

Assessment of Physico-chemical Status of Coastal Seawater of the Saint Martin's Island, Bangladesh

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ABSTRACT: Saint Martin's island is a beautiful tourist attractive place and a unique coral island in Bangladesh. Marine biodiversity of this island is very rich for its favorable environment but its marine environment is facing threats day by day due to natural calamities, various types of pollution, and other anthropogenic activities. So it is very important to know the present physico-chemical status of seawater around the island as a baseline scenario. At first, coastal water samples were collected from 24 sites. Niskin water sampler is used to collect samples from 26 February to 02 March, 2018. Six physico-chemical parameters like temperature, salinity, conductivity, dissolved oxygen (DO), pH and total dissolved solids (TDS) were measured directly at in-situ position. The ranges for the physico-chemical parameters of coastal seawater were 25 to 30°C for temperature, 30.8 to 33.4 ppt for salinity, 48966 to 55235 $\mu\text{S}/\text{cm}$ for conductivity, 5.08 to 6.87 mg/L for DO, 8.05 to 8.38 for pH and 29575 to 31980 mg/L for TDS. The highest and lowest salinity was found in the southern and northern part of the Saint Martin's Island respectively. The highest DO is found on three sides' especially the northern side but the lowest DO was found in the eastern side of the Island.

KEYWORDS: Temperature, Salinity, Conductivity, Dissolved Oxygen, Coastal Seawater and Saint Martin's Island

1 INTRODUCTION

Saint Martin's island is one of the unique coral islands and popular tourist destinations in Bangladesh due to its and favorable environmental condition [1]. It is also recognized as the richest biodiversity hotspot in terms of marine biotic resources in Bangladesh [2]. St. Martin's Island is only 8 km² dumb-bell shaped sedimentary Continental Island located in the northeast part of the Bay of Bengal and about 9 km far from the Cox's Bazar-Teknaf peninsula tip, and the southernmost part of Bangladesh [3]. Contrary, it is about 8 km west of the northwest coast of Myanmar at the mouth of the Naf River. There is a small connected island that is separated at high tide, called Chera Island. The area of the island itself is about 5.9 km² whereas with the rocky platforms extending into the sea the total area of the island is about 12 km². It was connected to the mainland of the Teknaf peninsula as-recently-as 6,000-7,000 years ago [4].

It is also treated as an ideal site for fishing zone that provides a variety of marine fish species. Mr. Hossain stated that about 1650 Metric Tons (MT) of marine fishes are being caught in every year [5]. There are about 234 species of fish, 66 species coral (36 are found living), 187 species crab 14 species of algae have been recorded from this island [6]. The major macro-invertebrate communities of this island comprises with about 61 species of mollusks, 9 species of echinoderms, 4 species of Zoanthids and 4 species of Bryozoans [7].

The ecosystem of Saint Martin's island is blessed of nature with vast resources but these resources are facing threats day by day due to natural calamities, various types of pollution, and other anthropogenic activities [2]. Over exploitation of renewable marine and coastal resources (e.g. rocky reef fisheries, coral and shell for marine ecosystem of the island. Destructive fishing practices, mainly the use of rock-weighted gill nets over the inshore boulder reefs are one of the prime aggravates [6]. The environmental quality and ecological value of this island is regularly degrading by the increasing of human intervention and natural disasters in every year. There are several

authorities are tried to concern about the sustainability of waste management, drainage system and water quality problems for the island [8]. It may definitely append to increase of solid wastes by rising of visitors or tourists into the Saint Martin's island that is also future threat for the coral habitat. The physical action of wastes throwing by tourists either on the beach or in the water might not be an apparent threat. The Marin park islands would have coped with the waste problem from the local inhabitants of the islands as well as with the increased amount of wastes from hotels, lodges, and resorts. At present, solid wastes disposal system remains absent [9].

