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**Article** *in* Journal of Aquaculture Research & Development · September 2015

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Miah et al., J Aquac Res Development 2015, 6:9
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# Present Status of Coastal Fisheries in Sitakunda Coast with Special Reference on Climate Change and Fish Catch

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## Abstract

Climate change is the burning issue of the present world and considered as a social fabrics. Present study was carried out at Sitakunda coast, Chittagong and aimed to assess the trend of climate change and identify its impact on coastal fisheries. Meteorological data for assessing climate change trend from 1980 to 2010 were collected from meteorological department and primary data from extensive field survey to identify the climate change impact on fisheries resource. Data revealed that seasonal pattern of meteorological parameters i.e. temperature and rainfall has been changing for past thirty one years. The fisheries resources of Sitakunda coast have been declined gradually for the past thirty one years as a consequence of continuous change in the climatic pattern.

**Keywords:** Coastal fisheries; Climate change; Sitakunda; Temperature; Rainfall

## Introduction

The human demand for fish as a consumable, because of its rich protein content, has been going up the world over, consistent with the growth of human population [1]. In 1970, coastal fisheries constituted only 10.6% of the total fishery production but the proportion of coastal fisheries production increased to 28.2% in 1993. In 1996 this proportion, however, declined to 22% [2]. The coastal belt of Bangladesh is blessed with a wide variety of economically important coastal fisheries resources is important as much as 25% of the population, estimated 30.6 million people live there [3]. This is an important area where active fishing is practiced and hence contains unique importance in the fishery of the Bay of Bengal [4].

Coastal areas are highly vulnerable to both natural and man-made hazards and disasters like coastal flooding, cyclones, storm surges, erosion, salinity, arsenic contamination, and pollution [5]. These disasters are triggered by a number of critical factors. Temperature is fundamental component of climate which has wide ranges effects on ecosystem. Changes in temperature can in turn cause change in sea temperature, precipitation patterns and other aspects of climate. Generally, increased temperature results in evaporation from the oceans and lands, leading to more overall precipitation. Rainfall can also affects the amount of water available for drinking and irrigation and can also determine what types of animals and plants can survive in a particular place [6]. Change in rainfall can disrupt a wide range of natural process, particularly if these changes occur abruptly and living species don't have time to adopt [6]. Sea level change can affect mangrove and their animals in coastal areas. For example, rising sea levels can lead to increased flooding and erosion, which is a particular concern in low lying areas in coast. The sea level changes that affect coastal systems involve more than just expanding oceans. In order areas, land can sink because of erosion, sediment compaction, and natural subsidence. Sea level rise also can alter ecosystem, transforming marshes and other wetlands into open waters and freshwater system to salt water. Sea level rise in the coming decades will create over 25 million climate refugees [7]. Hurricanes, tropical storms and other intense rotating storms fall into a general category called cyclone. The associated storm surge: the large volume of ocean water pushed ashore by the cyclone's strong winds can also cause severe flooding and destruction [8].

Sitakunda is an area along the south eastern coast of Bangladesh with an area of 483.97 sq km, is bounded by the Feni River on the north, the Karnaphulli River on the south and the Sandwip channel on the west. It is one of the western most locations of Chittagong by the Sandwip channel. It has a population of nearly 3, 35, 180. There are 8 unions in Sitakunda. Main occupations of the inhabitants are agriculture, fishing, agricultural laborer, wage laborer, transport, business, service and others [9].

A large number of the populations of Sitakunda coast are directly or indirectly dependent on the local inshore capture fishery. It also plays an important role in the rural economy and the livelihood of the rural population. However a few researches have been conducted on the effects of climate change on fisheries resources of Sitakunda coast. Hence, the present study was conducted to get a preliminary idea about the effect of climate change on the fisheries resources of Sitakunda area.

