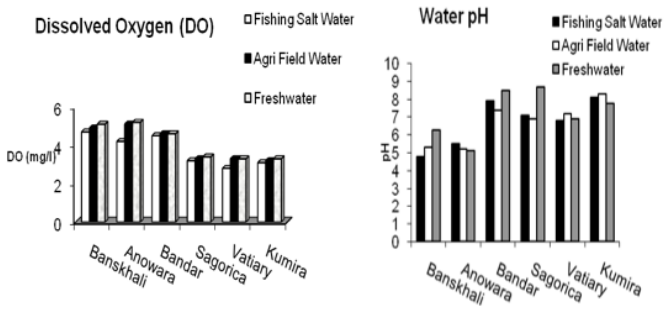

Figure 3. DO and pH values of fishing, agricultural field and fresh water

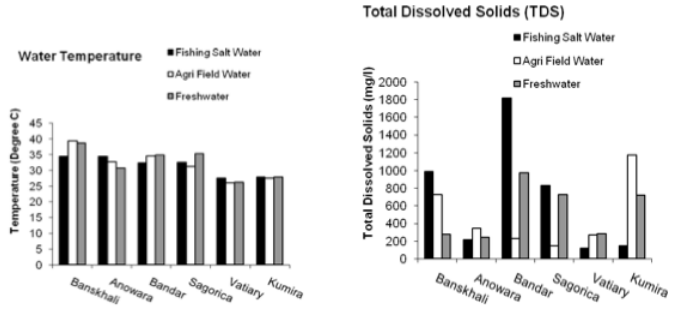

Figure 4. Temperature and TDS values of fishing field, agricultural field and fresh water

to give prime importance, physico-chemical assessment of the water bodies and the socio-economic analysis from coastal belt of Chittagong has been carried out.

3.1 Dissolved Oxygen (DO) and pH

It is worthwhile to mention that liquid wastes, oil or other auxiliary chemicals like salt, acid, paint etc severely affect water quality. Figure 3 shows the corresponding DO and pH values.

Regulation of many chemical process and biological activity within a water body depends on DO. Abdus-Salam et al. (2010) reported 4-9 mg/l of DO is the optimal range that will support a large, diverse fish population. Generally, DO concentrations above 5 mg/l are considered supportive for marine lives while below are harmful. At about 3 mg/l, bottom fishes may start to leave the area, and the growth of sensitive spices such as crab larve is reduced. At 2.5 mg/l, the larvae of less sensitive species of crustaceans may start to die and the growth of crab species is limited. Below 2 mg/l, some juvenile fish and crustaceans that cannot leave the area may die, and below 1 mg/l, fish totally avoid the area or begin to die in large numbers (U.S.EPA, 2000; Sreenivasulu et al., 2015). It was observed that the DO values ranged from 2.8-5.2 mg/l. The highest value of 5.2 mg/l at Anowara, Chittagong and lowest value of 2.8 mg/l at Vatiary, Chittagong were found. The lower value of DO in the area of Sagorica, Vatiary and Kumira may be due to presence of various industries. The present DO status was not sufficient and is an alarming condition indeed for the future. However, in this range of DO, many aquatic animals and aquatic insects can survive.

The water pH is an indicator of hydrogen ion concentration in the water. The pH values of fishing field, agricultural field and natural fresh water (ponds) were also present in Figure 3. The recommended range for water-pH values are 6.0-8.5 (WHO/UNEP and GEMS, 1989). pH values at Banshkhali (4.8-6.3), Anowara (5.1-5.5), Bandar (7.4-8.5), Sagorica (6.9-8.7), Vatiary (6.8-7.2), and Kumira (7.8-8.3). The little lower value of pH at Banskhali and Anowara might be due to high temperature of that region (R et al., 2016). Nevertheless, it can be concluded that the pH value lies between the acceptable limit.

