2020 ANNUAL REPORT

Bangladesh Oceanographic Research Institute
Ministry of Science and Technology
Government of the People's Republic of Bangladesh


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Bangladesh Oceanographic Research Institute
BORI
Explore the Ocean, Serve the Nation
বাংলাদেশ ওশানোগ্রাফিক রিসার্চ ইনস্টিটিউট

Annual Report
of
Bangladesh Oceanographic Research Institute

December
2020

Bangladesh Oceanographic Research Institute
Ministry of Science and Technology
Government of the People's Republic of Bangladesh

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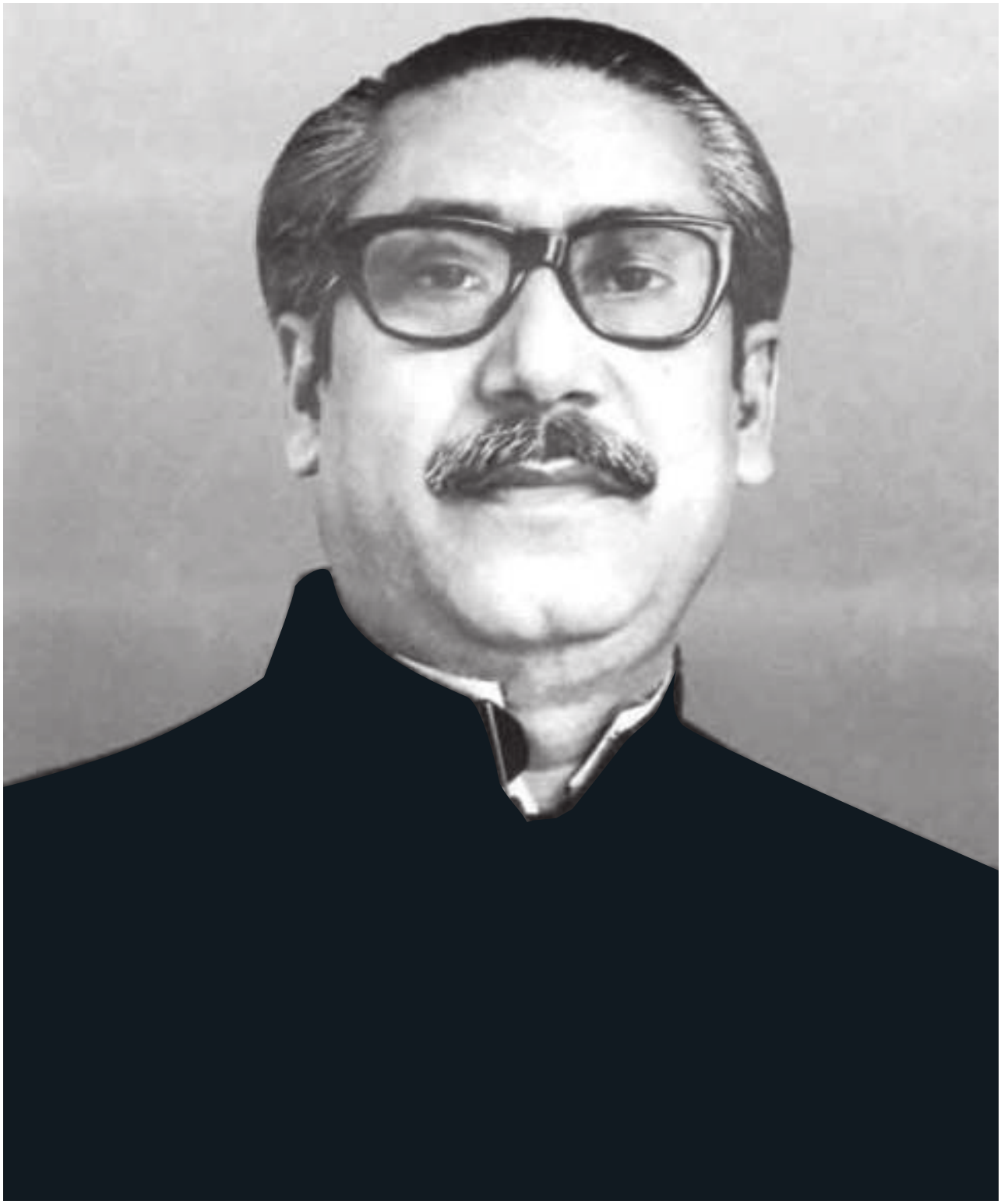


Father of the Nation Bangabandhu Sheikh Mujibur Rahman

Bangabandhu established the legal entitlements of Bangladesh maritime areas and marine resources by passing the "Territorial Waters and Maritime Zones Act-1974"

Prime Minister Sheikh Hasina at Inani Sea Beach, Cox's Bazar (6 May, 2017)
(Photo : PID)

"*There is a link between the development of human civilization and ocean. The nearer a society is to the ocean; the better the life is of its members* (14th HACGAM, 2018)"

- Sheikh Hasina

Arch. Yeafesh Osman
Minister
Ministry of Science and Technology
Government of the People's Republic of Bangladesh

MESSAGE

It is indeed a great pleasure for me to know that Bangladesh Oceanographic Research Institute (BORI) is going to publish the Annual Report-2020, which reflects the outcome of different projects completed by the young scientists in last year.

Father of the nation Bangabandhu Sheikh Mujibur Rahman took the first initiative to set up National Ocean Research Institute just after the liberation war. The dream of Bangabondhu has become a reality by the establishment of BORI in Cox's Bazar.

The vast sea area of Bangladesh is full of fish, oil, natural gas and other undiscovered valuable minerals. There is no other alternative except using these resources for the development of the national economy. The whole world is now focusing on marine resources as the limited land resources are being used frequently everywhere.

I think the research activities of BORI will improve day by day and will create positive impact in oceanographic research for Bangladesh.

(Architect Yeafesh Osman)

Md. Anwar Hossain
Senior Secretary
Ministry of Science and Technology
Government of the People's Republic of Bangladesh

MESSAGE

I am delighted to know that Bangladesh Oceanographic Research Institute (BORI) is going to publish their Annual Report-2020, which showcases their year-long performances along with the achievement of their research activities.

Bangladesh is now on the Development Boulevard with the efficacious leadership of our Honorable Prime Minister H.E. Sheikh Hasina. Establishment of BORI in 2017 is the result of her visionary determination. She rightly understood that we have to explore, exploit, preserve and utilize marine resources to achieve our development goals.

We achieved a total of 1,18,813 sq. km of sea area by the historic maritime delimitation settlement with our neighboring countries. Within this sea area in the Bay of Bengal, we have a huge amount of living and non-living resources. Our job is to find out and utilize these resources. Our present government has taken different measures for utilization of this Blue Economy resources and its contribution to the development of the country.

Ministry of Science and Technology has been funding BORI since its inception for innovative research ideas, research works and research projects. At present BORI has eight modern laboratories equipped with highly sophisticated instruments for different streams of oceanographic research. BORI will play key role in harnessing marine resources in near future.

I hope, the scientists of BORI will come up with productive and innovative research ideas and will devote themselves for the best uses of oceanographic resources.

Joy Bangla
Joy Bangabandhu
May Bangladesh Live Forever

(Md. Anwar Hossain)

MESSAGE

Md. Shafiqur Rahman

Director General (Additional Charge)

Bangladesh Oceanographic Research Institute

Bangladesh Oceanographic Research Institute (BORI) is going to publish Annual Report-2020 compiling research and other activity of previous fiscal year.

Father of the Nation Bangabandhu Sheikh Mujibur Rahman initiated maritime boundary negotiations with India and Myanmar, and even settled 12 NM territorial sea boundaries with Myanmar in November, 1974.

BORI under Ministry of Science and Technology (MoST) is doing its duty to implement the research planning of the government. Scientists of BORI are expending their knowledge to research oceanographic resources and to use it in national economic development.

The present government has formulated Blue Economy policy for the safe and environmentally sustainable use of resources. We have started our work to implement this and I believe this will play a significant role in the development of Bangladesh.

I thank all the divisions of BORI for their respective activity and hope they will work more and more to contribute in the development of the country.

(Md. Shafiqur Rahman)

Executive Editorial Remark

Bangladesh Oceanographic Research Institute (BORI) has been conducting oceanographic research for three years. Since inception, BORI scientists are gradually working in different perspective of ocean science. They started their journey from the beach to near-shore area of the Bay of Bengal Bangladesh. Research activity and research results are summarized in this annual report along with other divisional functions.

In this fiscal year, BORI scientists have faced hurdles during field work due to COVID-19 pandemic. Nationwide lockdown has reduced their field activity but they successfully completed their research projects in due time maintaining government health regulations.

Physical and Space Oceanography division, Geological Oceanography division, Chemical Oceanography division, Biological Oceanography division, Environmental Oceanography & Climate division and Oceanographic data center have their own projects and outcomes. Institutional development activities by admin, planning & finance wing has their particular way of works to support research wing.

It's my pleasure to work in this report. I would like to thank each and every person who has helped me directly or indirectly to complete this report successfully.

Abu Sharif Md. Mahbub-E-Kibria
Senior Scientific Officer & Head
Environmental Oceanography and Climate
Bangladesh Oceanographic Research Institute
Cox's Bazar-4730

PREFACE

Bangladesh Oceanographic Research Institute (BORI) publishes annual report every year which abridges activities of different wings of this institute for 2019-2020 fiscal year. Research wings of six divisions set forth their research activities and respective outcomes. Administrative wing set out their fiscal year activities in a nutshell.

In this fiscal year (2019-2020), six divisions of research wing of BORI conducted eight research projects in different areas of ocean. Physical and Space Oceanography division has projects on Chlorophyll and Beach profiling; Sedimentological characterization has been done by Geological Oceanography division; Chemical Oceanography division worked on green mussels; Biological Oceanography division has been working on algal taxonomy; marine pollution has been a concern for Environmental Oceanography and Climate division and Oceanographic Data Center has statistical analysis on non-conventional marine fisheries.

There were eleven research projects in the last two fiscal years from institutional budget. In this fiscal year (2019-2020), there are eight research projects completed by all the divisions of research wing.

Admin, planning & finance wing has a wide variety of activities including engineering, finance & accounts, ICT, Library and medical center.

BORI has been increasing its research works to achieve the goal of blue economy through ocean exploration and exploitation in the Bay of Bengal. We hope BORI will play a great role in the development process of Bangladesh by using marine resources.

MUJIB 100

Sheikh Mujibur Rahman, a young football player. Front row third from left (1940).

Bangabandhu Sheikh Mujibur Rahman during the signing of Mujib-Indira treaty (May 16, 1974).

Sheikh Mujibur Rahman with his political compatriots (1952).

Sheikh Mujibur Rahman was conferred with the title 'Bangabandhu' at Race Course Maidan (February 23,

Bangabandhu takes oath as the Prime Minister of a free and independent Bangladesh (January 12, 1972).

Bangabandhu delivering his historic 7th March Speech at Race Course Maidan (March 7, 1971). This 19 minutes-speech has been included in the MEMORY OF THE WORLD INTERNATIONAL REGISTER as a Documentary Heritage of UNESCO.

Bangabandhu addressing a meeting at Tejgaon during the election campaign (1970).

Bangabandhu along with his fellow political leaders on their way to the Race Course Maidan (January 3, 1971).

www.mujib100.gov.bd

Celebrating Glorious 100th Anniversary of the Father of our Nation

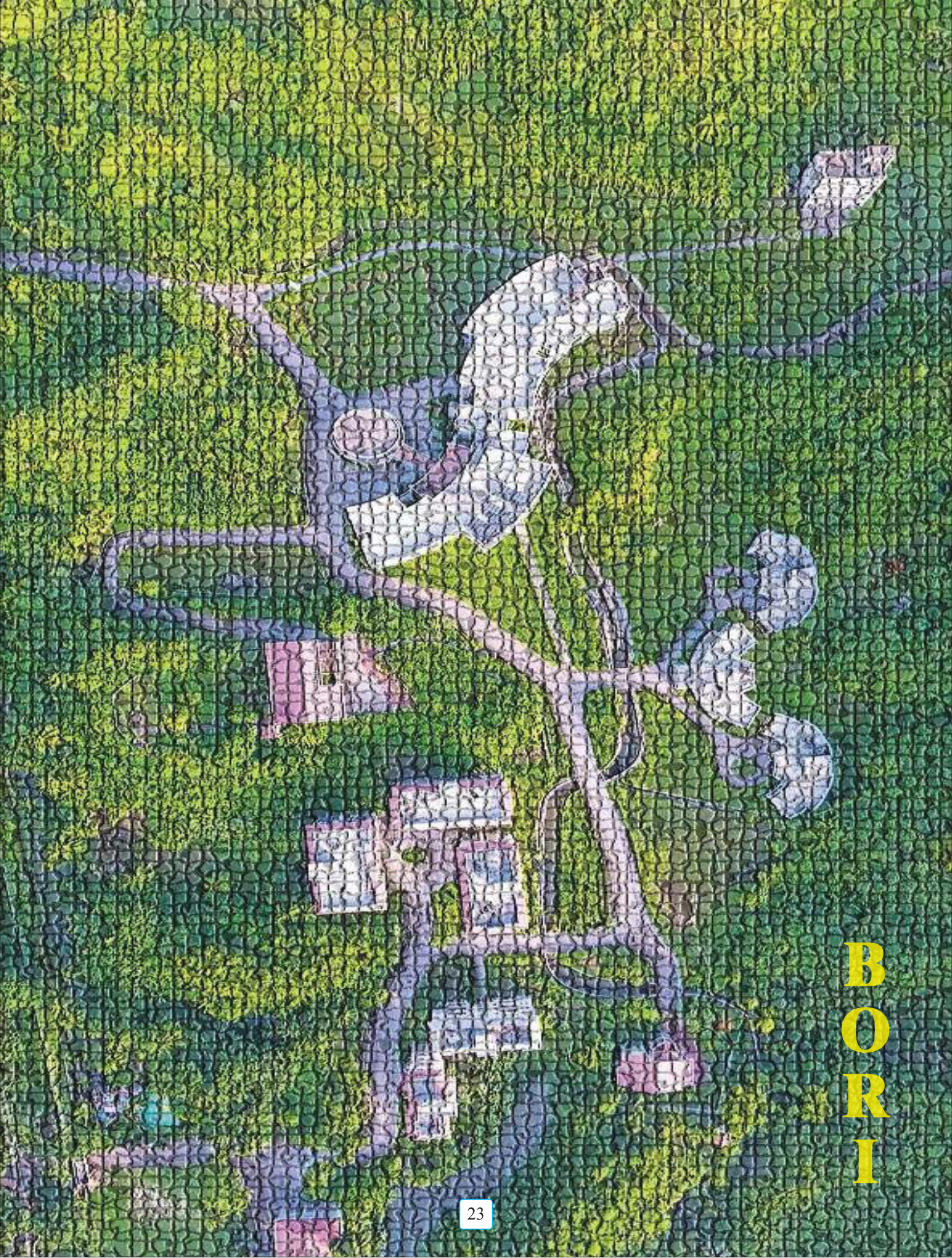
100 Birth Year Celebration “Mujib Borsho” or “Mujib Year” is very important for the Nation of Bangladesh. Mujib Borsho has been declared by the Government of Bangladesh marking the 100th anniversary of the birth of the Father of the nation, Bangabandhu Sheikh Mujibur Rahman. Mujib Borsho is celebrated with due respect from March 17, 2020 to December 16, 2021 (The government has extended the celebrations of Bangabandhu Sheikh Mujibur Rahman’s birth centenary to December 16, 2021 citing the disruptions caused by the pandemic COVID-19) through yearlong various programs nationally & globally. The UNESCO was also announced to celebrate Mujib Borsho jointly with Bangladesh. This announcement of UNESCO paves the way for celebrating Mujib Borsho all over the world.

Bangabandhu Sheikh Mujibur Rahman was born at Tungiparha in Gopalganj on March 17, 1920. He spearheaded the Bengalis’ liberation struggle and Bangladesh emerged as an independent country from Pakistan on the world map in 1971.

On the Occasion of Mujib Borsho Celebration, Government of Bangladesh has been taken different programs over the year. Bangladesh Oceanographic Research Institute (BORI) has been celebrating the Mujib Borsho or Mujib Year, marking the birth centenary of Bangabandhu Sheikh Mujibur Rahman by undertaking different programs.

- The photo gallery of Sheikh Mujibur Rahman has been setup at the ground floor in the Institute Building of BORI in the first week of March 2020.
- The Oceanographic Fair with Seminar 2020 had supposed to happen in the Bangabandhu Sheikh Mujibur Rahman Novo Theater or National Museum of Science and Technology, Dhaka. But the fair has been postponed due to the coronavirus.
- The “Beach Cleanup Program” had been arranged in the popular sea beach areas of Cox’s Bazar especially Sugondha Beach, Laboni Beach and Inani Beach in 30 December 2020.
- The LED display for activities of ocean, ocean research, awareness of marine pollution, has been positioned beside the main gate of BORI.
- It has been made a professional documentary on BORI and had been organized the marine awareness program in different schools and collages of Cox’s Bazar.
- On the occasion of celebration, BORI has been published e-bulletin on “Blue Economy” as a part of showcasing program.
- BORI, also taken a great initiatives program “Incentives for Research” as a part of Mujib Borsho Celebration.