## Materials and Methods

Participatory rural appraisal (PRA) was carried out using field observations and community level group meeting with different stakeholders group to gather primary information, following the approaches [10-13]. Data on community perception were collected through structured questionnaire survey, focus group discussion and participatory observation. Questionnaire interviews are suitable for eliciting perceptions, motivations and feelings [14]. Questionnaire was prepared with a varieties of questions emphasizing on people engaged in coastal capture fisheries activities, harvested fish, catch trend, duration of fisheries operation, most abundant species, problems of fishermen,

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**Received** June 03, 2015; **Accepted** June 15, 2015; **Published** September 15, 2015

**Citation:** Miah MNU, Shamsuzzaman MM, Harun-Al-Rashid A, Barman PP (2015) Present Status of Coastal Fisheries in Sitakunda Coast with Special Reference on Climate Change and Fish Catch. J Aquac Res Development 6: 362. doi:10.4172/2155-9546.1000362

suggestions of fishermen for the management of coastal fisheries management. Questionnaire for people engaged in coastal capture fisheries activities. Participatory observation offer a good opportunity to get a comprehensive and authentic insight in actual situations of the evaluation topic including "actions, conversations, and physical descriptions" [14]. Participatory observation was conducted to realize the existing realities of climate change impact on fisheries resource. FGD were conducted to identify the seasonal and daily activities of the community as it has the advantage that a tendency of self-correction mechanism within the group because if one person put across an over-favorable picture of his/her own or group's behavior, a peer would give a more realistic observation. Greenhouse gases, high temperatures, high rate of evaporation, heavy rainfall, high humidity, fairly marked seasonal variations (hot summer season, hot and humid monsoon season and cooler and drier winter season), cross boundary river flows, mean sea level are related with meterological condition [15-17].

Temperature and rainfall, cyclone intensity data (1980-2010) were collected by Bangladesh Meteorological Department (BMD) which keeps historical records from weather coastal station around the Bangladesh. To get a specific view of the rising of the sea level in Bangladesh, an average mean sea level was calculated based on the Permanent Service Mean Sea Level (PSMSL) database from the Proudman Oceanographic Laboratory. The average sea level in the Bay of Bengal has risen from 1979 until 2003. This rise of sea level is in line with the global sea level rise. Yearly, monthly and seasonal temperature and rainfall, cyclone intensity and sea level data variation, comparison and distribution were evaluated using computer program Microsoft excels.

## Study Area

Sitakunda coast was mainly selected as research site which is one of the western most locations of Chittagong and Chittagong hill tracts. It is situated at the north-western part of Chittagong district between 22°34' N and 22°43' N latitude and 91°38' E and 91°41' E longitude. It occupies an area of 483.97 sq. km and 23 miles away from the port city Chittagong. It is delimited in the north by Feni River, the Karnaphulli River in the south and the Halda River in the east and the Sandwip channel in the west. The richest Sandwip channel (area of 1723.75 hectare) is adjacent to the Sitakunda coast (Figure 1). There are 14 canals are crossed and 16 marine fish landing canters in Sitakunda area [9].

## Results and Discussion

### Meteorological trend: the sign of climate change

Average annual (1980-2010) temperature have been compared between Sitakunda and coastal areas of Bangladesh as a whole showed in Figure 2. The highest average annual temperature in Bangladesh coastal areas was recorded 27.29°C in 1998 (May) at Teknaf and the lowest average annual temperature 21.35°C in 1980 (December) at Cox's Bazar. In Sitakunda, the highest average annual temperature was recorded 26.96°C in 1998 (May) and the lowest average annual temperature 24.63°C in 1997 (January).

The climate change parameters have considerable impact on coastal fisheries. In the study (1980-2010), the highest and lowest average annual temperatures at Sitakunda coast were recorded 26.96°C (1988) and 24.64°C (1997) respectively. Ali et al. [14] recorded temperature which varied from 26.4°C to 33°C at Moheskhali channel. The highest and lowest annual average temperature of coastal area of Bangladesh were recorded 27.29°C of 1988 at Teknaf and 21.35°C of 1980 at Cox's Bazar. The average temperature of Sitakunda varies from season to season. The temperatures of monsoon and post-monsoon season have risen, the winter season temperature has remained stable and the pre-monsoon season temperature has slowly declined.