Marine aquatic ecosystem needs careful protection to maintain the water quality and its standard. Water quality plays an important role for the production of fisheries [10]. Although monitoring water quality does not measure the environmental health on an ecosystem, it is argued that the water quality of an aquatic ecosystem can provide a rapid assessment of the environmental quality before it is manifested in living organisms [11]. The objective of the research was to assess the physico-chemical Status of Seawater around the Saint Martin's Island. The study has been conducted with the following objectives:

- a. To determine the physico-chemical properties (temperature, salinity, pH, conductivity, dissolved oxygen and total dissolved solids) of coastal water of the Saint Martin's Island
- b. To investigate the present status of physico-chemical properties of North and South, East and West of coastal water of the Saint Martin's Island

2 STUDY AREA

The Saint Martin's Island, locally called 'Narikel Jinjira' is located in the northeast of the Bay of Bengal (Figure.1). The island is an administrative union of Teknaf Upazila under Cox's Bazar district in Bangladesh. Saint Martin's Island is situated between 20°34' to 20°39' N latitude and 92°18' to 92°2' E longitude (Figure 1). To the east the Myanmar boundary (Arakan coastal plain) lies only 4.5 km away, while to the west and southwest it faces the Bay of Bengal.

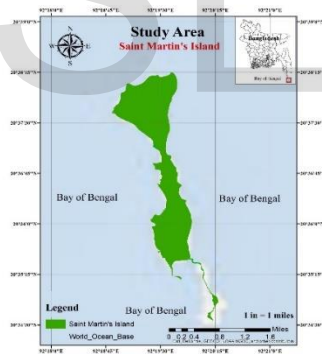


Fig 1. Geographic location map of St. Martin Island, Bangladesh

3 MATERIALS AND METHODS

Seawater samples are collected by two systematic ways. The coastal seawater samples are collected from 24 sites of the around of Saint Martin's Island by niskin water sampler (Fig. 2c) from 26 February 2018 to 02 March 2018. These sampling sites included intertidal areas and inshore. The Site positions, sampling dates, sampling time, weather and tide conditions are given in Table 1. The sampling locations included areas with different environmental backgrounds for examples fish aquaculture, restaurants, resorts, jetty, and recreational sea beach areas.

The physico-chemical properties of the surface water (0-0.5m) seawater samples are collected by niskin water sampler and analyzed directly in the field at each sampling sites are temperature, salinity, pH, conductivity, Total Dissolved Solids (TDS) and resistivity by using an YSI water quality multi-probe and DO was analyzed by in-situ DO meter (Fig. 2a & 2b). When doing the measurements, the probe was submerged fully into the water at least around 30 cm from the coastal water surface and collecting seawater samples. From each sampling sites, 500 ml of water are collected by PVC water sample bottles. Before sampling, the bottles were cleaned and washed with detergent solution and rinsed 3 to 4 times with the water to be sampled. Hydrochloric acid is used as preservative in these sample bottles and containing samples are sealed immediately to avoid exposure to air and placed into the safe place. A total of two replicates are taken for each parameter at every sampling site. The sample bottles are screwed carefully and marked with the respective identification number. Surface water (0-0.5m) seawater samples are collected for analysis of total dissolved solids (TDS).



Fig. 2. (a) Multi-water analyzer (YSI Professional Series-626909-4, Made in USA), (b) In-Situ DO meter (SmarTROLL RDO CA30, Made in USA) and (c) Niskin Water Sampler

3.1 DATA PROCESSING AND ANALYSIS

The relevant data are processed and analyzed through manually and for computer based analysis MS Excel of Office 2013 version is used. For graphical and data displaying, Arc GIS is used.

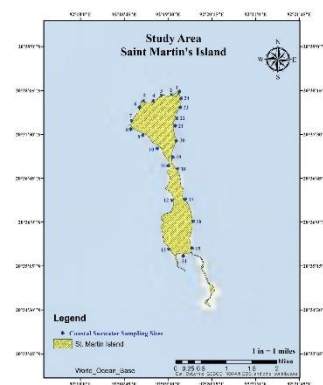


Fig. 3. Map showing the water samples collecting sites in Saint Martin's Island. Numbering of sampling sites followed those detailed in Table 1.