TABLE OF CONTENTS


BORI

Chapter 1

Bangladesh Oceanographic Research Institute (BORI)

Background of BORI

Bangladesh Oceanographic Research Institute (BORI) is the first and only national research institution on marine science in Bangladesh, which will be able to play an important role in ensuring the development of Blue Economy. After winning the maritime boundary settlement case with Myanmar on March 14, 2012 andIndia on July 7, 2014, Bangladesh achieved sovereign rights to a total of 1,81,813 square kilometers of sea area, 200 nautical miles of exclusive economic zone, and all types of living and non-living ocean resources. If Bangladesh can ensure the sustainable use of the ocean resources, then the economy of Bangladesh will progress faster. The potential for setting up an international level ocean research institution, development of integrated coastal zone management, mining of mineral resources, and proper utilization of ocean resources including development of tourism and mariculture have increased the interest of the international community towards the Blue Economy in Bangladesh. The prospect of this newly developed sector is unlimited. For this reason, BORI will be able to play an important role in oceanographic research and create skilled manpower. The organization will work to conduct all the activities as a focal point of Bangladesh at national and international levels in the field of oceanography. Besides conducting its own research, BORI will assist in the research work of other local or foreign organizations, colleges and universities as well.

The Father of the Nation Bangabandhu Sheikh Mujibur Rahman initiated the establishment of ocean research institute in 1973 with the aim to enrich the country's economy and reducing poverty through exploring, exploiting and conserving valuable resources of the Bay of Bengal. But after the brutal and tragic killing of Bangabandhu in 1975, that initiative totally stops. In 1996, Honorable Prime Minister Sheikh Hasina constituted a Review Committee for the establishment of National Institute of Ocean Science. After receiving the recommendation of the review committee, the decision of establishing the National Oceanographic Research Institute was acceptedin 2000. In order to ensure proper utilization of marine resources, a project under the Ministry of Science and Technology was adopted in the period from June 2000 to July 2005 for the establishment of National Oceanographic Research Institute (1st Phase). After a long time in 2009, the visible progress of the establishment of National Oceanographic Research Institute (NORI) was achieved through the intensive initiative of Honorable Prime Minister Sheikh Hasina. When presenting the proposal for establishing the institute on 4 acres of land in the ECNEC meeting on 02/07/2009, Honorable Prime Minister extended the amount of land to 40 acres instead of 4 acres. She also ordered to redesign and represent the project including laboratory, residential building, club building, playground, school buildingand marine aquarium with international quality. Acquisition of 40 acresof land in Jungle Goalia Palang Mouza of Khunia Palang Union of Ramu Upazila of Cox's Bazar district was completed in 2010. The establishment project was implemented at a cost of Taka 102.80 crore. Under the heading of "National Oceanographic Research Institute Establishment Project (NORIP) (1st phase) (2nd Revised)" has been constructedwith 13 buildings including 3-storey Institute building with laboratory, 5-storey 3 officer quarters & 2 staff quarters, 1 Director General's Bungalow, 2-storey 1 Officer Dormitory & 1 staff Dormitory, 3-storey 1 Club Building & 1 Rest House, 5-storey 1 security personnel building, and 2-storey 1 school-cum-Medical Centre. Initially BORI has been purchased about 1096 nos. of scientific instruments for oceanographic research. For the implementation of the overall function of the project, 14 officials were working including 1 senior scientific officer, 3 scientific officers, 1 administrative officer and other employees. In addition, under the project, there was 1 platoon Ansar & VDP members for the safety of the Institute and 8 daily-basis manpower to keep the Institute premises neat and clean.

On 5 March 2015, "Bangladesh Oceanographic Research Institute Act, 2015" was passed in the national parliament for the keen endeavor of the present Honorable Minister Architect Yeafesh Osman of the Ministry of Science and Technology. It was a great achievement for oceanographic research. The institute has been established on 08/09/2015 with the powers given in sub-section (1) of 3 of "Bangladesh Oceanographic Research Institute Act, 2015" (Act 07 of 2015). On 19/05/2017, for the appointment of officer and staff the 'employment regulatory of Bangladesh Oceanographic Research Institute, 2017' was issued. A total of 223 posts have been created for

the institute. The first meeting of the Board of Governors of BORI was held on 25/05/2017. The organogram of BORI comprises 2 wings. Among them one is research wing (6 research divisions) and the other is administrative wing including engineering sector, medical centre, ICT and library cell. Considering the seer thoughts of Honorable Prime Minister Sheikh Hasina, initiatives have already been taken to establish a Marine Aquarium of international quality in the institute premises for ocean research & tourism.

BORI at a Glance

The Bangladesh Oceanographic Research Institute (BORI) has emerged as an independent organization. It is the first and only national institution in the field of marine science. This institution will be able to play an important role in the exploration and development of country's marine resources and play a leading role in revenue earnings. Multiple research and development programs will be conducted in each of the research departments. Successful implementation of the current action plan will be possible through the development of sustainable technology in the country, achieving poverty alleviation programs and various development targets of the United Nations. Future research activities will be expanded more widely. If this institute effectively handles the management of the sea related research activities, application of research results and management of all the related activities, Bangladesh will emerge as a prosperous and developed country by using marine resources. We have won the sea under the dynamic and visionary leadership of the daughter of Bangabandhu, Prime Minister Sheikh Hasina, and there is no doubt that we will soon emerge as a developed nation using the sea resources. There are two wings of BORI. One is Research wing and another is Admin, Planning & Finance wing.

Research Wing	Admin, Planning & Finance Wing
1. Physical and Space Oceanography	1. Administrative Division
2. Geological Oceanography	2. Accounts & Finance Division
3. Chemical Oceanography	3. Engineering Division
4. Biological Oceanography	4. Information Management Division • ICT Cell • Library Cell
5. Environmental Oceanography and Climate	
6. Oceanographic Data Center	5. Medical Center

Vision of BORI

"To contribute in the economic development of the country by adopting maritime research activities, applying research results, operating, managing and controlling all related activities"

Mission of BORI

- Development of mineral, agriculture, fisheries, environment and industrial sectors through utilization of sea resources and the development of environmentally friendly and sustainable technology and research activities to increase productivity for the benefits of mankind.
- To improve knowledge related to maritime education, research, training and development of knowledge related to the research and use of sea resources and to take action to protect the environment.
- To search all living creatures of the sea and to expedite sustainable production of those resources for economic welfare.
- Identity and research the presence of offshore island, coastal areas and ocean bottom minerals, placer deposits, coal, oil and other minerals including gas.
- Study of hydrography, sedimentation, astrology, meteorology, navigation & communication system and the development of commercial communications.
- Encourage public and private organizations to invest in the trade and trade related to the marine and marine environment and to serve as consulting organizations.
- Providing assistance in respect of the country's maritime strategies and policies and proposals for planning including maritime law.
- Identify various environmental issues (coastal, deep sea circulation, delta formation, water flow, etc.) and environmental natural disaster and climate issues.
- Undertake coordinated approach to improve international relations and linking the oceanography with the local and international organizations.

Potential areas of Marine resources in Bangladesh

According to different research and Ministry of Foreign Affairs-

- Experts are speculating that there is one of the world's largest fuel (oil or gas) reserves in the Bay of Bengal which can control the energy-politics and economy of the day.
- In the Bay of Bengal, Heavy Mineral, such as Ilmenite, Titanium oxide, Rootail, Zircon, Garnet, Magnetite, Monazite, cobalt etc. have been found, which can be a huge source of foreign currency.
- There are about 475 species of fishes in the Exclusive Economic Zone (EEZ) of the Bay of Bengal. Fishing capacity can be increased to the desired level by reviving modem fishing trawlers and training.
- Salt can be exported abroad by using advanced technology in salt cultivation.
- Construction of deep sea ports with modern facilities will increase the activities of feeders of international commercial vessels.
- Marine shellfish and finfish farming can bring foreign currencies. There are already many opportunities of commercially produced PUFA's (Poly Unsaturated Fatty Acids) such as omega-3 and omega-6 antioxidants from different seaweed species.
- Development of existing fish resources can be done through the use of marine biotechnology. Organic technology also can play a role in preventing oil spillage.
- Use of adequate research and advanced technology is necessary to prevent marine and coastal environmental pollution in ship breaking industry.
- Because of the high wind speed in the offshore areas of the sea, renewable energy can be generated by establishing windmills. Electricity can be produced using the wave and tide as well as by applying the Ocean Thermal Energy Conversion (OTEC) technology.
- According to various sources, by the year 2030, l0% of the output the world's cobalt, copper, zinc and Rare Earth Element (REE) will be produced from the sea.
- Construction of marine aquarium, travelling system by cruise ship & by ensuring adequate safety in the coastal area can become one of the main sources of national revenue.

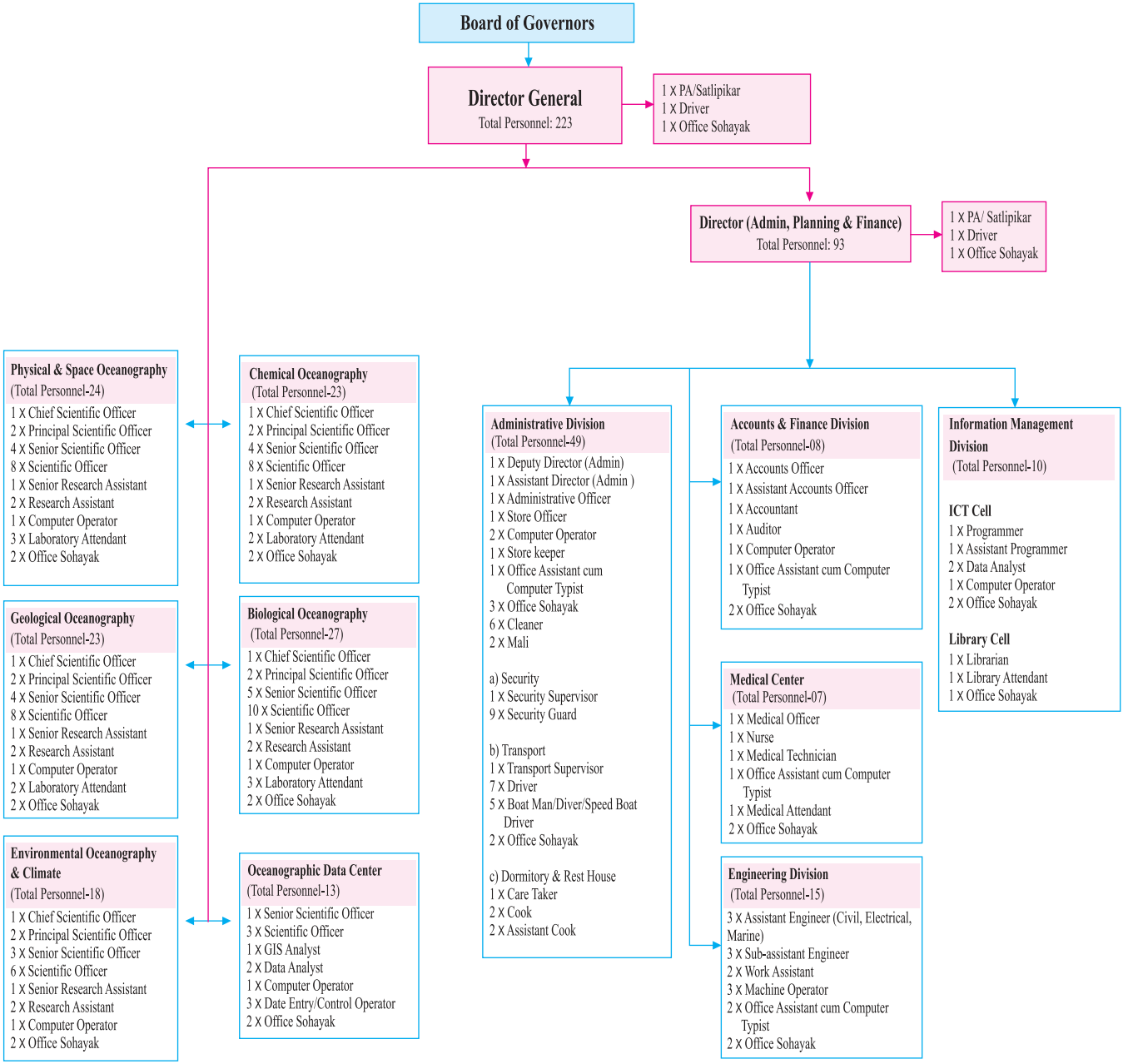
Major achievements of BORI

- It has managed and financed for 8 R&D projects in FY 2019-20, 6 R&D projects in FY 2018-19 and 5 R&D projects in FY 2017-18.
- It has taken a Comprehensive Blue Economy Plan and implementing successfully.
- It has taken a Complete & Comprehensive Safety Plan for its employees for the ongoing Pandemic COVID-19 response.
- BORI has recently assisted technical support with RT-PCR as a COVID-19 response to Cox's Bazar Medical College to detect SARS-CoV-2 virus in nasal swab sample.
- A Development Project Proposal (DPP) has been proposed for establishment of marine aquarium on 10 acres of land in Institute area.
- A Development Project Proposal (DPP) has been proposed for establishment of Bangladesh Oceanographic Research Institute (Phase-II).
- 19 scientists, engineers and other officials have attended at a training program at National Institute of Oceanography (NIO), Dona Paula, Goa, India.
- In the recent meeting of JSTC with India possibility of mutual co-operation was discussed.
- A delegation of China's Third Institute of Oceanography recently visited the Institute campus in Cox's Bazar and discussed about joint activities.
- Already 104 persons against 223 posts in the revenue sector has been recruited/posted and recruitment process for the remaining posts is in progress.
- Construction works including construction of building, residential building, quarters, dormitory, guest house, DG bungalow on 40 acres of land is already completed.
- Eight modern laboratories equipped with latest equipment have been established.
- The Bangladesh Ocean Research Institute Act-2015 is passed by the Jatiya Sangsad in the year 2017. The rules of the Institute were formulated.

Future Planning

- Acquisition of a modern oceanographic Research Vessel.
- Establishment of Marine Aquarium at BORI campus.
- Set up of a modern Oceanographic Data Center.
- Establishment of a modern Training Center cum International Hostel for oceanographer, ocean engineers and related professionals.
- Procurement of modern equipment for good research.
- Implementation of planning for Blue Economy.

Institutional Structure



Summary of Manpower

SL No	Name of Post	Number
1.	Director General (DG)	1
2.	Director	1
3.	Chief Scientific Officer (CSO)	5
4.	Principal Scientific Officer (PSO)	10
5.	Deputy Director	1
6.	Senior Scientific Officer (SSO)	20
7.	Programmer	1
8.	Scientific Officer (SO)	42
9.	Other Officers Equivalent to Scientific Officer	09
10.	GRADE: 1 to 9	90
11.	GRADE: 10	10
12.	GRADE: 11	10
13.	GRADE: 13	25
14.	GRADE: 14	18
15.	GRADE: 16	5
16.	GRADE: 19	19
17.	GRADE: 20	45
	TOTAL	223

Transport and Major office equipments

	Number
1. Transport	
a) Jeep	2
b) Pick up	2
c) Microbus	2
d) Minibus	1
c) Truck	1
f) Motorcycle	5
g) Speed Boat	3
h) Fishing Boat	2
2. Office Equipment	
a) Generator	03
b) Computer & Accessories (with UPS)	115
c) Printer	15
d) Multimedia Projector	5
e) Photocopy Machine	5
f) Scanner	5
g) Fax	3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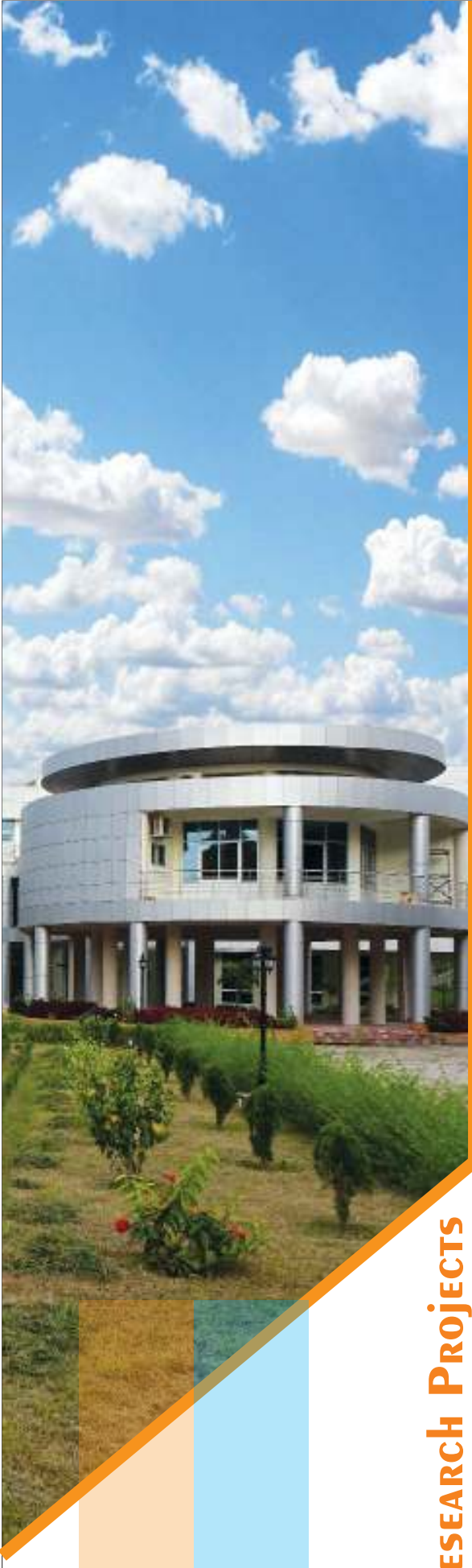

Chapter 02

Research Summary

- Activity
- Result
- Application
- Services

Research Projects
January, 2018 to June, 2020

Project Theme	Determination of spatial and temporal variations in sea surface chlorophyll and nutrients.
Duration	February 2018 to June 2020
Implementation area	Coastal marine area of St. Martin's Island, Cox's Bazar and Kutubdia.
Summary of project work	Determined spatial and temporal quantification of sea surface chlorophyll and nutrients (NO_2, NO_3, NH_4, SiO_2, PO_4). Besides, baseline data of physico-chemical parameters (SST, Salinity, TSS, TDS, pH, Secchi depth) of seawater have been collected in the Cox's Bazar and Kutubdia coastal marine area. Extension of this study is going on.
Roles in Public Welfare	It will be possible to determine the potential fishing zone by adopting integrated projects in the future using the status of chlorophyll and nutrients in the sea surface. This project will play an important role in marine fishing. The baseline data obtained through this project will play an important role in regulating any project at the government/private level in the coastal area. The level of conservation and exploitation of aquatic animals are determined by knowing the feeding and migration habits of aquatic animals in coastal areas.