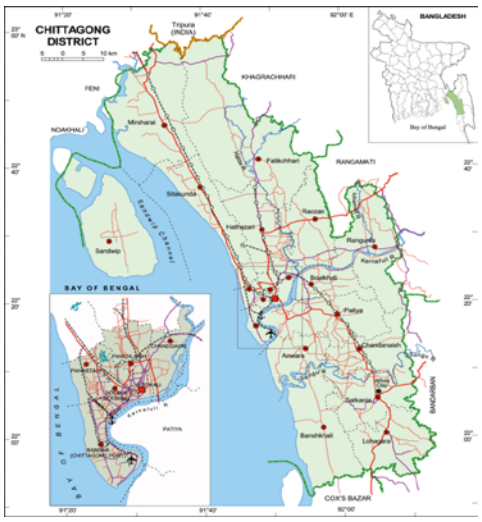


**Figure 1:** The study area (Sitakunda coast) (Banglapedia, 2009).

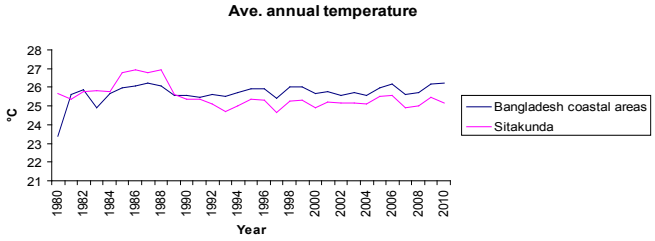


**Figure 2:** Graphical comparison of average annual temperature (°C) between Bangladesh coastal areas and Sitakunda.

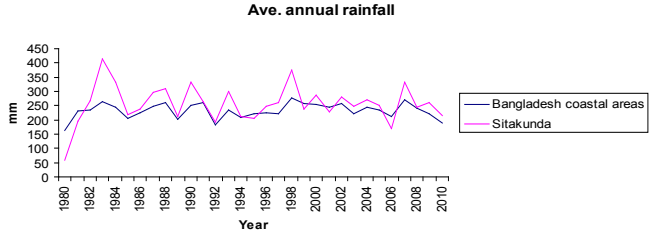


**Figure 3:** Graphical comparison of average annual rainfall (mm) between Bangladesh coastal areas and Sitakunda.

Average annual (1980-2010) rainfall have been compared between Bangladesh coastal areas and Sitakunda showed in Figure 3. During fro the pre-monsoon (April, 103.13 mm) and monsoon (July, 660.07 mm) season rainfall was found to be risen. In contract post-monsoon (November, 52.88 mm) season rainfall has slowly declined and in winter (January, 8.16 mm) season rainfall has firstly fall down and then again slowly increased from pre-monsoon Figure 3. From the data of thirty one (1980-2010) years in the coastal areas of Bangladesh, the highest average annual rainfall was recorded 540.63 mm in 2002 (July) at Sandwip Island and the lowest average annual rainfall 10.25

mm in 2010 (April) at Teknaf. In Sitakunda, the highest average annual rainfall was recorded 414.27 mm in 1983 (August) and the lowest average annual rainfall 57.50 mm was recorded in 1980 (April).

Just as rainfall patterns vary across the world; so will the effects of climate change. Karmakar and Shrestha [11] predicted that annual total rainfall over Bangladesh is likely to increase by 296 mm and 543 mm by 2050 and 2100, respectively. Singh et al. [17] showed that mean tidal level at Hironpoint, Hatyia and Cox's Bazar increased 4.0, 6.0 and 7.8 mm/year, respectively. In the study (1980-2010), the highest and lowest annual average rainfall (mm) at Sitakunda coast was recorded 414.27 mm in 1983 and 57.50 mm in 1980 respectively. The highest and lowest yearly average rainfalls (mm) of coastal area of Bangladesh were recorded 540.63 mm in 2002 at Sandwip and 10.25 mm in 2010 at Teknaf. Islam et al. [18] pointed that rainfall estimation is essential because of such consequences as flooding and drought, common natural disaster in Bangladesh. The highest and lowest rainfall (mm) trends in Sitakunda have been observed in August 1983 and in February 1986. The highest and lowest rainfall (mm) trends in coastal areas of Bangladesh have been observed in 2004 at Sandwip and in 1980 at Kutubdia. The average rainfall (mm) of Sitakunda varies from season to season. The rainfall has increased in the monsoon and post-monsoon season, declined in the winter season and slowly increased in the pre-monsoon season.