Table 1. Coastal seawater sampling information with descriptions of sampling sites

Site No.	Site Position (From Saint Martin's Island)	Date	Time/ Weather	Geographic Coordinate System (GCS)		Tide
				Latitude (°) N	Longitude (°) E	
1	North	26 Feb 2018	05.10 p.m. Clear and Mild Sunny	20.63719	92.32824	High Tide
2	North	26 Feb 2018	05.25 p.m. Clear and Mild Sunny	20.63628	92.32594	High Tide
3	North	26 Feb 2018	05.34 p.m. Clear and Mild Sunny	20.63608	92.32317	High Tide
4	North	26 Feb 2018	05.42 p.m. Mild Sunny	20.63456	92.32076	High Tide
5	North	26 Feb 2018	05.51 p.m. Mild Sunny	20.63452	92.31798	High Tide
6	North	26 Feb 2018	06.02 p.m. Twilight	20.63265	92.31683	High Tide
7	North	26 Feb 2018	06.17 p.m. Twilight	20.62886	92.31459	High Tide
8	West	27 Feb 2018	12.05 p.m. Clear and Sunny	20.6265	92.31441	Low Tide
9	West	27 Feb 2018	12.22 p.m. Windy and Sunny	20.6248	92.3178	Low Tide
10	West	27 Feb 2018	12. 35 p.m. Windy and Sunny	20.62095	92.32193	Low Tide
11	West	27 Feb 2018	12.48 p.m. Windy and Sunny	20.61606	92.325	Low Tide
12	West	27 Feb 2018	01.02 p.m. Sunny	20.60618	92.32612	Low Tide
13	South	27 Feb 2018	01.15 a.m. Clear and Sunny	20.59225	92.32519	Low Tide
14	South	27 Feb 2018	01.28 a.m. Clear and Sunny	20.59033	92.32936	Low Tide
15	South	27 Feb 2018	01.39 a.m. Clear and Sunny	20.59259	92.33192	Low Tide
16	East	27 Feb 2018	01.52 a.m. Clear and Sunny	20.60022	92.33219	Low Tide
17	East	27 Feb 2018	02.05 p.m. Clear and Sunny	20.6065	92.32914	Low Tide
18	East	01 Mar 2018	02.03 p.m.; Sunny	20.61518	92.32771	Low Tide
19	East	01 Mar 2018	02.18 p.m.; Sunny	20.61853	92.32639	Low Tide
20	East	01 Mar 2018	02.30 p.m.; Sunny	20.62312	92.32736	Low Tide
21	East	01 Mar 2018	02.42 p.m.; Sunny	20.62743	92.32709	Slag Tide
22	East	01 Mar 2018	02.55 p.m.; Sunny	20.62955	92.32748	Slag Tide
23	East	02 Mar 2018	05.56 p.m. Twilight	20.63268	92.32849	High Tide
24	East	02 Mar 2018	06.08p.m. Twilight	20.63528	92.32873	High Tide

4 RESULTS AND DISCUSSION

The water quality parameters at the 24 sampling sites of coastal water of the Saint Martin's Island are summarized in Table 2.

4.1 Coastal Seawater Temperature: Coastal seawater temperatures ranged from 25 to 30°C. The study showed that the lowest temperature of coastal seawater was at the St-23 (25.7°C) near the Jetty Ghat and highest temperature of coastal seawater was at the St-11 (29.5°C) near the Gola-Chipa of the Saint Martin's Island. The average temperature was 27.53°C (Table 2).

Table 2. Overall values of physico-chemical parameters of the intertidal waters (Inshore) collected from the Saint Martin's Island (N= 24)

N=24	Minimum	Maximum	Mean	Standard Error
Temperature (°C)	25.7	29.5	27.53	0.216
Salinity (ppt)	30.8	33.4	32.76	0.133
Conductivity (µS/cm)	48966	55235	52477.63	307.73
pH	8.05	8.38	8.19	0.018
DO (mg/L)	5.08	6.87	5.89	0.051
TDS (mg/L)	29575	31980	31083.96	143.1232

4.2 Salinity (ppt): Salinity is an ecological factor of considerable importance, influencing the types of organisms that live in a body of water. Coastal seawater salinity ranged from 30.8 to 33.4 ppt. The study showed that the lowest salinity of coastal seawater was at the St-2 (30.8 ppt) and highest salinity of coastal seawater was at the St-14 (33.4 ppt). The average salinity was 32.76 ppt (Table 2).

4.3 Conductivity (µS/cm): The conductivity of water depends on the concentration of ions and its nutrient statuses. Conductivity of coastal seawater ranged from 48966 to 55235 µS/cm. The study revealed that the lowest conductivity of coastal seawater was at the St-02 (48966 µS/cm) and highest conductivity of coastal seawater was at the St-11 (55235 µS/cm). The average conductivity was 52477.63 µS/cm (Table 2).