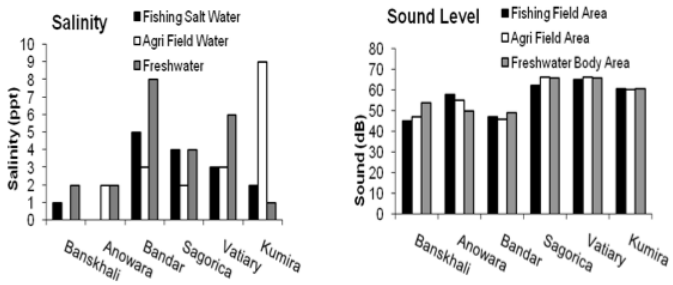

Figure 5. Salinity values and sound level of fishing field, agricultural field and fresh water

3.2 Temperature and Total Dissolved Solids (TDS)

The temperature and TDS values of fishing field, agricultural field and natural fresh water (pond) were depicted in Figure 4. The standard expected temperature values are 20-30 °C (M.F and Rahman, 2000). The temperature values were found in our investigation at Banshkhali (34.5-38.8 °C), Anowara (30.7-34.4 °C), Bandar (32.4-35 °C), Sagorica (31.2-35.4 °C), Vatiary (26-27.6 °C), and Kumira (27.6-27.9 °C). It is to notify that that the temperature ranges Banshkhali, Anowara and Bandar area were little bit high as per the standard limit (20-30 °C). However, it can be concluded that the temperature values largely lies between the acceptable limit.

The contents of inorganic salts and soluble organic matter from different sources indicating the presence of water TDS (R et al., 2016). The TDS content varied from less than 30 to as much as 6000 mg/L depending on the solubility of inorganic salts and organic matter in different regions WHO/UNEP and GEMS (1989). A water TDS value less than 1000 mg/L is fairly acceptable to the consumers (W.H. and H.J, 1969). Actually, the physical and chemical nature of the natural water disturbed due to the intrusion of TDS (W.H. and H.J, 1969). It was observed that TDS values ranged from 114-1814.92 mg/L (Figure 4). The highest value of1814.92 mg/L at Bandar, Chittagong (Figure 4) and the lowest value of 114 mg/L (Figure 4) at Vatiary, Chittagong were found. The higher value of TDS at Bandar and Kumira area (Figure 4) of the coastal belt of Chittagong indicates the disturbed water. This phenomenon can be explained by the fact that the

Table 1. Highest and lowest sound level (db) at each area

Area	Highest Sound Level (db)	Lowest Sound Level (db)
Banshkhali A1	43.3	47.1
Banshkhali A2	41	53.4
Banshkhali A3	49.5	58.4
Anowara A1	46.2	70.1
Anowara A2	48.9	62.2
Anowara A3	42.6	57.4
Bandar A1	42.2	51.7
Bandar A2	42.1	51.3
Bandar A3	43.1	54.8
Sagorica A1	57	67.2
Sagorica A2	62.4	80.2
Sagorica A3	51.5	63.2
Vatiary A1	58.1	72.2
Vatiary A2	51.3	81.2
Vatiary A3	54	78
Kumira A1	48.5	73
Kumira A2	49.3	71.2
Kumira A3	49	72

A2, and A3 indicates three different point of that specified area

mixing of various disposable materials with water.

3.3 Salinity value and Sound Level

Salinity is fundamental water quality parameter monitored by freshwater and marine water ecologists due to its effect on the biota (Sreenivasulu et al., 2015). Most aquatic organisms are adapted to only a narrow range of salinity. Generally the range of salinity in brackish water is from 0.5 to 30 ppt (Karleskint et al., 2012). In this study, salinity ranged from 0.0 to 9.0 ppt was recorded. The highest value of 9.0 ppt at Kumira and 8 ppt at Bandar, Chittagong and lower value of only 0.0 ppt at Banskhali and Anowara, Chittagong were found.

It is worthwhile to mention that all samples has been carried out in the premonsoon period (March-April) and the lower values of salinity were found at every site of sample stations could be explained by the input of rainwater. The more decrease in the Banskhali and Anowara site could be explained by the process of dilution by the wastewater discharged into this site.