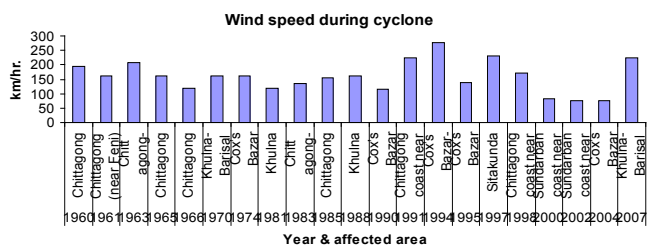


**Figure 4:** Wind speed during different cyclone.

From 1960 to 2009, many cyclones hit in Bangladesh. Among them the considerable cyclone's wind speed, tidal surge height and year have been shown in Figure 4 (Table 1). The most vulnerable cyclone was hitted Cox's Bazar-Teknaf area (wind speed 278 km/hr) at night in 1994. The next most vulnerable cyclone hitted Sitakunda coastal area (wind speed 232 km/hr.) at late night in 1997. The third most considerable cyclone was hitted Chittagong coast near Sitakunda (wind speed 225 km/hr) at night in 1998.

Bangladesh is a very low lying country with fisheries resources typically experiences storm surges of between 3 and 6 meters, with theoretical predictions of up to 7.5 m [19]. During 1876 and 2007 about 50 cyclones were recorded in the coastal region and the adjacent area all occurring during the April, May, October and November [20]. In the study (1960-2009), the highest and lowest wind speeds were recorded 278 km/hr in 1994 of Cox's Bazar-Teknaf and 65-85 km/hr in 2002 of Sundarban coast near Raimangal River. The highest and lowest tidal surges height were recorded 20-22 ft. in 1966 at Chittagong and 3 ft. in 1998 at Chittagong coast near Sitakunda respectively. Tropical cyclones are most common during the "Hurricane season" which runs from April to November. Nearly one million people have been killed in Bangladesh by cyclones since 1820; they are being estimated 10% of the world, depending on the Indian Ocean [21].