Project Theme	Beach profiling along the coast of Cox's Bazar.
Duration	July 2019 to June 2021
Implementation area	Coastal area of Cox's Bazar
Summary of project work	Geographical survey is done in the beach area. 10 benchmarks have already been set up for profiling work and work is underway to set up 10 more benchmarks. Beach profiles of most areas are being prepared using comparative use of satellite data, benchmark data and survey data. Work is underway to create beach profiles in the rest of the area.
Roles in Public Welfare	Once the complete beach profile of the coastal area of Cox's Bazar is completed, the coastal erosion trend can be identified. This section analysis will enable long-term planning of coastal areas. Currently the government has various mega projects on the coast of Cox's Bazar so that beach profile will play a vital role in the projects. Moreover, beach profile will also play an important role in creating tourist facilities.

Project Theme	Sedimentological and Mineralogical Distribution in the Nearshore marine Area and Determination of Sediment Source.
Duration	February 2018 to June 2020
Implementation area	St. Martin's Island, Cox's Bazar-Teknaf, Maheshkhali-Kutubdia (3100 sq. km area).
Summary of project work	Important heavy minerals such as zircon, rutile, magnetite, ilmenite and some Rare Earth Elements (REE) such as uranium, thorium and selenium are found in the bottom sediment of the Nearshore marine area. Significant amount of these minerals are found in some areas. Extension of this study is going on.
Roles in Public Welfare	Heavy Mineral is very important in blue economy. Significant quantities of precious minerals such as zircon, rutile, magnetite, ilmenite, etc. and elements such as uranium, thorium and selenium can be collected from the bottom sediment of the area that will bring economic benefits to the country.

Project Theme	Determination of the effect of tectonic activity on the relative rise of sea level fluctuation based on the rate of subsidence and upliftment in the eastern coastal belt of Bangladesh.
Duration	July 2019 to June 2020
Implementation area	Eastern coastal area of Bangladesh.
Summary of project work	The tidal trend is identified from the historical tidal data of 8 tidal gauges in the eastern part of Bangladesh. Data is collected from GNSS stations in Khulna and Chittagong for tectonic movement calculations. Relative tectonic maps have been prepared through bathymetric maps of Cox's Bazar coast, surface geological maps and topography analysis. Work is underway to identify the effects of the relative fluctuation of sea level.
Roles in Public Welfare	Earthquakes, geological changes, tidal surges, etc. are predicted in the coastal areas of the country. Based on the results of this project, the adverse effects of natural disasters on the public life of the coastal areas can be reduced by adopting a national integrated plan.

Chemical Oceanography Division

Project Theme	Adaptive responses to ocean warming and acidification of different marine invertebrates inhabit in Southeast coast of Bangladesh and to operate a seawater culture unit.
Duration	February 2018 to June 2020
Implementation area	Southeastern Coastal Area of Cox's Bazar.
Summary of project work	Adaptation process and salinity of marine invertebrates have been determined with p^H condition of the area adjacent to the south-east coast and other important plant and animal culture units including green muscle or oysters, crabs, shrimps have been set up on the BORI campus. Extensive of this study is going on.
Roles in Public Welfare	The salinity and p^H values of seawater are closely related to the adaptation of invertebrates in marine areas. These invertebrates have economic importance. Neither the cage culture nor the mericulture of these marine invertebrates will be profitable if the salinity and p^H valuesare not known properly. Considerably, the project has a robust public importance. Based on the results of the Biological Culture Unit on the BORI Campus, it will be possible to carry out large scaled marine culture in the coast in the future that will benefit the coastal fishermen and will play an important role in the national economy.

Biological Oceanography Division

Project Theme	Preparation of Preliminary Taxonomic Checklist of Marine algae (Seaweed) along the coast of St. Martin's Island, Monitoring quality of bottom sediment and physico-chemical parameters of water and extraction of economically important physico-colloids (agar-agar, carrageenan) after verification of available seaweed.
Duration	February 2018 to June 2020
Implementation area	St. Martin's Island
Summary of project work	Taxonomic lists of 103 species of Rhodophyta, Chlorophyta and Phyophyta have been prepared. Work is underway to verify the nutritional value of 11 seaweeds. Agar-agar of 3 species of seaweed are extracted and optimization is currently underway. Phytoplankton identification of 350 species has been completed from samples collected from Bay of Bengal area through Nansen Research Vessel. In addition, identification of 150 species of zooplankton and ichthyoplankton are completed.
Roles in Public Welfare	Seaweed and seaweed are in great demand in the world market. Seaweed is used as food, medicine and cosmetics at the same time. Through this study, a taxonomic list of seaweed is prepared that will be a proper guidance in seaweed research and play role in national development. This will increase the production of seaweed in the country and will create employment opportunities. If it is possible to extract important phycocolloids from seaweed, it will play an essential role in the domestic pharmaceuticals, cosmetics, foods and beverage and toiletries industries.

Project Theme	Identification of marine pollution through seasonal quality monitoring and presence verification of marine organisms in the coastal area of Cox's Bazar.
Duration	July 2019 to June 2020
Implementation area	Coastal area of Cox's Bazar.
Summary of project work	Various physico-chemical parameters (Temperature, Salinity, pH, TDS, TSS, DO & BOD_5) of Kolatali, Laboni, Sugandha and Inani Beach area, Teknaf Beach, Maheshkhali Channel, Jetty No. 6, Badarkhali Jetty area have been fixed.
Roles in Public Welfare	Cox's Bazar beach and surrounding tourist areas are constantly facing severe pollution due to overcrowding, irresponsible behavior of domestic tourists, tour operators and hoteliers and unplanned waste management. Besides, due to lack of sewerage system, liquid waste from hotels and motels is flowing directly into the Bakkhali River. Then, it goes to the Maheshkhali channel and from the channel to the sea. First the river water, then the channel water, and finally the seawater are being polluted. In this way, the seawater is being polluted that has a devastating effect on the coastal environment, marine ecosystems and biodiversity of Cox's Bazar. This study will play an important role in determining the current state of pollution, identifying sources of pollution and preparing and making plans for pollution control.

Project Theme	Determination of Marine Pollution through Marine Litter (Plastic) and Water Quality in Coastal Area.
Duration	February 2018 to June 2020
Implementation area	St. Martin's Island and Cox's Bazar coast.
Summary of project work	The level of pollution has been determined by checking the quality of litter (plastic) and water in the coastal areas of St. Martin's Island and Cox's Bazar. A pollution map of the St. Martin's Island area has been published. Extension of this study is going on.
Roles in Public Welfare	Excessive tourist pressure and mismanagement have resulted in severe plastic pollution on St. Martin's Island. Every year from November to March tourist ships reach St. Martin's Island from Teknaf Jetty every day. This allows the tiny sand particles from the bottom of the ocean to move into the aquatic environment through the propeller of the ship and spread the tiny sand to the east and southeast of the island with the help of ocean waves and currents created by the strong north winds of winter. Determining the quality of water around St. Martin's Island, it is found that the amount of Total Dissolved Solid (TDS) is higher in the east and east south of the island. In the light of this project, it will be an important tool in determining the national policy on the use and settlement in this island. Moreover, the project will also play an important role in making policies for the conservation of biodiversity along the Cox's Bazar coast.

Conducting thesis activities

Sl	Name of Service	Service Receiver Organization	Department of Service Providers
1	University of Chittagong	4	Department of Biological Oceanography Department of Environmental Oceanography and Climate
2	Dhaka University	14	All research departments
3	Chittagong University Dhaka University Jahangirnagar University BSMR Maritime University	10	All research departments

Service delivery activities

Sl.	Name of Service	Serviced Organization	Department of Service Providers
1	Consultancy services on the impact of the ocean on the Marine Drive Road project	16 ECB, Bangladesh Army	Department of Geological Oceanography and Department of Physical and Space Oceanography
2	Provide technical support for Covid-19 test work using RT-PCR	Cox's Bazar Medical College and Hospital	Department of Biological Oceanography
3	Analysis and consulting services	FAO and the Department of Fisheries	Department of Biological Oceanography
4	Analysis Services	Jahangirnagar University, University of Dhaka, National Institute of Biotechnology (NIB) Sher-e-Bangla Agricultural University	Research Laboratories

Collaboration activities

Sl	Name of Collaborative Organization	Participating department	Participating scientists
1	Participated in the survey work at the Norwegian based NENSEN Research Vessel	Department of Biological Oceanography	1 person
2	Participated in the survey work at BNS Saibal Research Vessel of Bangladesh Navy	Department of Physical and Space Oceanography, Geological Oceanography and Chemical Oceanography	4 person

Chapter 3

Physical and Space Oceanography Division

Muhammad Shahinur Rahman
Scientific Officer

Md. Masud-Ul-Alam
Scientific Officer

Rupak Loodh
Scientific Officer

2017-2018

Investigate the status of Chlorophyll and nutrients around Saint Martin Island

Abstract

The relationship of nutrients and phytoplankton chlorophyll-a (Chl-a) is a basic for understanding eutrophication in a coastal marine ecosystem. This study was conducted to determine the concentration of Chl-a and nutrient distribution during the post monsoon in the coastal water of Saint Martin's Island, Cox's Bazar, Bangladesh. Distribution of Chl-a were described by the spatial map using collected samples of the water. While nutrient distribution was explained using kriging technique and mapped using ArcGIS. Due to the terrestrial influence especially from anthropogenic activities and Naf river discharge, higher Chl-a found in near coastal area and lower towards offshore area. High value of nitrate, ammonia and phosphate in near coastal area during the pre-monsoon indicates influence of terrestrial discharge especially from river outflow and human intervention. Distribution of Chl-a along the Saint Martin's coastal area was influenced by nutrient.

Keyword: Nutrients, Chl-a, St Martin.

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Rupak Loodh
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2018-2019

Spatio-temporal variation of stratification and surface chlorophyll–a concentration in terms of physical parameters along the Cox's Bazar coast, Bangladesh

Abstract

This study focus on spatio-temporal variation of stratification and surface chlrophyll-a concentration along the Cox's Bazar coast as well as Moheskhali-Sonadia Island adjacent area in winter and pre-monsoon season. In the study we also evaluate the physical parmeters like Sea surface temperature, Sea surface Salinity, Dissolved oxygen, pH, secchi disk depth and nutrients (nitraite, Nitrate, Ammonia, Phosphate and Silicate) in sea water. The area experienced with high chlorophyll a value (range 2.43-14.1 mgl-1) with mean value of 5.78 mgl-1. The highest mean chlorophyll a concentration is found in march (7.65 mgl-1) and lowest mean chlorophyll a concentration is found in January (4.83 mgl-1). This study indicated that this area's Chlrophyll-a controlled by primarily nutrient. This study reveals that there is no significant stratification has seen in the winter and pre-monsoon season in the study area. Partial correlation table indicate that chlorophyll a and Phosphate has positive correlation.

Keyword: Spatio-temporal variation, Chl-a, Cox's Bazar coast.

PSOD

Physical oceanography focuses on describing and understanding the evolving patterns of ocean circulation and fluid motion, along with the distribution of its properties such as temperature, salinity and the concentration of dissolved chemical elements and gases. Approaches include theory, direct observation, and computer simulation. Research frequently takes place in the context of important multidisciplinary issues including the dynamics and predictability of global climate and the sustainability of human use in coastal and estuarine regions.

Space oceanography deals with the research and development of remote sensing data on the world's oceans, and calibrates instruments, verifies the data, and creates products to meet the needs of users for satellite data and other information on the oceans.

The activity of Physical and Space Oceanography Division (PSOD) started by the mandate of BORI Act, 2015 (article 8) with the starting of BORI. Research activity has been started on 2017-2018 FY with taken a R&D project in the marine area of Saint Martin's Island. The R&D project topic was the spatial and temporal variation of chlorophyll-a and nutrients of the Saint Martin's island near shore area.

In the next FY 201 8-2019, another R&D project has been taken on the nearshore area of Maheshkhali Island. The R&D project deals with the coastal stratification study with physico-chemical parameters. During the field activity of 2018-2019 FY research, a cruise has been operated with the help of Bangladesh Navy R/V Saibal and covered about 900 sq. km.

Besides research activity, PSOD is giving oceanography based analytical service and technical support to different government and non-government institutions.

Project 1

Spatial and temporal variations of surface Chlorophyll and nutrients in the coastal area of Kutubdia Island

Muhammad Shahinur Rahman
Scientific Officer

Rupak Loodh
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Abstract

The present study conducted around the coastal water of the Kutubdia Island to analyze the spatial and temporal variation of surface chlorophyll and nutrients which located in the Northern Bay of Bengal. Samples were collected from November to April in a bi-monthly interval. From the present study, the surface chlrophyll, secchi disk depth, sea surface temperature, sea surface salinity, dissolved oxygen and pH varied from 3.03-7.1 mg/l , 0.1-1.4 m, 22.26-27.27^{o} C, 22.26-33.20 psu, 2.36-9.70 mg/l and 8.04-8.39 respectively. The concentration of nutrients in surface water recorded 0.10 to 2.00 mg/l for nitrate, 1.00 to 5.00 mg/l for nitraite, 0.15 to 0.48 mg/l for ammonia, 0.28 to 3.86 mg/l for phosphate, 0.98 to 5.00 mg/l for silicate and 0.10 to 3.12 mg/l for Iron. Trophic status index (TRIX) was used for evaluate the trophic state of the study area. The present study indicated that the water of the surrounding of the Kutubdia Island is eutrophic during the study period. High spatial and temporal variation was seen in Kutubdia Channel and the variability was low in the open water.

Keywords: Chlorophyll, nutrient, TRIX, Kutudbia Island.

Project 1

Introduction

Phytoplankton is the aquatic microscopic free-floating autotrophs are considered as an important ecological indicators of the oceanic and coastal waters (Lotliker et al., 2019). They are the primary source of a food chain which regulate the food web and contributes to the major fishery resource around the world (Falkowski et al., 2008; Field et al., 1998). In marine ecosystem, they play a vital role by releasing oxygen during photosynthesis and aid in energy exchange process (Khan, 2003). Their growth, abundance, decay and biomass varies with nutrients, dissolved oxygen, temperature, light and mixed layer depth according to time and space (Piehler et al. 2004). The concentration of chlorophyll-a (hereafter referred as chl-a) which is the dominant pigment of phytoplankton cell considered as proxy for phytoplankton biomass (Huot et al. 2007). Enhanced concentration of chl-a in water from high phytoplankton abundance and productivity can produce bloom (Tang et al. 2003). The chl-a concentration of ocean water information is becoming increasingly important because of its potentiality of monitoring water quality, climate change, and the pollution impact in the ocean (Lotliker et al. 2018).

Ions required for plant growth are known as nutrients and these are the fertilizers of the oceans (Duxbury and Duxbury 1999). Nutrients are life supporting factors of the marine ecosystem. Inorganic substances of nitrogenous nutrients (nitrate, nitrite, and ammonia), phosphorus and silicate are considered to be more important than others due to their key role in phytoplankton abundance, growth and metabolism (Grant and Gross 1996). The nutrient contents in any coastal water determine its potential fertility (Pitchaikani and Lipton, 2016). Highly dynamic relationship between phytoplankton and nutrient is exist in marine ecosystem (Chattopadhyay et al., 2003). It has always been the major focus among the researchers to investigate the nutrients distribution and behavior in different coastal ecosystems are prerequisites for productivity evaluation (Pitchaikani and Lipton 2016). Considering these, the present study was conducted to understand the spatial and temporal variability of chl-a and nutrients in the coastal water of Kutubdia Island.

Aim and objectives

- Spatial and temporal variability of Chlorophyll-a in the Eastern coast of Bangladesh
- Spatial and temporal variability of nutrients in the Eastern coast of Bangladesh
- To collect the Physico-chemical baseline data in the Eastern coast of Bangladesh

Study Area

Kutubdia Island lies between latitude 21^{O}44'23" to 21^{O}55'24" N and longitude 91^{O}50'40" to 91^{O}54'04" E, situated in the south-eastern part of Bangladesh having an area of 215.8 km² and separated from the main land by Kutubdia channel. The island is north-south elongated, approximately 20 km long and 5.5 km wide. This offshore island of Cox's Bazar district was upgraded to an upazila in 1983 which is bounded by Banshkhali upazila of Chittagong district on the north and by Banshkhali, Chakaria and Moheskhali upazila on the east and by the Bay of Bengal on the south and west.

Geologically this island is young and getting its present shape in the Holocene time dominantly consists of unconsolidated sediments. Major physiographic unit of Kutubdia Island is young coastal plain having average elevation of ~6 meters surrounded by active coastal plain. According to Majlis et al. 2013, major portion of the study area dominantly consists of tidal deposits, i,e intertidal and supratidal deposits composed of sitly clay with organic clay mix and little sand whereas beaches and dunes are composed of loose fine to medium sand with considerable amount of heavy minerals.

The study area facing strong long shore currents in the rainy season which eventually cause rapid erosion in the southern and western shorelines. This area is characterized by tropical and subtropical climate. Monsoon period is the main source of rainfall. About 90% of the annual rainfall occurs during this time period, beginning in May and continuing up to September (Islam et. al., 2014).