The subject of noise pollution is one of the most silent of all forms of pollution. Sound that is uncomfortable for human beings is called noise. Continuous exposure to noise leads to the hearing impairment and some other effect as well. Moreover, industrial noise affects the workers and the residents close to industrial proximity. Sound is measured in a unit known as decibels (dB). The average sound level of the coastal belt of chittagong (Six point) are presented in the following Figure 5. Moreover, highest and lowest sound level of each point were also presented in Table 1.

Noise level in dB, safe exposure time per 24 hours is 80 dB 8 hours, 86 dB 2 hours, 92 dB 30 minutes, 98 dB 7 minutes, 100 dB, no more than 15 minutes (NIDCD). In our present investigations, we have observed that sound level in Banshkhali, Anowara, Bandar, and Kumira were within the permissible limit whereas in Sagorica and Vatiary were not because of the presence of ship-breaking industry over Sagorica and Vatiary region.

3.4 Socio-Economic Assessment

3.4.1 Demographic and socio-economic status

Bangladesh is one of the most vulnerable countries in the world in term of climate induced natural hazards especially in the coastal belt region in Chittagong. This affects severely to the livelihoods of coastal people. From the table, it is found that A1, the educational rate among the people of coastal belt area is not good, because a trifling portion 7% respondent passed higher secondary school certificate. Primary education is the highest education (38%) among the respondents whereas illiteracy rate is same in the study area. Being lower educated many of this people are not competent to combat natural hazards in their locality, consequently they fall vulnerability of climate induced hazards (see Table 2).The table also shows that majority of the people who live in the study area are Muslim in religion (65%). The result shows the occupational status of respondents of the coastal belt area where approximately 55% respondents replied that they work as fisherman. The inherent cause of taking this profession as the source of their livelihoods is the availability of fishes in the adjacent sea. Service holder is the second largest occupation in the selected area that is approximately 17%. Only a trifling number of people (15%) do agricultural activities as their occupation. The inherent cause is that due to climate induced natural hazards; a large proportion of the land of the coastal area is inundated by salinity water during the cyclonic storms. This water severely affects the soil and reduces the capacity of producing crops. For this why, people are bound to set apart from doing agricultural activities. In addition, approximately 8% respondents are unemployed as they cannot get job/or loss their working sources due to climate induced natural hazards (see Table 2).

From the table, it is found that a large proportion of the respondent income level is within $ 40 and approximately 27% respondents earn more than $110. According to the respondents, day by day, their income level is decreasing due to the limited working sources. Many of them claimed that before the natural hazards, they managed to earn much but now they cannot do that due to frequent natural hazards. For example, they cannot get much profit from the cultivation as soil salinity reduces the crop productivity. The table also shows the monthly expenditures of the hazards affected people. Approximately, 59% respondents' monthly expenditure level is $1-80. Only 33% respondents can spend more than 110 USD monthly as they can earn much comparing the other affected people (see Table 2).Many of the respondents claimed that they have been facing deficient throughout the year as they have to spend much comparing their income. For example, they have to borrow money from relatives/NGO to bear the expenses of their family.

Table 2. Demographic and socio-economic variables of the respondents

	N = 60	%		N = 60	%
Marital status			**Occupational status**		
Married	47	78.3	Farmer	9	15
Unmarried	13	21.7	Laborer	3	5
Religious status			Fisherman	33	55
Hindu	21	35	Service holder	10	16.7
Muslim	39	65	Unemployment	5	8.3
Educational status			**Monthly Income (USD) ($1=80 BDT)**		
Illiterate	23	38.3	01-40	21	35
Primary	23	38.3	41-80	13	21.7
Secondary	10	16.7	81-110	10	16.7
Higher secondary	4	6.7	111-above	16	26.7
Monthly expenditure (USD) ($1=80 BDT)					
01-40	19	31.7			
41-80	16	26.7			
81-110	5	8.3			
111-above	20	33.3			

Source: Field work, March, 2016

Table 3. Climate change and its possible impacts on the livelihoods of coastal people