| Sl No. | Scientific name | Local name | Order | Family | Composition % |
|---|---|---|---|---|---|
| 1 | *Harpodon nehereus* (Hamilton-Buchanan, 1822) | Lotia | Scopeliformes | Harpodontidae | 6.95 |
| 2 | *Trypauchen vagina* (Bloch and Schneider) | Lal chewa | Perciformes | Trypauchenidae | 5.65 |
| 3 | *Johnius dussumieri* (Valenciennes, 1833) | Poa, Kala poa | Perciformes | Sciaenidae | 4.50 |
| 4 | *Mugil corsula* (Hamilton-Buchanan, 1822) | Bata mach | Mugiliformes | Mugilidae | 3.07 |
| 5 | *Eleutheronema tetradactylum* (Shaw, 1862) | Tailla | Polynemiformes | Plynemidae | 0.98 |
| 6 | *Lates calcarifer* (Bloch, 1790) | Koral | Perciformes | Centropomidae | 6.37 |
| 7 | *Lepturacanthus savala* (Cuvier, 1829) | Churi | Perciformes | Trichiuridae | 4.67 |
| 8 | *Sillago domina* (Cuvier and Valenciennes, 1828) | Hundra | Perciformes | Sillaginidae | 5.34 |
| 9 | *Tenualosa ilisha* (Hamilton-Buchanan, 1822) | Ilish | Clupeiformes | Clupeidae | 10.68 |
| 10 | *Polynemus paradiseus* (Linnaeus, 1758) | Tapshi, Rishsha | Polynemiformes | Plynemidae | 3.07 |
| 11 | *Pomadasys hasta* (Block, 1790) | Futki datina | Perciformes | Pomadasyidae | 2.50 |
| 12 | *Pampus argenteus* (Euphrasen, 1788) | Foli chanda | Perciformes | Stromatidae | 0.01 |
| 13 | *Crab spp* | Kakra | Decapoda | Portunidae | 2.95 |
| 14 | *Metapenaeus brevicornis* (H. Milne Edwards, 1837) | Loilla echa | Decapoda | Penaeidae | 2.44 |
| 15 | *Scylla spp* | Sila kakra | Decapoda | Portunidae | 3.08 |
| 16 | *Acetes indicus* (Milne Edwards, 1930) | Gura echa | Decapoda | Sergestidae | 5.61 |
| 17 | *Cynoglossus cynoglossus* (Hamilton-Buchanan, 1822) | Kukr jib | Pleuronectiformes | Cynoglossidae | 3.29 |
| 18 | *Thryssa dussumieri* (Valenciennes, 1818) | Phaisya, Pati | Clupeiformes | Engraulidae | 2.41 |
| 19 | *Arius spp* | Kata mach | Suiluriformes | Aridae | 1.89 |
| 20 | *Mystus guilo* (Hamilton-Buchanan, 1822) | Nuna-tengra, Guilla | Suiluriformes | Bagridae | 4.98 |
| 21 | *Penaeus indicus* (H. Milne Edwards, 1837) | Chapda chingri, | Decapoda | Penaeidae | 3.94 |
| 22 | *Penaeus monodon* (Fabricius, 1798) | Bagda chingri | Decapoda | Penaeidae | 2.57 |
| 23 | *Metapenaeus monoceros* (Fabricius, 1798) | Harina chingri | Decapoda | Penaeidae | 2.30 |
| 24 | *Scomberomorus guttatus* | Maittya | Perciformes | Scombridae | 3.67 |
| 25 | *Coilia dussumieri* (Valenciennes, 1818) | Karati alua | Clupeiformes | Engraulidae | 0.95 |
| 26 | *Glossogobius giuris* (Hamilton-Buchanan, 1822) | Baila mach, Bela | Perciformes | Gobiidae | 1.38 |
| 27 | *Pangasius pangasius* | Pangas | Siluriformes | Pangasidae | 1.89 |
| 28 | *Macrobrachium rosenbergii* | Golda chingri | Decapoda | | 2.09 |

**Table 1:** Species composition (in terms of number in each sampling) of estuarine set bag net (ESBN) at Sitakunda coast.

## Coastal Biodiversity

In Sitakunda coast, estuarine set bag net (ESBN) samples represented a total number 28 species, of which 20 species of finfish, 2 species of crab and 6 species of shrimp were found. On the other hand, small mesh size drift net (SMD) catches constituted mainly *Tenualosa ilisha*. Species composition of the estuarine set bag net (ESBN) have been shown in Table 1. Islam [18] listed a total number of 62 species were found from the Fouzderhat coast, Sandwip channel, Chittagong. In the present work the author observed a total of 28 species from the catch of estuarine set bag net (ESBN) of Sitakunda coast which indicate degradation of Biodiversity in this area. Islam [18] observed the family Gadidae, Centropomidae, Scombridae in the ESBN catches but the present study showed dissimilarity with the works of Islam [18]. It is also indication of climate change. The highest catch rate and composition were found in the month of October [22,23] but present work showed dissimilarity with his work. Islam [18] listed 8 species of shrimps and 3 species of crabs from Fouzderhat coast, Sandwip channel. In present study 6 shrimp species belonging to 3 families have been identified and these records more or less coincide with the report of Islam [18]. Both Chowdhurey et al. [24] and Islam et al. [22] observed the family Serranidae in the ESBN catches from Moheskhali channel but the present study no Serranidae species was observed. They also observed species of Enguraulidae were the highest in position followed by Clupeidae and Gobidae which disagrees with present result.