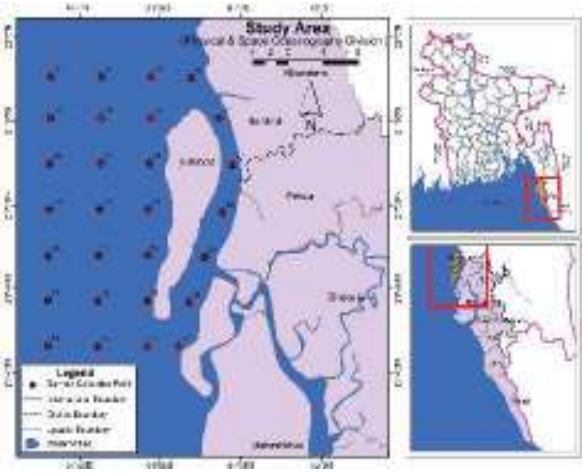

Figure 1: Study Area

Methodology

Samples were preserved in ice during the collection till transportation to the laboratory. Samples were immediately filtered using 0.45 µm Millipore membrane filter paper and analysed for various physicochemical and biological parameters, viz., nutrients such as inorganic phosphate (PO_4^{3-}), nitrite (NO_2-N), nitrate (NO_3-N), Ammonia (NH_3-N), silicate (SiO_2) and Chlorophyll a (CHL-a), following the standard methods (Grasshoff et al. 1983; APHA 1995). Nutrients were measured by the photometric methods (UV-1800, Shimadzu, Japan). Chlorophyll a was extracted in 90% acetone and measured spectrophotometrically following Strickland and Parsons (1984).

Results and Discussion

Generally, the spatio-temporal variability chl-a, depends on the availability of light, nutrients and oxygen together with physical processes (Vinayachandran, 2009). In the tropics, shallow coastal water is usually well mixed and oxygen rich and phytoplankton growth is not light limited and in that case, phytoplankton growth and abundance are controlled by nutrients (Baliarsingh et al., 2015). However, in case of highly turbid coastal waters, where nutrients are present at moderate to high concentrations, light availability can be a limiting factor for primary production (Vinayachandran et al. 2005). The river discharge is the main source of nutrients in coastal waters (Sarma et al. 2009; Mishra et al. 2009).

In order to find the spatial and temporal distribution of chl-a concentration in the study area are represented by box plot in figure 2(a). Chl-a concentration has varied from 3.03 mg/l (March-April) to 7.1 mg/l (Nov-Dec). The mean value of chl-a concentration is 5.83±0.71, 4.68±0.35, 4.09±0.23 and 3.73±0.44 mg/l for transect A, B, C and D respectively. High chl-a always associated with coastal region which is always influenced by terrestrial input and value is low in the offshore region. Coastal area has large spatial variability with seasonal variability. Near shore and offshore region has less spatial variability and the seasonal variation is less prominent.

Secchi disk depth (SDD) is a measure of water transparency which has a positive relationship between secchi depth and transparency. Figure 2 (b) represents the spatial and temporal variability of SDD in the coastal water of Kutubdia Island. SDD values varied from 0.1m to 1.4m. During the study period, the mean value of SDD is 0.24±0.12, 0.74±0.28, 1.10±0.20 and 1.07±0.25 m for transect A, B, C and D respectively. Low values which indicate high turbidity associated with coastal region and high values are found in the offshore region. Water transparency is high in Mar-Apr due to less river discharge from Karnafuly and Sangu River. SDD has high spatial variability in Nov-Dec period.

Temperature is an important factor for marine environment as it influences the life of organisms and physico-chemical parameters (Sukumaran et al., 2013). Figure 2 (c) represents the spatial and temporal variability of sea surface temperature (SST) in the coastal water of Kutubdia Island. The SST range varied from 22.26^0 C to 27.27^0 C. The mean value of sea water temperature for transect A, B, C and D are 25.51±1.52, 25.53±1.60, 25.64±1.35 and 25.62±1.46 ^{0}C respectively. The variations in temperature may attribute with atmospheric temperature, influx of freshwater and wind force (Vajravelu et al., 2017).

Salinity as an important limiting factor plays a vital role in controlling the faunal and floral diversity of coastal ecosystems (Govindasamy et al., 2000). The spatial and temporal variation of salinity was represented by figure 2 (d) and it reached a maximum of 33.20 ppt (Mar-Apr) and minimum was recorded as 22.26 ppt (Nov-Dec). The mean value of salinity was 27.22, 28.32 and 31.79 for Nov-Dec, Jan-Feb and Mar-Apr respectively. The low value associated with river induced fresh water influx and increasing with lack of it and high intensity of solar radiation in pre monsoon period.

Dissolved oxygen is a major component in an aquatic ecosystem which determines the quality of water and support aquatic life. Dissolved oxygen in water was shown in figure 2 (e) and ranged varied between 2.36

mg/l to 9.7 mg/l. During the study period, low dissolved oxygen has found in winter time (Jan-Feb). Other times the concentration shows less marked difference. The mean value of Dissolved Oxygen was 5.57±2.04, 7.35±1.40, 7.57±1.17 and 7.52±0.97 mg/l for transect A, B, C and D respectively. Low dissolved oxygen has found in tranject A which located in the Kutubdia channel. In the study area, possibly wind is the controlling factor for dissolved oxygen concentration.

Figure 2 (f) shows the spatial and temporal variation of Hydrogen ion concentration (pH) in Kutubdia coastal water and it varied from 8.04 to 8.39. The mean value of pH was 8.19±0.07, 8.24±0.06, 8.26±0.06 and 8.26±0.05 for transect A, B, C and D respectively. Low pH associated with the coastal water due to river derived fresh water discharge and value increasing with the decreasing of river discharge. The low pH value of transect A was explained by the influence of terrestrial freshwater input.

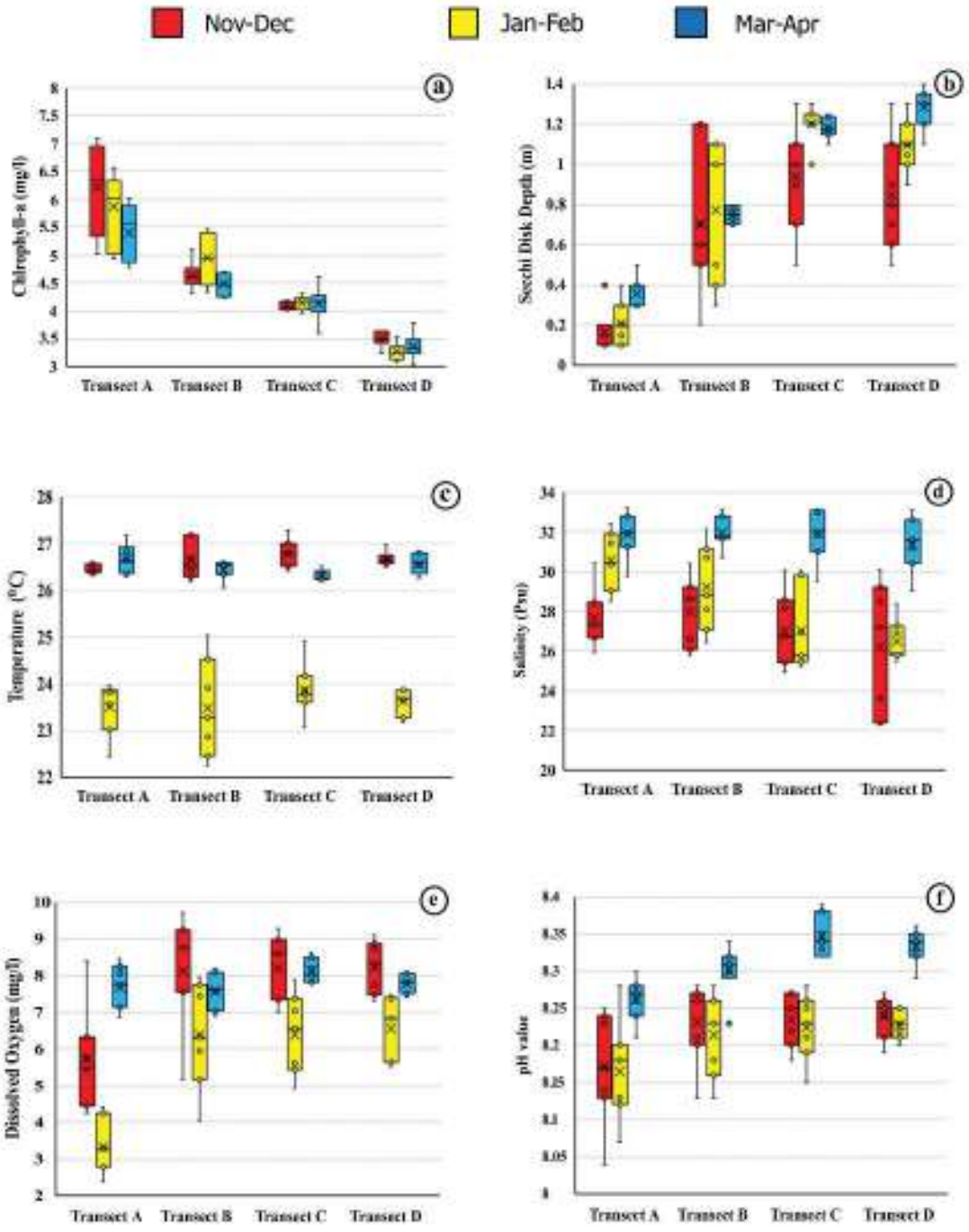

Figure 2: Bi-monthly variation of physico-chemical parameters during the study period. Chlorophyll-a (a), Secchi disk depth (b), SST (c), Salinity (d), Disssolved Oxygen (e), pH value (f).

Nutrient Dynamics

Nutrients such as nitrate, nitrite, ammonia, Phosphate and silicate in the coastal environment would exhibit substantial seasonal variations depending on the rainfall, freshwater input, tidal ingress and consumption of nutrients by autotrophs (Vajravelu et al., 2017).

From the figure 3(a), the nitrate (NO_3) concentration are high within the channel area and range varied between 0.10 to 2.00 mg/l. There is high spatial variation has seen in channel and coastal water of the study area and possible reason is the coastal agriculture and aquaculture related activities. High concentration value are found in nov-dec period and low in jan-feb period. The mean value of nitrate was 0.90±0.46, 0.70±0.33, 0.60±0.22 and 0.67±0.27 mg/l

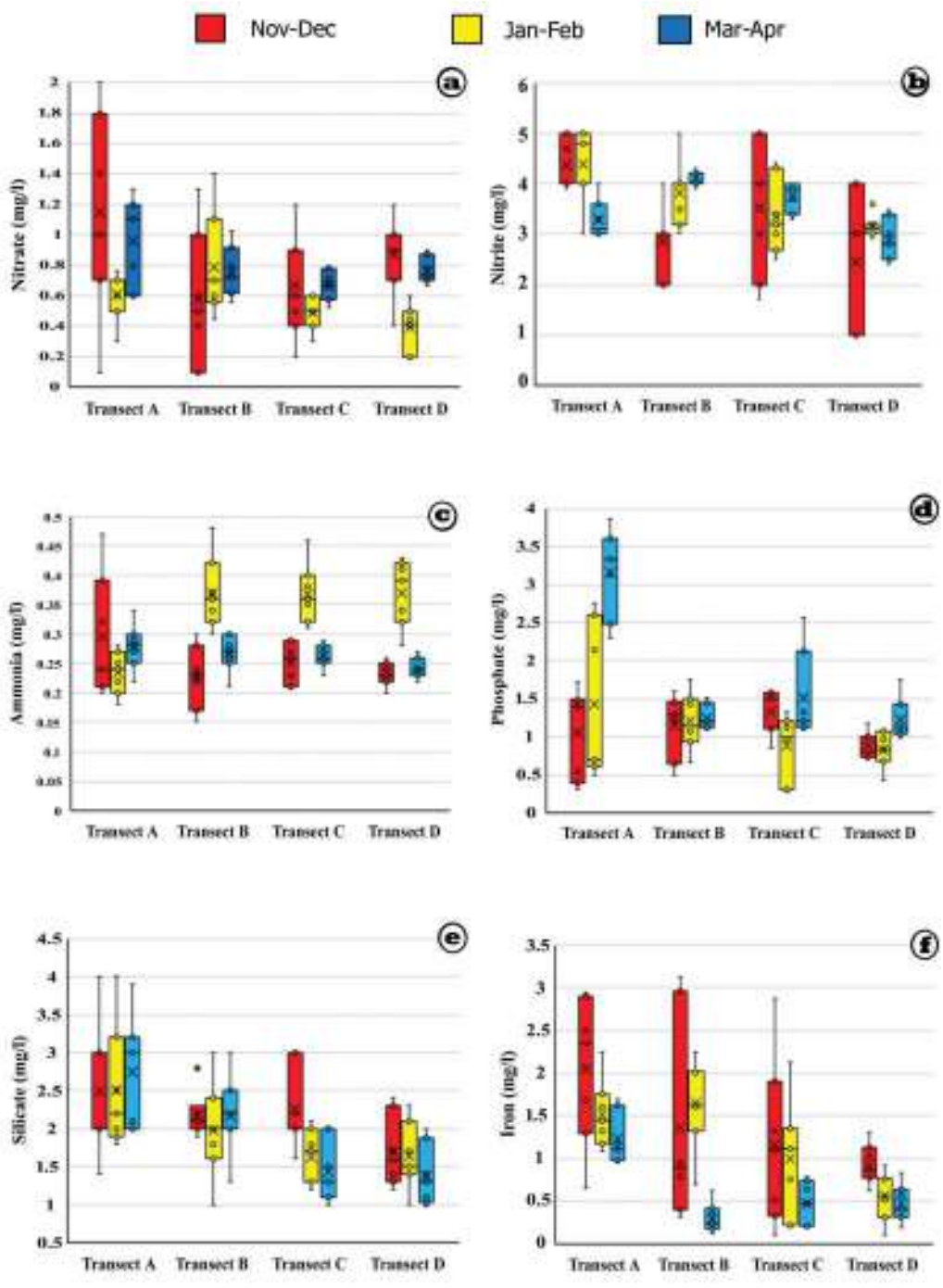

Figure 3: Bi-monthly variation of physico-chemical parameters during the study period. Nitrate (g), Nitraite (h), Ammonia (i), Phosphate (j), Silicate (k), Iron (l).

input, high rate of biological production, oxidation of ammonia, reduction of nitrate by recycling of nitrogen and also by biodegradation of planktonic detritus are the possible reason for higher value of nitrate in nov-dec period (Santhanam and Perumal, 2003). The lower concentration of nitrate explained by high consumption of nitrate by photosynthetic organisms and the incursion of neritic water which constitute only the smaller amount of nitrate (Govindasamy et al., 2000). From the figure 3(b), the nitraite (NO_2) concentration are high within the channel area and range varied between 1.00 to 5.00 mg/l. The mean value of nitraite was 4.01±0.75, 3.60±0.76, 3.54±0.86 and 2.82±0.85 mg/l for transect A, B, C and D respectively.In the channel area and coastal area of seaward part of Kutubdia Island, the spatial variability is low during the whole study period and low concentration value has seen in mar-apr period. High spatial variability has seen in nearshore and offshore part of the study area has seen in nov-dec period and possible reason is the incoming nutrient from Karnaphuli and other rivers.

From the figure 3(c), the ammonia (NH_4) concentration are high within the channel area and range varied between 0.15 to 0.48 mg/l. Highest value for ammonia concentration has found jan-feb period for most of the study area but for channel area, it is seen in nov-dec period. The mean value of ammonia was 0.27±0.06, 0.29±0.07, 0.29±0.06 and 0.28±0.07 mg/l for transect A, B, C and D respectively. One possible reason for low ammonia concentration during Mar-Apr period as well as pre-monsoon season, may be attributed to quick utilization of specific phytoplankton community due to their preference of ammonia more than nitrate (Dugdale et al., 2007; Lipschultz, 1995).

Phosphate (PO_4) plays an important role in primary productivity in an aquatic ecosystem by promoting growth for organisms and limits the phytoplankton production (Cole and Sanford, 1989). From the figure 3(d), the phosphate concentration are high within the channel area and near shore water and range varied between 0.28 to 3.86 mg/l. High spatial and temporal variability of phosphate concentration both are seen in the channel area. For other area, the variability is not prominent. The mean value of phosphate was 1.87±1.18, 1.2±0.32, 1.24±0.50 and 0.98±0.28 mg/l for transect A, B, C and D respectively.

Variation in silicate (SiO_2) concentration is controlled by physical mixing of seawater with a freshwater addition, adsorption and sediment particles, interaction between chemicals and minerals, co- precipitation with humic components, and biological removal by phytoplankton, particularly diatoms and silicoflagellates (Satpathy et al., 2009). From the figure 3(e), the silicate concentration are high within the channel area and range varied between 0.98 to 5.00 mg/l. The mean value of silicate was 2.46±1.03, 2.32±0.86, 2.26±0.95 and 2.16±0.78 mg/l for transect A, B, C and D respectively. The temporal variability of silicate concentration for four transects are not prominent.

Iron (Fe) is one of the important limiting nutrient for phytoplankton growth along with N and P (Coale et. al., 2003). From the figure 3(f), the iron (Fe) concentration are high within the channel area and range varied between 0.10 to 3.12 mg/l. The mean value of iron was 1.60±0.64, 1.10±0.92, 0.87±0.72 and 0.65±0.31 mg/l for transect A, B, C and D respectively. High spatial and temporal both variability has seen in transects A, B and C. The variability of Iron concentration is not prominent for transect D.