Change of occupations	**N = 60**	**%**	**Change in family income**	**N = 60**	**%**
Yes	33	55	Yes	44	73.3
No	27	45	No	16	26.7
New occupation due to hazards			Situation of family income		
Agro laborer	16	26.7	Increased	17	28.3
Industrial laborer	9	15	Decreased	37	61.7
Fisherman	10	16.7	Stable	6	10
Van puller	5	8.2			
Service holder	4	6.7			
Marginal labor	16	26.7			
Food insecurity in terms of consumption					
Deficit of food through whole year	17	28.3			
Seasonal deficit especially dry lean period	15	25			
During disaster period	10	16.7			
Neither deficit nor surplus	16	26.7			
Surplus	2	3.3			

Source: Field work, March, 2016

3.4.2 Changing occupations due to climate induced hazards

From the table 3, it is found that about 55% of the respondents have changed their occupations due to climate induced natural hazards. The frequency and intensity of natural hazard has decreased soil fertility by inducing salinity in the soil that has reduced the productivities of crops. In the same way, excessive salinity declines the shrimp production and other fish production in the river. So fisherman cannot get much fish in the river. So a large proportion of this people are bound to change their

Table 4. Climate change impacts on agricultural productivity and food security

Problems of crop productivity	N = 60	%	Climate change responsible for low yielding of crop	N = 60	%
Yes	48	80	Yes	52	86.7
No	12	20	No	8	13.3
Types of problem			Inundation of agriculture land is great threat for food security		
Less yielding	21	35	Yes	52	86.7
Affected by diseases	14	23.3	No	8	13.3
Absent of irrigation	3	5	Access of food immediately after natural disaster		
Increased of soil salinity	22	36.7	Yes	18	30
Increase of flood, soil salinity due to Sea level rise that affect food security			No	42	70
Yes	47	78.3	Negative impacts of climate change on livestock		
No	13	21.7	Yes	47	78.3
Factors affecting agriculture productivity			No	13	21.7
Soil erosion	7	11.7	Natural hazards and impacts on livestock		
Flood	14	23.3	Cyclone storm washed away the cattle	20	33.4
Soil salinity	23	38.3	Many cattle have injured due to disaster	8	13.3
Cyclone	10	16.7	Unavailability of sufficient animals fodders	10	16.7
Tidal surge	6	10	insufficient shelter for cattle	8	13.3
			Spreading of diseases	14	23.3

Source: Field work, March, 2016

occupation (see Table 3). From the finding, it is found that 27% respondents have chosen agro laborer as their new occupation and marginal labor is the same as new occupation. Moreover, fisherman and industrial labor are the new occupations as 17% and 15% respondents claimed this respectively (see Table 3).From the table, it is found that 28% respondents claimed that they have food deficient throughout year and 25% respondents have deficit in dry lean periods. Only a trifling portion of respondents (3%) claimed that they have surplus food throughout the year (see Table 3).

From the table, it is found that due to climate change induced natural hazards, approximately 73% people said that their family income have changed. Moreover, among this people, 62% said that their family income decreased. However, only 28% respondents' family income increased and 10% said that their family income was stable (see Table 3).

3.4.3 Problems in agricultural productivity and food security

From the table 4, it is found that most of the people (80%) face problems in cultivating crops. About the problems of crop productivity, 37% respondents state that the intensification of salinity in the soil is the main problem where as 35% interviewees claimed that less yield is the main problem in crop productivity. However, only a small portion of the respondents (5%) said that absent of irrigation is the problems in crop productivity.