4.4 pH: pH value is very important for plankton growth through the marine ecosystems. The pH values which measure how acidic/basic water is, ranged from pH 7.9-8.4 for all sampling sites. pH of Coastal seawater ranged from 8.05 to 8.38. The study showed that the lowest pH of coastal seawater was at the St-10 (8.05) and highest pH of coastal seawater was at the St-18 (8.38). The average pH was 8.19 (Table 2).

4.5 Dissolved Oxygen (mg/l): The dissolved Oxygen (DO) refers to the amount of oxygen dissolved in the water and it is particularly important in limnology (aquatic ecology) [12]. In the present study DO of Coastal seawater ranged from 5.084 to 6.87 mg/l. The study showed that the lowest DO of coastal seawater was at the St-19 (5.084 mg/l) and highest DO of coastal seawater was at the St-02 (6.87 mg/l). The average DO was 5.89 mg/l (Table 2).

4.6 Total Dissolved Solids (mg/L): TDS of coastal seawater ranged from 29575 to 31980 mg/L. The study revealed that the lowest TDS of coastal seawater was at the St-02 (29575 mg/L) and highest TDS of coastal seawater was at the St-11 (31980 mg/L). The average TDS was 31083.96 mg/L (Table 3). Mainly primary sources for TDS in receiving waters are agricultural runoff, leaching of soil contaminant and point source water pollution discharged from industrial or sewage treatment plants.

4.7 Comparison of average physico-chemical properties around the Saint Martin's Island

The present status of physico-chemical properties of surface water of the North and South, East and West of the coast (inshore) of the Saint Martin's Island are given in the Table 3.

Table 3. Comparison of average physico-chemical properties at different sides of the Saint Martin's Island

SL No	Parameter	North	South	East	West	Average
1	Temperature (°C)	26.95	27.6	27.62	28.14	27.58
2	Salinity (ppt)	32.58	33.36	32.76	32.65	32.84
3	Conductivity (µS/cm)	51345.57	53412.67	52719.56	53066	52635.95
4	pH	8.14	8.21	8.20	8.17	8.18
5	DO (mg/L)	5.98	5.96	5.83	5.87	5.92
6	TDS (mg/L)	31262.14	31515	31039.56	30666	31119.26

The average temperature of coastal seawater were 26.95, 27.6, 27.62 and 28.14 °C at the north, south, east and west sides of the Saint Martin's Island respectively. The average temperature of coastal seawater was 27.58 °C at 28 February and 01 & 02 March 2018. The highest and lowest temperature were found at the west and north sides of Saint Martin's Island respectively (Fig.4a). The average salinity were 32.58, 33.36, 32.76 and 32.65 ppt at the north, south, east and west sides of the Saint Martin's Island respectively. The average salinity of coastal seawater was 32.84 ppt. The highest and lowest salinity were found at the south and north sides of Saint Martin's Island respectively (Fig.4b). The average conductivity is similar pattern to the salinity of the coastal seawater. The average conductivity of coastal seawater was 52477.63. The maximum and minimum conductivity were found at the south and north sides of Saint Martin's Island respectively (Fig.4c).