Surface current and sea level height anomaly

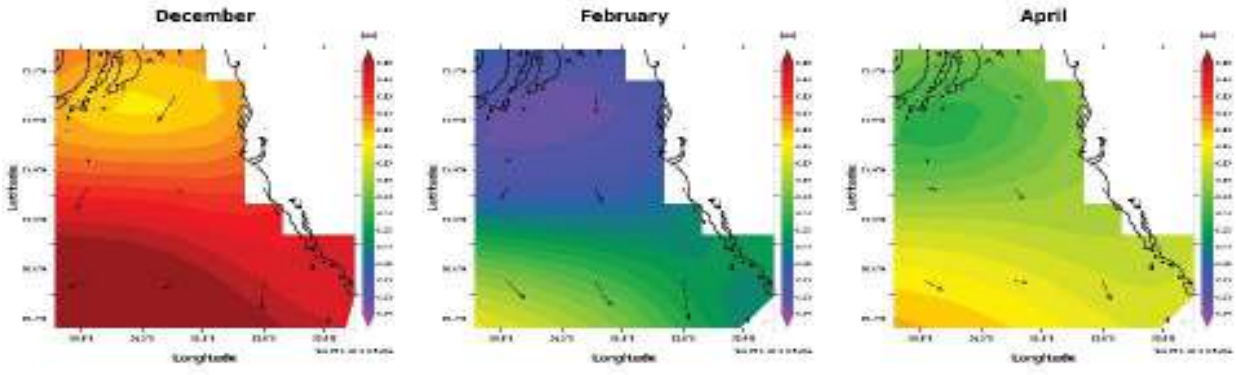

Figure 4: Climatological sea level height anomaly with current speed and direction for December (left), February (middle) and April (right).

Current speed was calculated from the combined product of CMEMS NRT satellite daily mean Geostrophic Surface Currents and modeled Ekman current upon a 1/4 degree regular grid with a temporal range of January to March 2020 (Rio et al., 2014). From the figure 4, three maps represents the monthly climatological current speed and direction for December, February and April along with sea level height anomaly. In December, positive sea level height anomaly and the strong current direction to the south west direction which bring terrestrial input. In February, the current direction is to the south direction and sea level anomaly is not prominent. In April, the weak current direction is to the south-east direction and positive sea level anomaly is found in this month.

Trophic Status evaluation

The trophic status classification of coastal water in Kutubdia Island was evaluated using trophic status index (TRIX) developed by Vollenweider et al.(1998).

TRIX= (Log10[Chl-a*a%DO*N*P]++1.5)/1.2 (1)

The trophic index (TRIX, Eq. 1) is a linear combination of the logarithms of four state variables (Chl-a, N, P and the absolute percentage deviation of oxygen saturation from 100% (a%DO)). We used DIN for N and DIP for P in this study. The index is scaled from 0 to 10 for oligotrophy-hypertrophy, wide range of trophic conditions and divided into four classes: 2<TRIX<4 (high), 4<TRIX<5 (good), 5<TRIX<6 (moderate), 6<TRIX (poor).

Figure 5 represents the trophic status map of the coastal water of Kutubdia Island which produced by the equation of TRIX. From the figure, the value of coastal water of the Kutubdia Island was always more than 6 which indicating the eutrophic condition of this area. The channel area has highest TRIX value during the study period and the value has decreased with the distance from land.

Figure 5: Bi-monthly Trophic Index (TRIX) map for study area

Conclusion

The hydrological parameters of coastal water of the Kutubdia Island exhibited distinct variations at spatial and temporal scale. River derived fresh water and wind magnitude and direction play the main factor for this type variation. Regular water quality monitoring of coastal and marine area is not established yet. This research will be used as a baseline information for climate change induced hydrological characteristics alteration of this area.

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Project 2

Beach Profiling along the Coast of Cox's Bazar

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Abstract

The study was conduct to investigate the monthly impact on beach dynamics along the study area. Beach-profile measurement using theodolite were conducted in 10 profiling sites along the coast of Cox's bazar on monthly basis among the month of January, 2020 to April, 2020. Profile data was used to calculate the variation in beach width, slope and volumetric changes. The monthly action of wind and wave currents create near-shore bar and erosion of berms during monsoon. The results reveal that the deposited sediment has been eroded from the month of January 2020 to the month of April 2020. The long-shore current measurement also shows that the current speed varies monthly interval. The results suggested that monsoonal action has influenced the seasonal changes in beach morphology. The beach profile helps to understand the change in the beach morphological characteristic.

Keyword: Beach profiling, Coastal area, Cox's Bazar.

Project 2

Introduction

Beaches are the most dynamic zone in the coastal areas and they changes continuously with time. In spite of active changes, beaches are usually prone to maintain stability. The study of Shoreline changes and beach profiles gives information on cyclic/seasonal Morphological changes at all dimensions. These studies are essential to understand the Erosional and depositional features, which in turn helps in understanding changes in Oceanographic processes in the coastal areas in short span of time. Stability of a beach can be assessed from the profile changes during rough and fair weather seasons and can be monitored by recording the winds, waves, currents, tides breaker characteristics, sediment characteristics. If the beach material is washed away during the rough weather season they are re-deposited during fair weather. Thus erosion and accretion are continues processes. And these process are responsible for forming unique landforms like coastal plains, river deltas, wetlands, beaches and dunes, reefs, mangrove forest, and lagoons.

The information from beach profile and beach dynamics processes are very useful for coastal planning authorities for their planning of new development (Cambers and Ghinna 2005). Again, better understanding of beach dynamics processes, requires basic knowledge of the coastal landforms and its influences factors. So, beach morphology can be considered as a sensitive indicator for the coastal dynamic processes of a particular coastline (Wright and Short 1983; Hardisty 1994). The spatial and temporal morphological changes of a beach over time, a good estimate of the rate and direction of coastal changes can be obtained (Dean 1983; Brunsden 2001).

Beach profile gives us information about the surface shape, trend, slope and volume of sediments (Guillen et al. 1999). Simplest methods for measuring beach profiles were well explained by Delgado and Lloyd (2004). With the advancement of science and technology, various methods have been applied to monitor the beach profile changes. Among them, using GPS-RTK (Global Positioning System-Real Time Kinematic) (Ruggiero, P et al. 2009), total station or theodolite survey or even use a dumpy level etc. (Lee, J.M. et al. 2013) are direct measurement methods. Some remote sensing techniques are also used in order to measure beach profile. There are coastal imaging airborne LIDAR (light detection and ranging), and Unmanned Aerial Vehicles (UAVs) for coastal surveying for determining beach profiles (Turner el al. 2016).

Many studies on beach profile has been carried at different regions by various researchers around the world including India and Myanmar (Anil Cherian 2003; Rajamanickam 2006; Antonio and Seelam 2008, Manik Das Adhikari 2016). These beaches are mostly composed of rocky and sandy beaches. But this type of study relatively new in Bangladeshi sandy coast and So far such studies have not been conducted in the North Cox's bazar coast. The high rate of tourism and recreational activities is influence the coast and leads to morphological disturbances. Therefore, the main objective of the present study is to quantify the coastal morphological change by profiling and sediment analysis.

Objectives

- To investigate the seasonal impact on beach dynamics.
- To investigate the status of sediment distribution.
- To investigate the long term variation of shore line changes.
- Make and record observations.
- Graph the beach profile.
- Coastal erosion & accretion map for coast of Bangladesh.
- Marine drive conservation & management from Cox's Bazar to Ramu.

Study Area

Cox's Bazar, a coastal district, situated in the south-east in Bangladesh, and the northeast of the Bay of Bengal. Marine drive connect Cox's Bazar to its south most Thana of Bangladesh called Teknaf. Marine Drive situated at the very coastline of Cox's Bazar to Teknaf coast of Bay of Bengal. And the Marine drive has one side Bay of Bengal beach and the other side mostly covered by hills and other features like household, hotels, and agricultural fields.

So it is very common that, oceanic processes (action of wave, tide or current), as well as atmospheric processes (wind, rainfall, weathering, etc.), are highly affected on Marine drive adjacent beach.

These processes are so active that some part of marine drive (northern part) are already destroyed. Current study mainly focus on these point where marine drive is highly vulnerable. So we have selected 10 stations (fig. 1) for measurement the beach profiles.

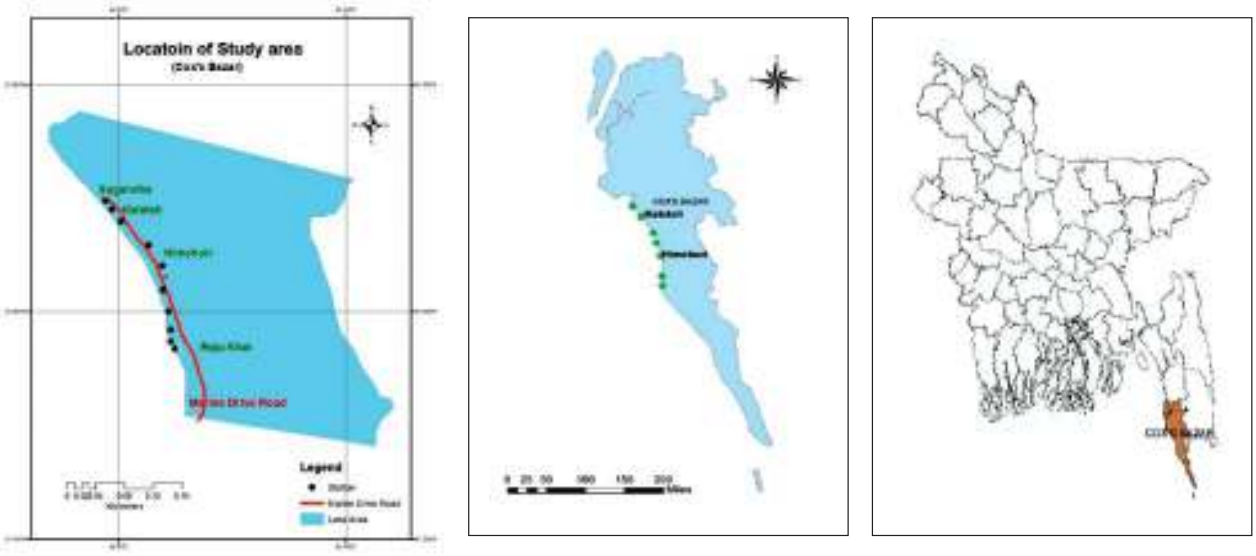


Figure. 1 Study area Map

Table.1 Select Station Information

Station Name	Description	Lat	Lon
Station 1	Adjacent South of Reju Khal mouth	21°17’29"N	92°02’45”E
Station 2	Adjacent North of Reju Khal Mouth	20°19’20”N	90°02’00’’E
Station 3	North of Reju Khal near Parasailing zone	21°20’41”N	92°01’46”E
Station 4	Himchori South	21°20’49”N	92°01’42”E
Station 5	Adjacent of Himchori Beach near Police Box	21°21’14”N	92°01’29”E
Station 6	Himchori North	21°21’44”N	92°01’12”E
Station 7	South of Dariar Narag	21°23’38”N	91°59’54”E
Station 8	Kalatoli South	21°24’19”N	91°59’25”E
Station 9	Kalatoli North	21°24’53”N	91°58’58”E
Station 10	Adjacent of Suganda Beach	21°25’05”N	91°58’49”E

Methodology

Firstly, tidal data have observed for profiling. As tide is an important parameter that influences the beach morphology. Hence, it is important to understand the tidal characteristics of a region where beach profiling studies are planned. The only tidal station available in Cox’s Bazar is located.

Bangladesh Inland Water Transport Authority (BIWTA) tide table for the year 2020 was used to obtain the information on the time of occurrence and the height of the high and low tide values. Since the beach profiling studies were planned to understand the temporal variability from January to April, 2020, the months of April 2020 were chosen and these data were plotted (Figure 2) to understand the tidal variations.

10 permanent structures of the benchmark was selected, which was the starting the beach profiling. For obtaining the geographical coordinates with extreme precision of the permanent benchmarks, we used a GPS carefully.

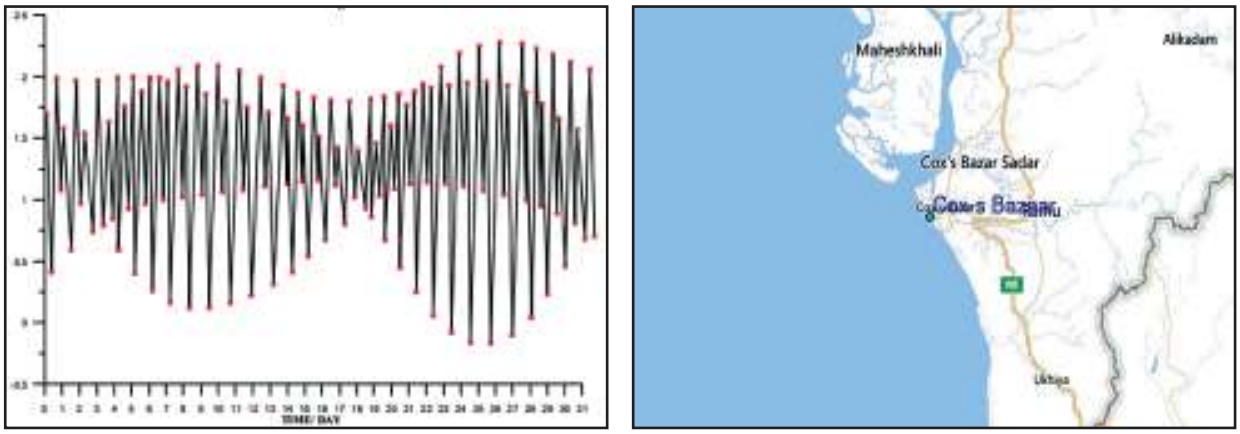


Figure 2 Tidal gauge location and Tidal data for the month of April, 2020

Before measuring the elevation, all the equipment were calibrated to avoid errors in measurements. After calibration, the benchmark elevation was measured from a fixed distance from the benchmark using theodolite and measuring staff (Figure 3).

For understanding the beach level changes, it is very important to recognize all the features of the beach and characterize them. The profile of the beach allows us the information about the general beach morphology.

A beach profile is a cross-sectional view of the beach, which has been plotted showing the variation of elevation with distance from a fixed benchmark. The profile of beach at each station was plotted and the HTL (High Tide Line) and LWL (Low Water Line) were marked.

Thereafter, different features of beach like dune, berm, backshore and foreshore etc. were identified. The accuracy of the measuring staff is 0.01cm. The least count of the leveling staff used is 1cm. A rope was placed in a straight line from the benchmark through the tripod of the dumpy level along which beach elevations were measured at an interval of 5m with the help of dumpy level and measuring staff. To obtain the elevation of the point, this process was repeated until the low water line was reached.

Figure 3 Measuring the profile

The graduated staff reading which denotes the elevation was first reduced with respect to the fixed benchmark. This was necessary as readings were taken with respect to the dumpy level whose position changed from time to time so as to obtain the elevation within the length of the measuring staff. The data values were plotted with distance on the abscissa and reduced elevation on the ordinate for each station.

Results & Discussion

Beach profiling

As the main purpose of this study is conducting monthly beach profile surveys using electronic theodolite surveys for documenting beach evolution. These monthly beach profiles data used to understand the spatio-temporal (in this study monthly as well as the seasonal) changes in elevation at each point. Result includes change in slope, width and sediment volume were analyzed to understand the seasonal beach morphological change and its impact on beach dynamics.

Some stations profiles have considerable monthly topographical change, whereas some have comparatively less monthly changes observed (Figure 4). Overall, we have a clear topographical changes between the months of January, 2020 and April, 2020.

During the month of January, 2020, south of Reju Khal mouth (Station 1) had some berm and a steep sand dune but, during the month of April (very near of monsoon period) it was noticed that the berm was nearly eroded (Figure 4A). That indicate, during monsoon this berm will totally erode which reveals that the monsoon wave have affected the beach and has changed its topography. If we look at the monthly changes of profile, a little vertical changes will appear, but the Low Water Line (LWL) have remarkable change was observed. Station 01 had 40m horizontal change observed in between the 4 months of study period. There were a berm approximately 60 m wide was notice on the month of January, but the result of divergence in longshore sediment transport eroded totally at the month of April, 2020 (Figure 4A).

The dune has not changed much in Station 2 but the berm has a considerably got eroded (Figure 4B). Approximately 0.25m erroded on the month of April, where as is had 0.42m altitude in January. This may be due to the shifting of berm behind a distance of about 50m. On looking at the profile, it is apparent that the fore-shore has got eroded. The slope of the foreshore has become flatter and the elevation has also reduced with monthly time interval. In general, the major change that has occurred was the shifting of the berm. Approximately 40m LWL shifted from January to April.

In Station 3, monthly profiles showed backshore is more stable than the the foreshore and have a simillar pattern with station 02. As both station are well connected with Reju khal influence. Looking at the profiles (Figure 4C), foreshore gradually has become flatter and the elevation has also reduced with monthly time interval. In January, foreshore berm have a elevation near about 1m and in the month of April it's elevation remain about 0.5m. Probably, this erotion will continue untill the monsoon over.

There are gradual deposion occurred at the "V" shaped region behind the berm was got rise. Approximately 0.05m deposion on the month of April, where as is had 0.12m altitude in January. Behind this "V" shaped deposion region, there also some eroted are discovered extend to the backshore area. Approximately 40m LWL shifted from January to April.

Station 04 and station 05 is considered as a rapid vulnerable area for Marine Grive road, Cox's Bazar. As some protection of Marine drive there are of geobags and geoblocks are there. Aproximately, 30m and 40m geobags protection found there and they have a stable elevation found at four months study. The study reveil that, these two station have simillar monthly profiles found during the study period.