Table 4 indicates that inundation of agricultural land is the great threat for food security as 87% respondents agreed with that. About the access of food after the natural hazards, approximately 70% respondents said that they cannot get food for their survival; even they cannot have access to food in the market during the emergency periods. According to them, climate change induced hazards have severe impacts on livestock (78%) because it may destroy or wash away livestock from the habitats. About the negative effect of climate change, 33% respondents said that

Table 5. Climate change induced risk and vulnerability, coastal people face in Bangladesh

Family members face climate risk induced vulnerability	N = 60	%	Perception regarding frequency and severity of natural disaster	N = 60	%
Yes	37	61.7	Intensity has been increased	36	60
No	23	38.3	Severity has been increased	6	10
Ways they are affected in hazards			Intensity and severity have been decreased	9	15
Physical injured	23	38.3	Normal	9	15
Injured to other family members	7	11.7	Causes of most vulnerability of women children. etc during natural disaster		
Evacuation forced from the damage of property	17	28.3	Comparatively lower educated	7	11.6
Homestead diseases	23	38.3	Cannot swim	4	6.7
Nature of disasters in the affected area			Unable to get support	12	20
Flood	11	18.3	Had to take additional workload	19	31.7
Tidal surge	17	28.3	Had to suffer from various diseases	14	23.3
Cyclone	16	26.7	Facing deprivation	4	6.7
Erosion	5	8.3	Climate change limits women economic activities		
Water logging	3	5	Yes	44	73.3
Salinity	8	13.3	No	16	26.7

Source: Field work, March 2016

Table 6. Climate change induced natural hazards and health problems of coastal people

Suffering from any diseases	N = 60	%	Degree of suffering after natural disaster	N = 60	%
Yes	49	81.7	Extreme	42	70
No	11	18.3	High	10	16.7
Degree of suffering before natural disaster			Moderate	5	8.3
Extreme	2	3.3	Low	3	5
High	2	3.3			
Moderate	12	20			
Low	28	46.7			
Nothing	16	26.7			

Source: Field work, March, 2016

cyclonic storm wash away livestock during the hazard and 23% said that it spreads disease in livestock. Moreover, 13% interviewees opinioned that due to insufficient secured place, livestock are easily affected or died in natural hazards.

3.4.4 Risks and vulnerabilities that coastal people face

From the table 5, it is found that coastal people envisage different types of vulnerability during natural hazards as 62% respondent agreed with this. About the vulnerability 38% respondents said that they face physical injure during hazards. Another 38% respondents claimed that they fall vulnerability by the affliction of homestead diseases. Moreover, 12% respondents said that their family members face injured during natural hazards (see Table 5).

About the nature of hazards, the coastal belt people of Chittagong area said that tidal surge and cyclone are the common hazards as 28% and 26% explained this respectively. According to the respondents the frequency and severity of natural hazards has increased to a great extents in the recent year due to climate change variability. Approximately 60% respondents opinioned that the intensity of hazards augmented and only 15% said that the occurrence of hazards is normal (see Table 5).

From the study result, it is found that women, children and elderly people are the most vulnerable during the natural hazards.

Table 7. Coping strategies and structural challenges of coastal people in Chittagong coastal zone

Strategy to overcome losses of disasters	**N = 60**	**%**	**Challenge face with house during disaster**	**N = 60**	**%**
Borrow money from the local money lenders at high interest	20	33.3	Yes	54	90
Borrow money from NGOs	10	16.7	No	6	10
Relied on relief	13	21.7	Kind of challenges		
Borrow money from relatives	2	3.3	Damage the house fully	21	35
Sold livestock	3	5	Damage the house partially	30	50
Sold/leased land	2	3.3	Washed away	9	15
Migrated elsewhere	4	6.7	Damage of infrastructure due to disasters		
Changed occupation	6	10	Destruction of road	27	45
Kinds of relief they relied on			Damage of embankment	17	28.3
Cash money	15	25	Damage of educational institution	7	11.7
Food	19	31.7	Damage of mosque/temple/social/cultural institutions	9	15
House building materials	7	11.7	Having sustainability of livelihoods in coastal areas		
Medicine	6	10	Yes	25	41.7
Livestock	5	8.3	No	35	58.3
Agriculture inputs	6	10	Ways of bringing sustainability of coastal people		
Clothes	2	3.3	Being aware	8	13.3
Sold goods to cope with disaster			Developing infrastructure	26	43.3
Yes	41	68.3	Saving the environment	15	25
No	19	31.7	Combating with environment	11	18.3
Housing structure of the locality					
Tin shed	31	51.7			
Wall made by clay (mud) and thatched roof	17	28.3			
Thatched roof with bamboo wall	12	20			

Source: Field work, March, 2016

The inherent causes of this according to respondents are working load; illiteracy, affliction to diseases, deprivation, unable to swimming etc. (see Table 5). Moreover, most of the respondents claimed that climate change limits women's economic activities. For example, they (women) cannot do homestead activities, cannot prepare food, cannot collect forest creepers, larvae etc.