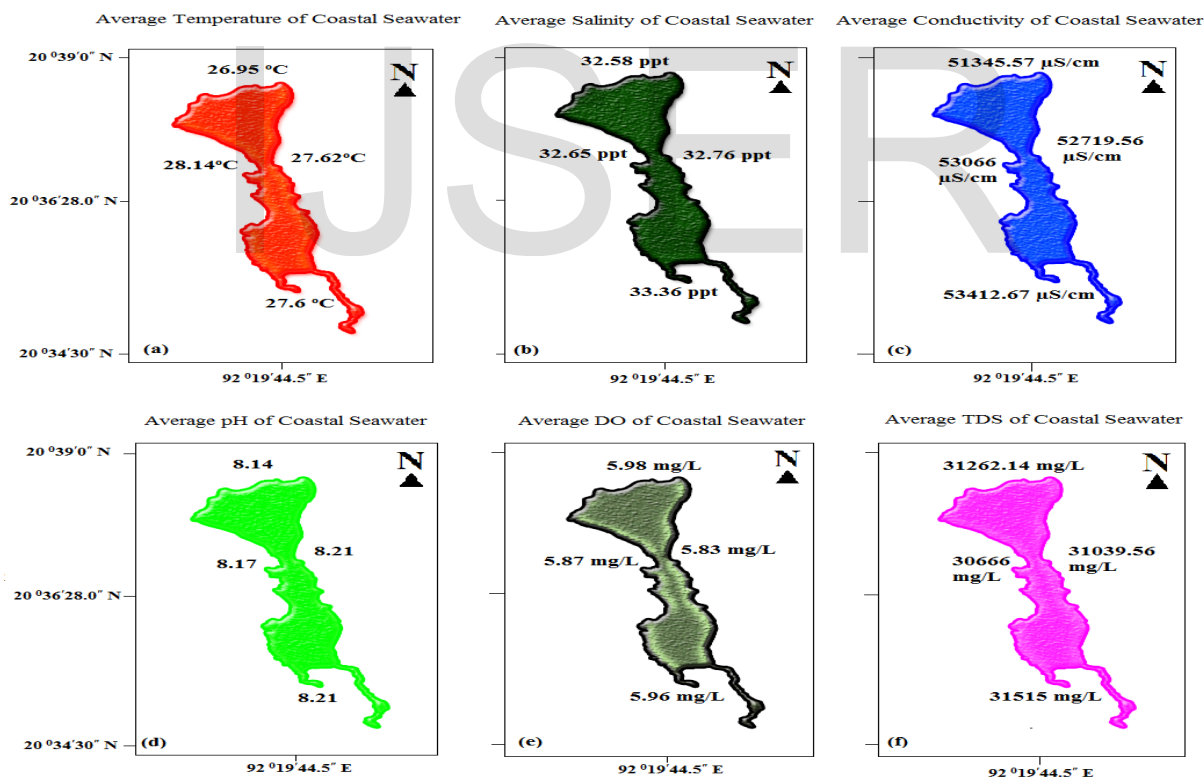


Fig. 4. Average coastal seawater temperature (a), salinity (b), conductivity (c), pH (d), DO (e) and TDS (f) of the north, south, east and west sides of the of Saint Martin's Island.

On the other hands, the average pH were 8.14, 8.21, 8.20 and 8.17 at the north, south, east and west sides of the Saint Martin's Island respectively. The average pH of coastal seawater was 8.18. The highest and lowest pH were found at the north and south sides of Saint Martin's Island respectively (Fig.4d). The average DO were 5.98, 5.96,

5.83 and 5.87 mg/L at the north, south, east and west sides of the Saint Martin's Island respectively. The average DO of coastal seawater was 5.92 at 28 February and 01 & 02 March 2018. The highest and lowest DO were found at the north & south and east sides of Saint Martin's Island respectively (Fig.4e). The average TDS of the coastal seawater were 31262.2, 31515, 31039.56 and 30666 mg/L at the north, south, east and west sides of the Saint Martin's Island respectively. The average TDS of coastal seawater was 31083.96 mg/L. The maximum and minimum TDS were found at the south and west sides of Saint Martin's Island respectively (Fig.4f).

5 CONCLUSION

Water quality is truly linked to the surrounding environment and land use. Seawater quality around the Saint Martin's Island is affected by community uses such as agriculture, settlements, unplanned infrastructure especially hotel, tourism, recreation drainage systems and sewerage line etc. In the present study, we try to assess the seawater quality around the Saint Martin's Island. The finding of the research are:

- the ranges for the physico-chemical parameters of coastal seawater were 25 to 30°C for temperature, 30.8 to 33.4 ppt for salinity, 5.08 to 6.87 mg/L for DO, 8.05 to 8.38 for pH, 29575 to 31980 mg/L for TDS, 48966 to 55235 $\mu\text{S}/\text{cm}$ for Conductivity and 18.08 to 20.43 $\Omega\text{-cm}$ for resistivity.
- The higher temperature is found at the west and south of the Saint Martin's Island which connect to the open ocean.
- The highest and lowest salinity is found at the south and north of the Saint Martin's Island respectively.
- The average DO of coastal seawater of the Island was 5.92. The highest DO is found in three sides' especially northern side of the Island.

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