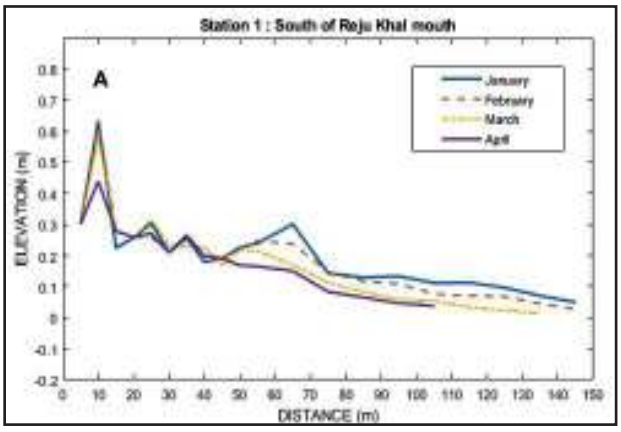
There are small change of vertical elevation in the foreshore area in monthly observed data in station 04 and station 05. There are small berms (0.12m and 0.11m consequently) in foreshore area in both cases at the month on January, 2020. The monthly observed data shows that these berms are gradually eroded and loss their elevation (Figure 4D & 4E). In the month of April, 2020, these berms is totally eroded. Beheind this berms area, there were a "U" shape feature with water passages in month of January which is gradually diposited with daily tidal activity. At the month of April 2020, the "U" shape features is totally diminish by dipositon in both area.

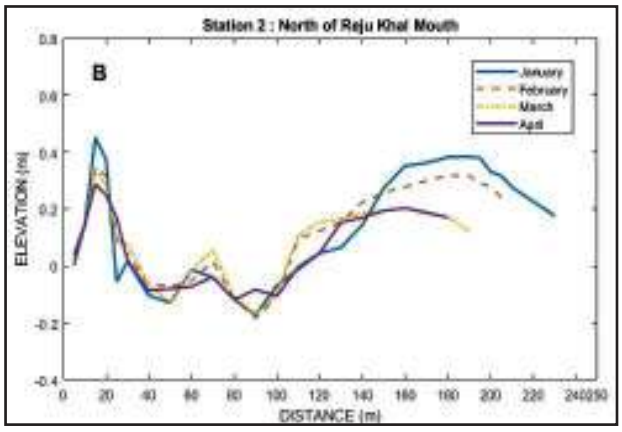
Looking at the low tide line, here are a huge difference observed on station 05 (Adjacent of Himchori Beach near Police Box). About 70m loss of LWL at station 05 in four months time scale. This is consider the height LWL loss along the coast. On the contray, station 04 have approximately 50m loss of LWL at station 04, which is simillar with other stations.

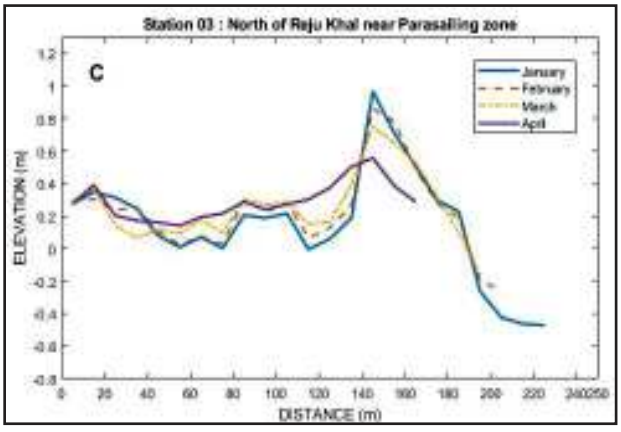
In station 06 (Figure 4F), backshore a dune height 1.135m in January 2020 have a slow erosion. Aproximately, 0.126m eroded by the longshore sediment transport on the month of April 2020. Following this dune area, there are a "U" shape lagoon have active dipositon there. Looking at the monthly profile, there are two berms approximately 97m wide are also got erosion. At the month of April 2020, very first berm of foreshore is totally eroded due to longshore current. Behind this berm, there were a "V" shape cut in month of January 2020 is getting flattening due to deposition of long shore current. About 39m low water line change in among these four month interval.

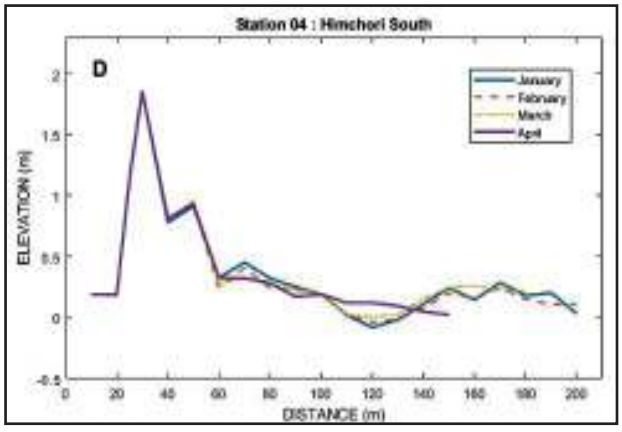
In station 07 (Figure G), monthly profiles showed that foreshore is more dynamic than the backshore area and approximately 59m LWL changes on this station. Monthly profiles showed that the foreshore berms are got eroded within the four month time periods. Behind the foreshore berms, highly diposition occurred in lagoon (approximately .48m) within the four month interval. Compare to the foreshore, backshore remain stable.

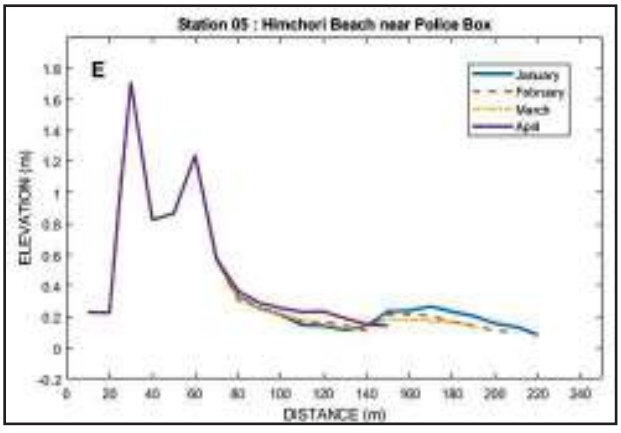
Station 08 (Kalatoli South), station 09 (Kalatoli North) and station 10 (Adjacent of Suganda Beach) have a simillar profiles pattern found (Fig: 4 H, 4 I, 4 J). All the station have comparatively wider shore line (average 300m wide) than the other station. And all the stations have backshore is almost stable rathen than the foreshore. As station 08 considered another vulnerable area, where LWL change almost 60m horizontally. Active longshore current and wave destroyed the Marine drive connecting road in this

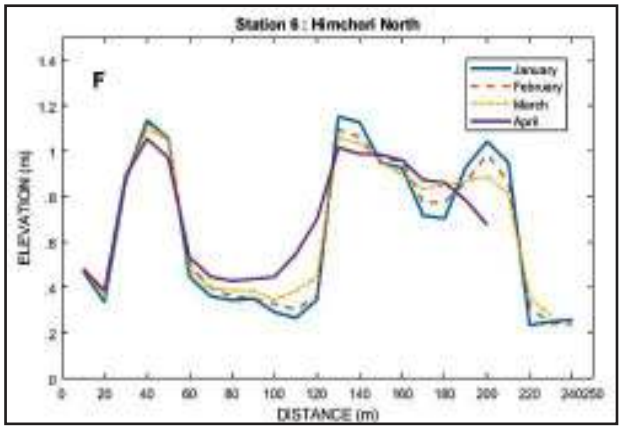

Station 1 : South of Reju Khal mouth
A
January
February
March
April
ELEVATION (m)
DISTANCE (m)

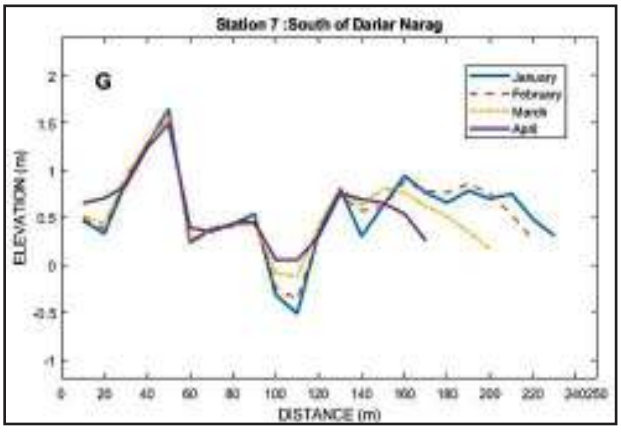

Station 2 : North of Reju Khal Mouth
B
January
February
March
April
ELEVATION (m)
DISTANCE (m)

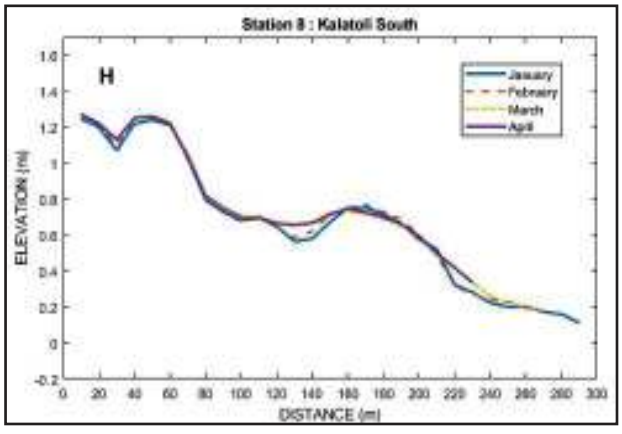

Station 03 : North of Reju Khal near Parasailing zone
C
January
February
March
April
ELEVATION (m)
DISTANCE (m)


Station 04 : Himchori South
D
January
February
March
April
ELEVATION (m)
DISTANCE (m)


Station 05 : Himchori Beach near Police Box
E
January
February
March
April
ELEVATION (m)
DISTANCE (m)


Station 6 : Himchori North
F
January
February
March
April
ELEVATION (m)
DISTANCE (m)


Station 7 :South of Darlar Narag
G
January
February
March
April
ELEVATION (m)
DISTANCE (m)


Station 8 : Kalatoli South
H
January
February
March
April
ELEVATION (m)
DISTANCE (m)

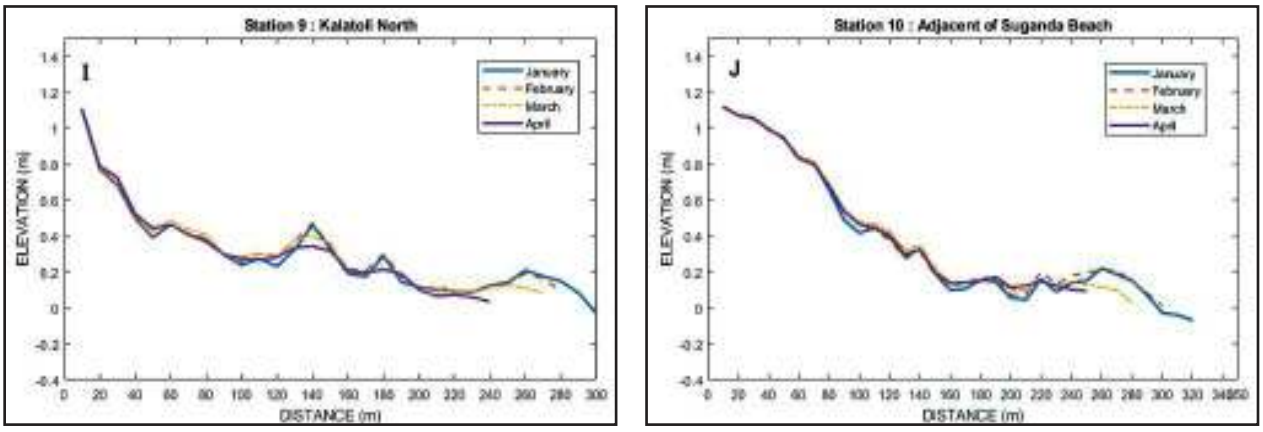


Figure 4: Station profiles variation at Station 1, (A); Station 2, (B); Station 3, (C); Station 4 (D); Station 5 (E) Station 6 (F); Station 7 (G); Station 8 (H); Station 9 (I); Station 10 (J);

area. Looking to the profiles, less vertical chage were observed on this station. Foreshore remain same almost every point but a small deposition is observed.

In station 09 and station 10, backshoe is almost stable and the foreshore berm is totall eroded. Approximately 59m LWL change from the January to April 2020. Looking to the profiles, behind the foreshore area, there are two berms are totally eroded and became flatter due to longshore wave activities. In station 10, foreshore LWL line changes about 70m. A small degree of vertical level chages were observed. These changes are basically minor depositional changes (Figure I,J)

Changes of Low Water Line

Looking at the profiles, Low Water Line (LWL) changes with monthly interval (Figure 5) and the average 56m from January 2020 to April 2020. Maximum Change of LWL observed about 70m both Station 05 (Adjacent of Himchori Beach near Police Box) & Station 10 (Adjacent of Suganda Beach). At station 08, approximately 60m LWL loss occurred with in 4 month interval. All of these 3 stations have comparatively higher longshore current. Station 05 and station 08 is consider as a vulnerable area, as there are already some distruction physical overserbed in these area. Minimum Change of LWL found at station 01 (Adjacent South of Reju Khal mouth) about 38m. The reason behind this minimum change is there also longshore current speed is also minimun comperatively the other staion.

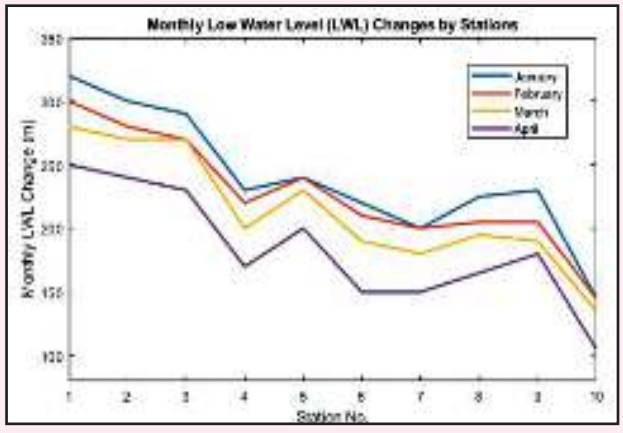


Figure 5: Station LWL and Monthly changes of LWL

Correlation between Stations monthly LWL changes

For better understanding of relation monthly changes of LWL with data we used pearson correlation technique. From the correlation analysis, we found a storng correlation between LWL changes with the station monthly data (table. 2). To look more closer at data, either this correlation is statistically singificent or not, we used hypothesis t test anova analysis in (Table 3)

Table 2: Correlation between monthly changes of LWL

	January	*February*	*March*	*April*
January	1			
February	0.986716	1		
March	0.980321	0.990033	1	
April	0.982356	0.978829	0.984932	1

N way analysis of variance (ANOVA)/two way ANOVA

A two-way between-groups analysis of variance was conducted to explore the impact of stations (special variation) and monthly time interval. There was a statistically significant effect for gender, F(5,10) = 203.87, p = .00. Therefore, the null hypothesis that there is no effect of station LWL on monthly chages in the population is rejected.

There was a statistically significant effect for station LWL, F (2,10) = 2.25, p = 0.00. Therefore, the null hypothesis that there is no effect of stations LWL change on monthly time duration is rejected.

Table 3: t-test ANOVA analysis for monthly changes of LWL

ANOVA: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
station 01	4.00	530.00	132.50	358.33
station 02	4.00	805.00	201.25	472.92
station 03	4.00	790.00	197.50	625.00
station 04	4.00	730.00	182.50	558.33
station 05	4.00	770.00	192.50	958.33
station 06	4.00	910.00	227.50	358.33
station 07	4.00	820.00	205.00	700.00
station 08	4.00	1060.00	265.00	633.33
station 09	4.00	1090.00	272.50	625.00
station 10	4.00	1150.00	287.50	891.67
January	10.00	2400.00	240.00	2661.11
February	10.00	2275.00	227.50	2101.39
March	10.00	2140.00	214.00	2221.11
April	10.00	1840.00	184.00	2110.00

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Stations	80655.63	9.00	8961.74	203.87	0.00	2.25
Monthly Change	17356.88	3.00	5785.63	131.62	0.00	2.96
Error	1186.88	27.00	43.96			
Total	99199.38	39.00				

Littoral current measurements

Beach intertidal zone is considered as the most dynamic zone of the coast and one in which constant mobility of sediment is observed. The movement of material in this zone depends mainly on three factors: the nature of material available for transport, orientation and other features of the coast and the angle of wave approach. For better understanding the beach morphology has been changed from time to time, we measured the littoral current. Current measurements were carried out using the LEO plate for determining the current speed and direction.

Almost similar current speed observed as this beach is continuous and formation is sandy. The onshore-offshore movement was dominant in station 1, 2 & 3,

along-shore current were not observed. On the contrary, all other stations, along-shore current was observed (Table 4 & Figure 6). This data helps to understand how a beach is directly or indirectly influenced by the surrounding environment.