### Seasonal calendar of fish catch

Fish catches are mainly varies between seasons. In Bangladesh there are four prominent seasons, namely winter (December to February), pre-monsoon (March to May), monsoon (June to September) and post-monsoon (October to November) season. The major season of fishing is June to September (monsoon season). The peak season starts during late June and continues up to early September. Chowdhurey et al. [23] listed 12 species of penaeid shrimp and 7 species of non-penaeid from Moheskhali channel which disagrees with present work where 6 species of shrimp belonging to 3 families were found. In Sitakunda coast, the highest 21 species were found in pre-monsoon and the lowest of 18 species in monsoon. From the present observation it was found that fish abundance is increasing during pre-monsoon and decreasing during monsoon. This deviation may be due to the change in temperature and rainfall between these two seasons. Another important parameter is salinity which becomes lowest (0 ppt) during monsoon period [25]. Fish collected from the Sitakunda coast were found to be moderately diverse and *Acetes indicus* was the dominant species in the coast. However, according to fish catch results, it was clear that other fish species like *Trypauchen vagina, Polynemus paradiseus, Johnius dussumieri* and *Harpodon nehereus* had also contributed significantly to the fish abundance structure of Sitakunda coast. In average *Johnius dussumieri* was found to be the most dominating species all seasons.

### Fish abundance and climate change

Hossain [26] reported about 475 fish and shrimp species from the coastal water of Bangladesh. From the coastal belt of Bangladesh, 185 species or group of species of fin and shell fish were reported by Islam et al. [22]. Nabi [18] reported about 64 fish and shrimp species from the coastal area of Chittagong-Cox's Bazar. Shamsuzzaman [27] reported about 34 fish and shrimp species around the Sandwip Island. Present study found about 28 fish and shrimp species in the Sitakunda coastal area. But many studies have shown that set bag net land a lot of juveniles, especially shrimp and if this practice goes unregulated there is great possibility to occur serious biological degradation of fishery resources [28].

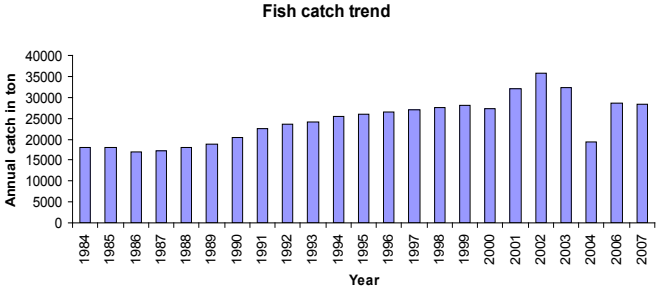


**Figure 5:** Effect of climate change on fish catch.

### Fish catch and climate change

Qasam and Iqbal [29] reported about 130 kg fish per ESBN. On the other hand Islam [22] reported about 27-30 kg of fish in ESBN. From the coastal area of Chittagong-Cox's Bazar, Nabi [30] reported about 3-6 kg of fish in ESBN. Shamsuzzaman [27] reported about 2.5-5 kg of fish in ESBN around the Sandwip Island. Present study found about 2-4 kg of fish in ESBN in the Sitakunda coastal area and according to BBS annual catch in ESBN has increased which have been shown in Figure 5.

Fish abundance and fish catch have been diminished respectively in Sitakunda coast. Occupations of fishing community have been diverted from their traditional profession due to climate condition, market condition, health condition etc [31-33]. In the present study, three categories of people were found engaged in fisheries such as fishing, net repairing and PL collection. About 60% of fishermen have their own fishing crafts and gears in this studied area which indicate that people of this area are not taking this occupation permanently due to try later of natural calamities.

## Conclusions

This paper has discussed about the impact of climate change on fisheries resources of Bangladesh with particular reference to temperature, rainfall, mean sea level and tropical cyclone frequency and intensity, storm surges. Fisheries resources of Sitakunda coast is of paramount importance to the nation because thousands of people are related to these fisheries resources for their livelihood maintenances as fishermen, net repairer, coastal aqua farmer, and shrimp fry collections etc. Fisheries are the second largest export sector in Bangladesh. Climate change may directly affect fisheries resources along many pathways. Fish abundance, catch and catch trend are all affected by temperature, rainfall etc. Tropical cyclones often cause a temporary decline in the abundance of some fishes due to loss of critical habitat of food for certain species and also increase the disturbance regime for fish community. Climate change is the greatest environmental challenge facing the world today. Decision makers and resources managers play one of the most important roles in tackling climate change. Though the effects of climate change on fisheries resource was not initiated with local people participation however increase awareness to conserve fisheries.

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