From the Table 6, it is found that approximately 82% people afflicted from different diseases during and after the natural hazards. About the degree of suffering before the natural hazards approximately 47% respondents said that their suffering degree are low, and 27% respondents said that they do not afflicted from any diseases. However, about the degree of suffering after the hazards 70% respondents said that they suffer from diseases extremely and 17% said that they suffer highly.

3.4.5 Structural challenges that coastal people face

From the study results, it is found that people of the coastal area are frequently faced with challenges due to their poor housing structure as 90% respondents explained this. More than 50% people said that their houses were made with tin sheds which

are very much vulnerable during cyclonic hazards where as 28% houses were built with mud with thatched roof which are vulnerable during tidal surges and floods. So this people are easily affected in the natural hazards. About the nature of challenges of housing structure, 50% respondents claimed that their house damaged partially and 35 % said that it was destroyed fully. Moreover, about the damage of infrastructure, approximately 45% respondents said that hazards had destroyed road massively and 12% opinioned that it destroyed educational institutions (see Table 7).

3.4.6 Coping mechanisms that coastal people depend on to overcome hazards

From the study, it is found that the people of Chittagong coastal zone apply different strategies to overcome the severity of natural hazards. For example, approximately 33% respondents said they lend money from local money lender with high interest to overcome hazards situations. Roughly, 22% people depend on relief for their survival in disaster periods and 10% people change their occupation as strategy to overcome the losses of disaster (see Table 7).Moreover, the relief on which people depend in disaster periods are mainly foods, house building materials, water, medicine, cash money, livestock and so on. The finding indicates that 32% respondents get food as relief and 25% as cash money during natural hazards. Moreover, 12% and 10% respondents said that they get house building materials and agriculture inputs as relief respectively during hazards. In addition, 68% respondents sold their goods, i.e. ornaments, livestock, and land to cope with the disaster.

About the prevalence of sustainable development in coastal area, majority of the respondent (58%) claimed that there is no sustainable development in Chittagong coastal area. However, to bring sustainability in the locality, they give priority on developing infrastructure (43%), saving environment (25%), and being aware (13%) about the environment.

4. CONCLUSIONS

Conclusively, in the above section of this study, water quality in terms of physico-chemical parameters of the coastal belt of Chittagong was assessed. The values obtained for water quality such as pH, temperature, dissolved oxygen and salinity were within the recommended value, however, the TDS values were not considerable indicating the disturbed water. It is concluded that the values were in recommended limit except the TDS value of World Health Organization (WHO) and United State Environmental Protection Agency (USEPA) for survival, metabolism and physiology of aquatic organisms. Moreover, the sound level at the area of Vatiary are not within the permissible limit whereas Banskhali, Anowara, Bandar were in the permissible limit.

Coastal zone of Chittagong has already experienced different climatic hazard and it is on rise due to climate change. Soil salinity, cyclone, tidal surge, water logging, floods, heavy downpours etc. are some of the common hazards in the coastal area of Chittagong. Moreover, these devastating hazards due to climate change affect severely to the life and livelihoods of coastal people as it destroyed their standing crops, washed away livestock and fish farms, wiped out housing structure and other infrastructure in that locality. Therefore, along with government, other active agents like civil society should pay keen attention to the issue and should formulate effective strategy to combat hazards in coastal area. In the same way, coastal people should take institutional training about disaster management and also should use their existing resources to bring sustainable livelihoods in the coastal area of Bangladesh.

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