Table 4: Monthly littoral current data

Station	January (m/sec)	February (m/sec)	March (m/sec)	April (m/sec)
station 01	0.22	0.21	0.24	0.25
station 02	0.21	0.23	0.22	0.26
station 03	0.19	0.22	0.24	0.25
station 04	0.23	0.25	0.22	0.27
station 05	0.23	0.24	0.27	0.28
station 06	0.21	0.23	0.24	0.27
station 07	0.22	0.23	0.22	0.24
station 08	0.24	0.24	0.25	0.26
station 09	0.23	0.22	0.24	0.24
station 10	0.21	0.24	0.25	0.27

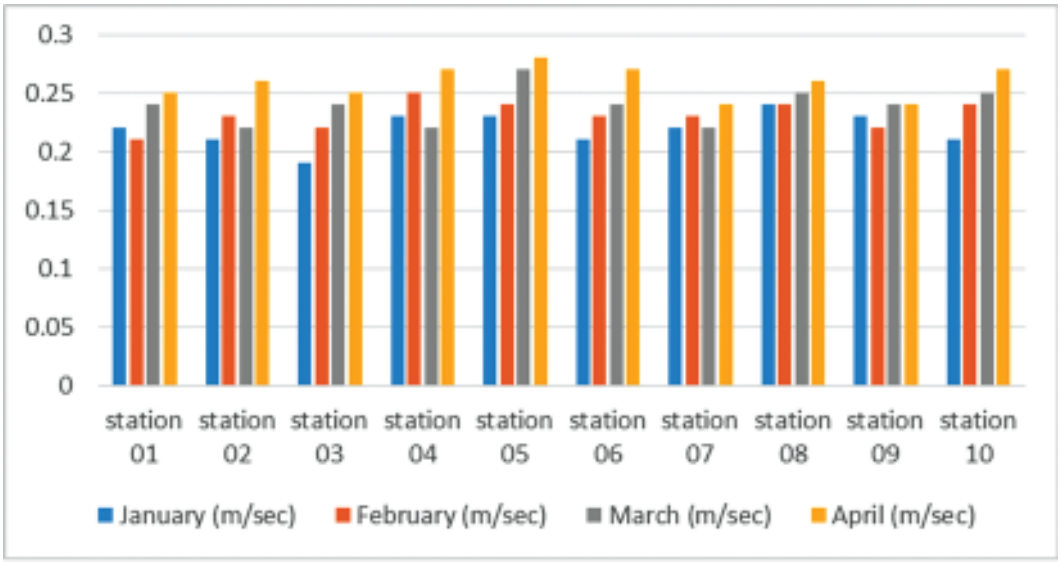


Figure 6: Monthly littoral current data

Conclusions

From this studies and analysis from all the stations, it can be concluded that there is a large variation in the beach topography, and the speed of the current. It was noticed that the two stations (station 2 & 3) have similar profile pattern. The fore-shore slope of station 2 and station 3 had higher elevation berm compared to the fore-shore slope of station 1 comparatively flatter.

In terms of monthly changes, it can be concluded that there is significant variation in the beach topography, water current and shoreline at the LWL. The prominent changes include erosion of the berm, widening and reduction of backshore and foreshore widths and changes in the slope. For all the station, the fore-shore is eroded with the monthly interval. But the prominent erosion found at the month of April, 2020 which is very near to the monsoon time. In terms of backshore elevation, it can be said that there have a little or not much changes observed.

The maximum variation was noticed at the station 5 (Himchori Point) and station 10 (Sugandha Point). Average long-shore current in the month of April was found to be higher than the month of January, 2020. There has been a marked shift in the LWL. The shoreline has shifted few meters towards the benchmark during the month of April. In general, a beach is a dynamic landform and undergoes changes continuously with the monthly profiles data. This study reveals the important changes in topography, type of sediment deposition, long-shore current and shoreline

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Chapter 4

Geological Oceanography Division

Determination of Sedimentary & Mineralogical Composition of the Nearshore Area of Saint Martin Island, Bangladesh

Summary

This study deals with the determination of Sedimentological & mineralogical composition of the nearshore area of Saint Martin Island. The study area is the nearshore area of the Bay of Bengal where silty sand to clay are mostly dominated. Some of the ground are hard and contain high organic fragment which indicate coral reef exist around it. Mainly suspended sediments are deposited in this marine area. Most of the identified mineral is quartz which is the most resistant mineral. Rutile and Zircon are present in the most sample indicate the presence of heavy mineral.

Md. Zakaria
Senior Scientific Officer

Md. Zakaria
Senior Scientific Officer

Determination of Sedimentological & Mineralogical Distribution and Sediment Province of the Nearshore Area of Cox's Bazar-Teknaf, Bangladesh

Summary

This study deals with the determination of Sedimentological characteristics & mineralogical composition of the coastal and nearshore area of Teknaf to Maheshkhali Island. The study area is the nearshore area of the Bay of Bengal where Medium to fine grained sand are mostly dominated. Some of the ground sediment sampling missing in some places with Van Veen grab sampler because of compact ground indicates lacking of loose sediment and deposition in this location. In the channel area of Naf River and Maheshkhali Channel contain high organic remnant. Most of the identified mineral is quartz which is the most resistant mineral. Aluminium and Iron are the next abundant element presents in the sediment. Heavy mineral concentration is high as 10% to 20% in some place which indicate rich zone of economic heavy mineral present in the most sample indicate the presence of heavy mineral.

At a Glance

Research Activity: The activity of Geological Oceanography Division (GEOD) started by the mandate of BORI Act, 2015 (article 8) with the starting of BORI. Research activity has been started on 2017-2018 FY with taken a R&D project in the nearshore area of Saint Martin's Island. In the next FY 2018-2019, another R&D project has been taken on the nearshore area of Teknaf to Maheshkhali Island. During research and survey, seabed sediment sample has been collected in the coastal and nearshore area of north-eastern part of Bay of Bengal covered about 3100 sq. km. The field activity during 2018-2019 FY, a cruise has been operated with the help of Bangladesh Navy R/V Saibal and the survey area was about 900 sq. km, distance 50 km seaward from the coastline of Cox's Bazar. In 2019-2020 FY, two R&D project have been taken from GEOD where the research topic of first R&D is sedimentological and mineralogical investigations in the marine area from Maheshkhali to Chottagram and the research topic of second R&D is the sea level fluctuations and effects of tectonic activity in the eastern coastal area of Bangladesh. Research proposed in the 2020-21 FY titled "Study of Benthic and planktonic Foraminifera as an indicator of Sea Level Fluctuation and identification of paleoenvironment condition of the Eastern Coastal Area of Bangladesh". Moreover, GEOD completed a research project of the Ministry of Science and Technology under R&D special allocation on "Delineation of Landslide Prone Area from Morphometric Analysis uses Geographic Information System (GIS) in the Cox's Bazar area of Bangladesh" during July, 2018 – June, 2019.

Technical Service: Besides research activity, GEOD is giving marine geology based analytical service and technical support to different government and non-government institutions. Two analytical services provided to private institutions and one technical support provided to 16 ECB Office, Bangladesh Army, Cox's Bazar for Marine Drive Road project. Also, GEOD working as per direction of the Blue Economy plan of BORI and Election Manifesto, 2018 of the government.

Workshop/Conference: GEOD participated in international conference such as Workshop on DeepData: Focusing on Data Management Strategy; Organized by: International Seabed Authority (ISA) during 21- 25 September, 2020, and participated and paper presented to the International Conference on Earth & Environmental Sciences and Technology (ICEEST), Organized by: Faculty of Earth and Environmental Sciences, University of Dhaka, Bangladesh during 25-30 January, 2020.

Image of geological structure (left) and beach sediment collection using hand auger (right) during field work of GEOD research activity

Delineation of Tectonic Activity effect on Relative Sea Level Fluctuation on the basis of Subsidence, Upliftment and Compaction rate of the Eastern Coastal Belt of Bangladesh

Md. Zakaria
Senior Scientific Officer

General discussions

The research work mainly deals with the tectonic subsidence and upliftment signature and their net effect on sea level fluctuation in the coastal area of Cox's Bazar, Bangladesh. Subsidence is the motion of the earth surface, as it shifts downward relative to a datum, such as mean sea-level. Land moves downward due to compaction, subsidence or/and both. Bangladesh is facing subsidence due to both conditions. According to England and Molnar (1990), uplift is the displacement component in the direction opposite to the gravity vector and Surface uplift is the displacement of the earth's surface with respect to the geoids (equipotential surface of equal gravity magnitude and always perpendicular to the local gravity vector). There have prominent effect of tectonic subsidence and upliftment on sea level. Because sea level fluctuation depends on the change of landmass adjacent to the sea. The cox's bazaar region is mostly affected by the tectonic activity.

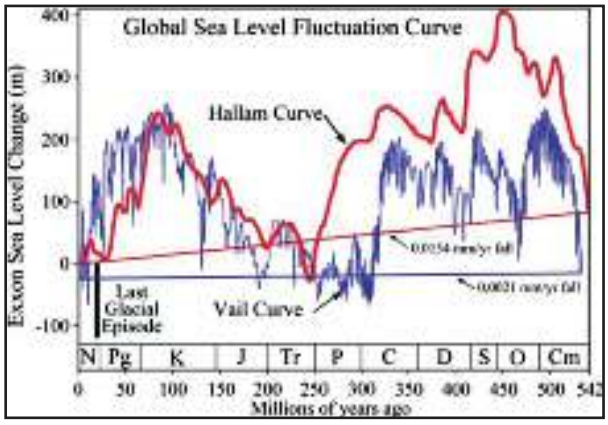

Figure: Hallam et al. (1983) and "Exxon", composite from several reconstructions published by the Exxon corporation (Haq et al. 1987, Ross & Ross 1987, Ross & Ross 1988).

The hill comprises the area name Inani Hill, Maheshkhali Hill and Dakshin Nhila Hill are the western extension of Arakan-Youma Hill range whih is the eastern part of Himalaya Hill range. All the hill ranges are belongs to the long period of tectonic convergent of Indian and Eurashian plate. As Himalaya still undergo by upliftement process, the eastern part such as the hills in the Cox's Bazar region is being undergoes by upliftment process. Besides Ganges-Brahmaputra-Meghna (GBM) has formed the world's largest delta system, covering greater part of Bangladesh, and depositing 1 Gigaton/year of sediment at the rapidly subsiding junction of three major rivers. Therefore, subsidence and upliftment both are experienced in this region which has effect on the sea level fluctuation in this region. Optimistically, the rapid subsidence and

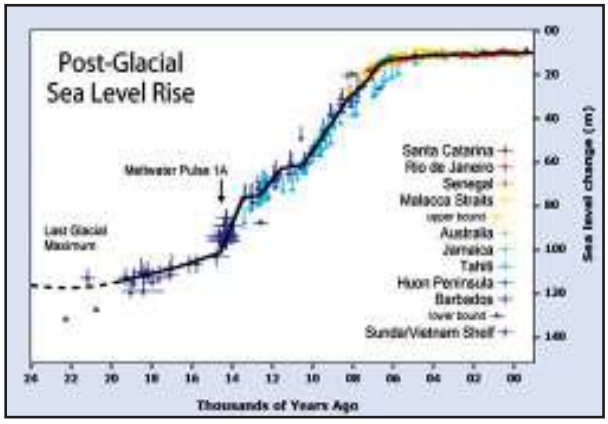

Figure: Rohde (2012), based on data from Fleming et al. (1998), Fleming (2000), Milne et al. 2005).https://commons.wikimedia.org/wiki/File:Post-Glacial_Sea_Level.png.

upliftment favours preservation of high-resolution records of the GBM delta dynamic fluvial processes, the tectonics of its growing accretionary prism, and the development of a new convergence boundary.

However, as the process of subsidence is interrupted in Bangladesh, there are unavoidable effects on coastal dynamics, ecosystem and human livelihoods. In case to calculate the actual effect of sea level rise on Bangladesh coastal region, it needs to consider the tectonic factor for the future development plan of Bangladesh.

Objectives

- To know the Relative Tectonic Activity of the eastern coastal belt.
- To know the Relative Sea Level fluctuation in the eastern coastal area.
- To find out Subsidence and Upliftment zone and their rate in the Study area.
- To delineate the compaction rate of the area to measure the overburden pressure of the area.
- To find out effect of Tectonic Activity on Sea Level fluctuation in the study area.

Significance of the Study

This study is closely related with SDG goal 13: Take urgent action to combat climate change and its impacts. Almost all states now agree on the emerging threats to security from climate change, especially risks from sea-level rise to global peace and security. Bangladesh is no exception. In fact, Bangladesh is one of the most vulnerable countries from the threats of sea-level rise. Sea-level rise (SLR) is a climate-induced and human-driven phenomenon. Growing population, increasing demand for natural resources, and rapid urbanisation are the major factors pushing sea-level rise to a risky extreme. Thermal expansion of water due to global warming remains one of the two main causes of SLR while the other is massive melting of ice sheets and glaciers. Scientists predict that even though the sea-level is estimated to rise 11 inches to 38 inches by 2100, a major breakup of the Greenland and West Antarctic ice sheets can easily raise it up to 23 feet, creating a doomsday scenario. Bangladesh will lose a significant part of its territory to the rising sea, causing mass displacement of people. Higher sea-levels have the potential to flood terrestrial habitat. Greater tidal intrusion will change the salinity regime of coastal freshwater. Due to increased depth of the sea, marine life will be exposed to various threats like lack of sunlight, wave energy, and oxygen, which will adversely impact the marine ecosystem and will become an existential threat. Alteration in chemistry of soil caused by saltwater will also impact the coastal plant life. Economic impact on the tourism sector due to SLR will be devastating. So it needs to keep measuring the sea level of the Bay of Bengal in Bangladesh. As GBM system of Bangladesh brings largest amount of sediment (subsidence cause) and eastern part of Bangladesh experiencing tectonic upliftment, so it is very much important to study the impact of tectonic in this region to accurate measure of sea level fluctuation rate in this region.

Study Area

The study area lies in the last south-east part of Bangladesh. The area is bounded by N 20°51'33.88" to N 21°43'49.6" latitudes and E 91°51'56.49" to E 92° 18'12.03" longitudes (Figure 1). The study area comprises Maheshkhali, Inani and Dakshin Nhila Anticline, where Teknaf, Ukhia, Ramu, Maheshkhali, Cox's Bazar sadar, southern part of Chakaria upazila (sub-district) of Cox's Bazar district has been covered the study area (about 903.91 sq. km area). The area is very important because of its location and existence of world's longest sandy beach which is about 120 km long. Lots of tourists come here.

Figure 1: Showing geological structure fold, fault and sedimentary structure of the study area.

Results

The quantitative geomorphic indices such as asymmetric factor (Af), Index of mountain front sinuosity (Smf), hypsometric integral (Hi), index of drainage basin shape (Bs), Transverse topographic symmetry factor (Tp) have been used to find out the index of relative active tectonic (IRAT). IRAT index represented a summary and average of the given geomorphic indices. In order to identify the hypsometry indices, also it has been used surface geology, lithology, geomorphology and structural maps. The study area comprises 48 small size drainage basin delineated by GIS tools. The IRAT index was developed by El-Hamdooni et al. (2008) for different studies based on the topographic conditions of a basin. The following classes were used in the IRAT index: Class (1), very high with $1.0 \leq IRAT < 1.5$; Class (2), high with $1.5 \leq IRAT < 2.0$; Class (3), moderate with $2.0 \leq IRAT < 2.5$; and Class (4), low with $IRAT < 2.5$.

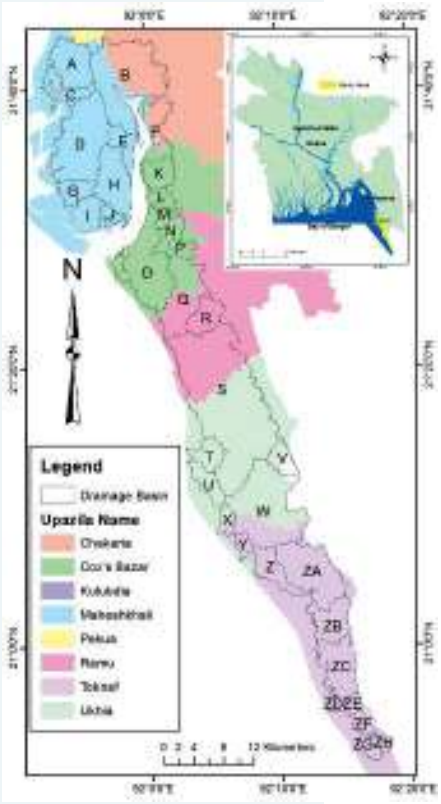

Figure: Location map and drainage basin boundary of the study area.

The basins and sub-basin of southern Maheshkhali (area of southern Maheshkhali upazila and northern Cox's Bazar Sadar Upazila) and northern Dakshin Nhila (major area of Ukhia Upazila) belongs to moderate to high tectonically active basin relative to other basins and sub-basins in this area.

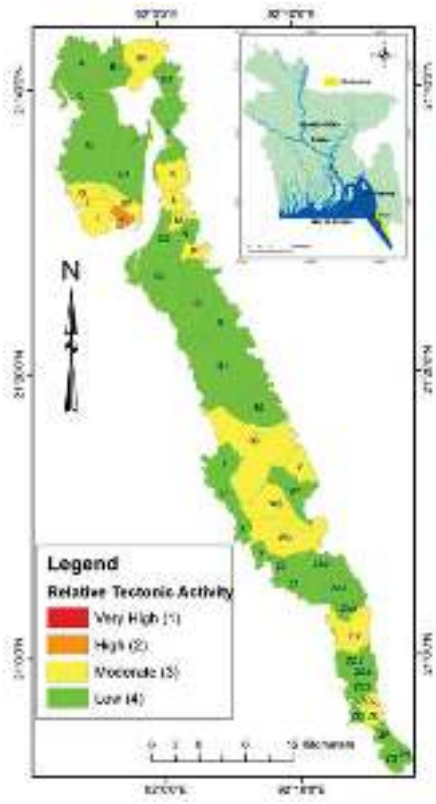

Figure: Relative Tectonic Activity map of the study area.

Figure: Showing the topography of the area (left) and signature of river bed upliftment (right).

Bottom Morphology: The north zone of the study area is mainly covered by recent deposit. The Maheshkhali channel carried out the sediment to the area and formed loose bottom morphology is very gentle deep westward. The south zone of the study area is covered by loose sediment carried out by Naf River and the bottom morphology is gently deep westward open bay. Some hard ground present in the south zone because of dead coral presence. The bathymetry map showing the shape of the bottom morphology of the area.

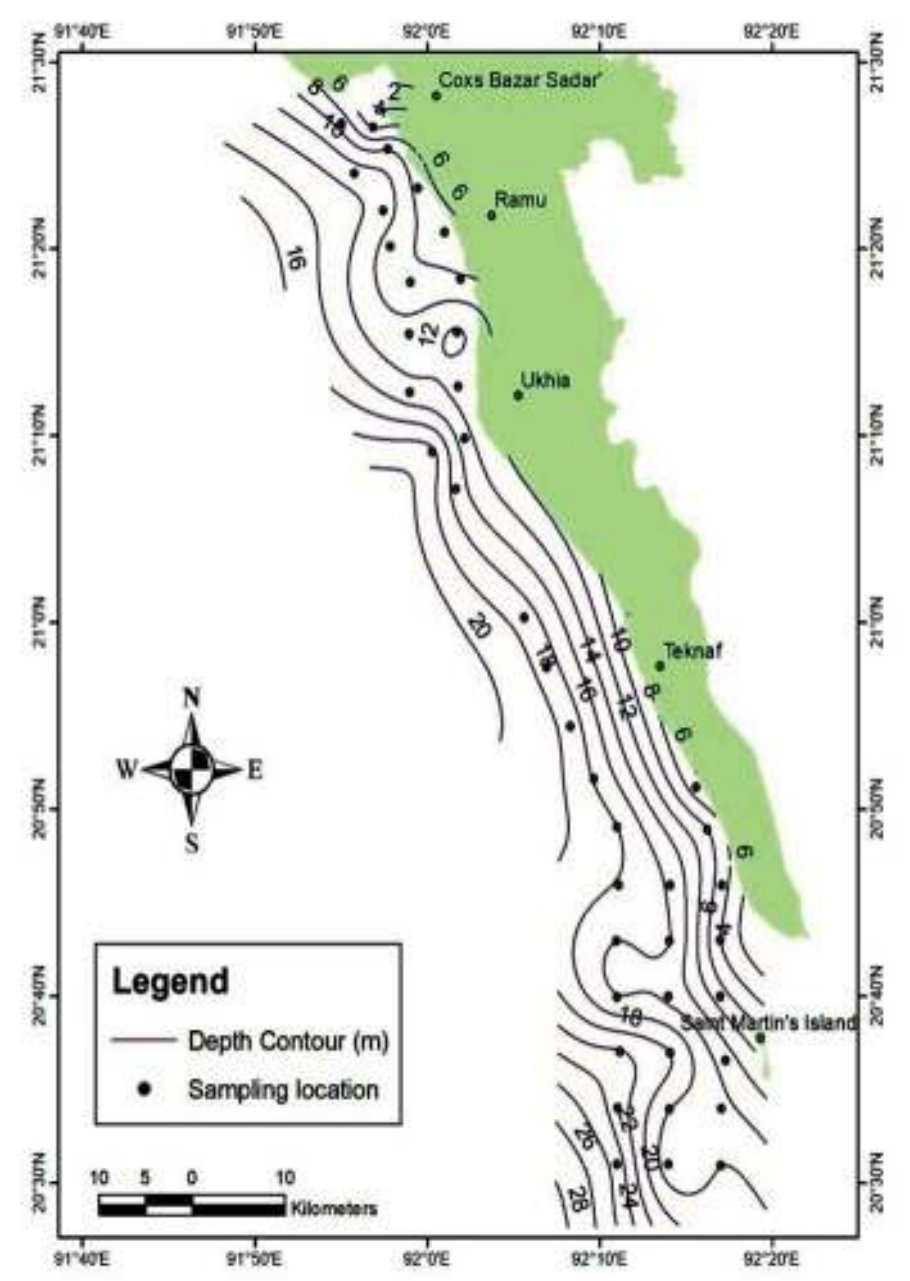

Figure: Bottom topography of the coastal marine area of Cox's Bazar showing about uniform depth increasing to the seaward.

Work under processing:

- GNSS data of two coastal stations has been collected form Survey of Bangladesh
- Tidal data of eight costal tide stations such as Hiron Point (1977-2017), Khepupara (1977-2017), Kuakata (1988-2020), Charchenga (1979-2020), Sandwip (1977-2020), Chottagram (sadarghat) (1977-2020), Cox's Bazar (1977-2020) and Teknaf (1982-2020) have been collected from BIWTA to calculate sea level trend for the periods.

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Rohde (2012), based on data from Fleming et al. (1998), Fleming (2000), Milne et al. 2005).https://commons.wikimedia.org/wiki/File:Post-Glacial_Sea_Level.png

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Chapter 5

Chemical Oceanography Division

Adaptive responses to ocean warming and acidification of different marine invertebrates inhabit in the South east coastal area of Cox's Bazar, Bangladesh

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2017-2018

Abstract

Ocean acidification, a complex phenomenon that lowers seawater pH, is the net outcome of several contributions. A study pertaining to the seasonal variation in physico-chemical properties and its impacts on marine invertebrates inhabit at the south east coastal waters of Cox's Bazar, Bangladesh for a period of January 2018 to June 2018. It shown that the coastal water was significantly influenced by the freshwater discharged from Naf River and other sources from upstream to the coastal area. Total five sampling stations namely saint Martin Island (S1), Naf River (S2), Teknaf (S3), Inani (S4) and Rezukhal estuary (S5) were considered for taking the desirable parameters reading. The physic-chemical parameters like Dissolved oxygen, Salinity, Temperature, Conductivity, Total dissolved solids, Transparency were determined by using Hanna HI98194, Refract meter, YSI Pro30 multimeter, Hach HQ11d, Winklers Titration method, Secchi disk respectively. There were implementing two types of experiment 1) Insitu experiment and 2) Exsitu experiment to assess the adaptive responses of different marine invertebrates inhabit on ocean acidification and their potential detrimental effects to marine environment as well as ecosystem processes and services. The foreseen danger to marine invertebrates by acidification is in fact expected to be amplified by several concurrent and interacting phenomena. In addition, a robust ocean acidification monitoring program over time will provide necessary information to scientists and resource managers on the status and trends in ocean parameters related to OA, and thus aid decisions in light of ocean change.

Keywords: Ocean Acidification, Invertebrates, Adaptability, Parameter, Ecosystem

A study on seasonal variation in physico-chemical properties and its impacts on coral associated biodiversity at the south eastern coastal waters of Cox's Bazar, Bangladesh

Abstract

The present investigation carried out to assess the seasonal variation in physico-chemical properties and its impacts on coral associated biodiversity at the coastal waters of Saint Martin Island, Bangladesh for a period of July 2018 to June 2019. It shown that the coastal water was significantly influenced by the freshwater discharged from Naf River and through heavy precipitation during the monsoon period. Total nine sampling stations namely Saint Martin Island (S1), Shahporir Dwip (S2), Teknaf (S3), Inani (S4), Rezukhal (S5), Himsori (S6), Bakkhali (S7), Moheshkhali (S8) & Sonadia (S9) were considered for taking the desirable parameters reading. The parameters like Dissolved oxygen, Salinity, Temperature, Conductivity, Total dissolved solids, Transparency were determined by using Hanna HI98194, Refract meter, YSI Pro30 multimeter, Hach HQ11d, Winklers Titration method, Secchi disk respectively. Salinity and water pH showed very strong changes between 14 psu to 34 psu and 7.78 to 8.28 due to heavy precipitation and freshwater discharges into the stations from the Naf River. Water pH, Total dissolved solids and Electrical conductivity displayed strong correlation with salinity changes. The physico-chemical parameters such as temperature, Salinity, pH, TDS, Water Transparency and EC were increased during Pre-Monsoon season and decreased during monsoon season. In contrast, only temperature was decreased during winter & monsoon season. The physico-chemical properties have exposed reasonable seasonal and spatial variations. Saint Martin is the only coral Island of Bangladesh and generally we referred it as a biological paradise. Due to the change of physico-chemical properties seasonally, its strongly influenced on the coral associated biodiversity. This study revealed that coral bleaching has been occurred frequently during the monsoon and post monsoon period. About 15% boulder coral were partly bleached. But it is a hope that most of the bleached coral were regenerate easily with the change of physico-chemical properties during the winter and pre-monsoon season. Physico-chemical properties have strong influence on Saint Martin seaweed vegetation. During the study period the author shown that from May to December about 95% seaweed was totally absence and January to April were heavily vegetated. On the other hand due to ocean acidification and surface water warming some of the invertebrate species were migrated from the coastal area to another place and some inhabitants face great problem.

Keywords: Physico-chemical parameters, Coastal waters, Seasonal variation, spatial variation, Cox's Bazar

Md. Tarikul Islam
Scientific Officer

2018-2019

At a Glance

Chemical oceanography is the study of ocean chemistry and the behavior of the chemical elements within the Earth's oceans. It is a broad and complex study of the metamorphosis that the chemicals within oceans, living marine organisms, and the ocean floor undergo. The ocean contains a multitude of chemicals; some are natural, and others are man-made. These chemicals enter the sea in a number of ways. The ocean is unique in that it contains-in greater or lesser quantities-nearly every element in the periodic table. Rivers and streams bring freshwater into the ocean along the coast line. Freshwater brings the chemicals which have been dissolved into it from natural weathering and human activities. Examples of this would be the weathering of rocks or soils, industrial sources like agriculture, power plants, or manufacturing facilities, and pollution from nearby towns and cities. Chemicals can also enter the oceans through the atmosphere by dissolving or dissipating. Substances like aerosols and pesticides can enter this way. Other ways chemicals can enter the ocean are through ocean exploration, the shipping industry, and the harvesting of oil. Many chemicals introduced to the ocean can be harmful to the ecosystems within it.

Chemical oceanography encompasses the study of the chemical components of the oceans, their reactions, and their pathways of transformation. We study both organic and inorganic compounds, particulate and dissolved material, and the ocean sediments. The pathways that compounds follow affect the global cycling of elements such as carbon and nitrogen, and are often intimately related to biological activity. We undertake our research in environments such as mangroves and saline lakes, salt marshes, and deep ocean sediments. We combine field observations, laboratory experiments, and computer models to understand factors affecting chemical compositions and how they vary in time and space.

Coral Biodiversity: A Mysterious Life beneath the Blue Water Body of Saint Martin Island, Bangladesh

Md. Tarikul Islam
Scientific Officer

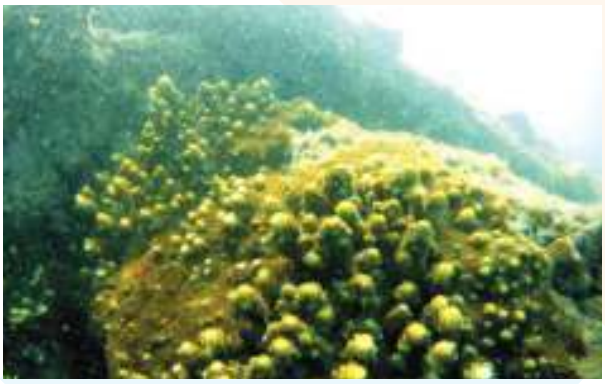
Abu Sharif Md. Mahbub-E-Kibria
Senior Scientific Officer

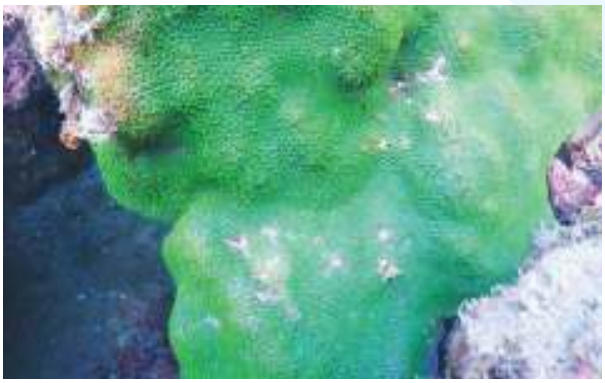
Abstract

The study carried out to assess the present status of coral biodiversity and water quality of Saint Martin Island for a period of February, 2018 to January, 2021, the only coral bearing island of Bangladesh in the Bay of Bengal which are generally referred as a biological paradise. The coral protect coastlines from storms and erosion, provide jobs for local communities, and offer opportunities for recreation and serve as a fish spawning, breeding and nursery ground and also a source of food and new medicines. Corals sampling were conducted at different locations around the Island by using the Video Transects method through snorkeling, scuba diving with proper underwater video camera. The video footage was analyzed back in the laboratory. This method provides a permanent visual record of the reef community, and reduces time required in the field and helps to monitor-percentage covers of organism groups, proportion of cover bleached and severity of bleaching, recovery rates, and nature of shifts in species composition, percentage of live coral, dominant coral, amount of coral bleached, presence/absence of bleaching at one or multiple sites, type, abundance and density of individual organisms. A total 74 species of 35 genera under 15 families of hard corals and 12 species of 7 genera and 6 families of soft corals image were collected & identified from the Saint Martin's Island. Among the hard corals Porites, Favites, Goniopora, Cyphastrea & Gonlastrea were the most abundant and among the soft corals Gorgonian sea fans, Small sea fans, Sea whips were mostly dominant. Seasonal change of physico-chemical parameters (salinity, P^H, turbidity, TSS, transparency, temperature) has strong influenced on the coral associated biodiversity. This study revealed that coral bleaching has been occurred frequently during monsoon period. About 15% boulder coral were partly bleached. But it is hope that most of the bleached coral were regenerate easily with the change of physico-chemical properties during the winter and pre-monsoon season every year. On the other hand, due to ocean acidification and global warming some of the temperature and P^H sensitive species were migrated from the coastal area to another place and some inhabitant face great problem.

Key Words: Coral, Seaweed, Physico-chemical Parameters, Snorkeling, Scuba diving.

Coral of Saint Martin's Island





Seaweed of Saint Martin's Island

Seasonal Nutritional Variability of Green Mussel (Perna viridis) at Maheshkhali Estuary, Cox's Bazar, Bangladesh

Md. Tarikul Islam
Scientific Officer

Sultan Al Nahian
Scientific Officer

Sonet Barua Emon
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Sumon Biswas
Research Assistant

Abstract

The seasonal nutritional variability of cultured green mussel Perna viridis were analyzed from July 2019 to June 2020 at the Maheshkhali coastal area of Cox's Bazar, Bangladesh. The present study revealed that the nutritional status was varied from season to season due to its dynamic characteristics of hydrological parameters. The highest protein (13.72%), Fat (5.44%), Carbohydrate (4.82%), Ash (2.46%), Calcium (227.36mg/100g), Magnesium (778.52mg/100g) and Iron (12.32mg/100g) were found during post monsoon season whether Moisture (74.89%) and Phosphorous (560.00mg/100g) were during monsoon period. On the other hand most of the nutritional values were found lower at monsoon season except moisture and phosphorous which is related to high or low of food abundance with phytoplankton availability. Total protein content did not show significant variations and ranged 13.30% to 13.72% in dry mussel for Perna viridis. Five minerals were detected and among that calcium were found to be high during pre-monsoon period. The investigation showed that marine bivalve Perna viridis is a valuable food source for human consumptions as well as for poultry and fish feed. We conclude that culture of green mussel Perna viridis at Maheshkhali estuary exhibit a natural biological performance and emphasizing their suitability as estuarine aquaculture candidates.

Key words: Green Mussel, Perna viridis, Nutritional Status, Seasonal Variation, Minerals

Introduction

Green mussel (Perna viridis) are commercially valuable species and easy to cultivate in coastal area of Cox's Bazar, Bangladesh. The knowledge on nutritional status of any edible organisms is enormously important due to the nutritive value is reflected to the biochemical composition. Green mussels are both ecologically and economically important throughout their ranges and have long constituted an important source of human food [1-5]. The green and brown mussels are distributed in tropical, subtropical, warm and cold temperate regions, mostly from the southern hemisphere, but also from northern Africa and the northern coasts of South America [6-7]. Green mussel contains approximately 20 to 28% calories from fat [8]. The green mussel Perna viridis [9] is used by the fisherman communities themselves for the food and bait. Consumption of green mussel provides an inexpensive source of protein with a high biological value, essential minerals and vitamins. Additionally, the green mussel muscle contains little saturated fat and significant amount of vitamin c and a good source of minerals such as calcium, potassium, zinc, iron, phosphorous and copper. Green mussels are important for marine ecology and human diet as well as for poultry and fish feed, since it is an important source of nutrients. Shellfish should be considered a low-fat, high protein food that can be included in a low fat diet [10].

Biochemical changes in the mussel from different sites and growth conditions may result from fluctuations of environmental parameters such as temperature, salinity and oxygen levels and to the physiological status of the animals, depending on food availability, gametogenic cycle and spawning [11]. Filter-feeding shellfish species such as green mussels are suitable candidates for extensive cultivation, as they do not require supplemental feeding [12-13]. Moreover, they can even improve water quality as essential bio-extractive organisms [14-15]. Green mussels, furthermore, represent high-value products. Compared to other shellfish species, they yield high prices on the market [16-17] and are therefore ideal candidates for cost-intensive offshore aquaculture. Several studies were carried out on seasonal changes of the biochemical composition of green mussels [18-25].

In general, shellfish is a highly nutritious foodstuff, since it contains appreciable quantities of digestible proteins, essential amino acids, bioactive peptides, long-chain polyunsaturated fatty acids, astaxanthin and other carotenoids, vitamin B12 and other vitamins, minerals including copper, zinc, inorganic phosphate, sodium, potassium, selenium, iodine and also other nutrients, which offer a variety of health benefits to consumers [26-27]. Different studies indicated the influence of environmental and nutritional conditions on the composition of bivalves [28]. The experiments on mussel culture were carried out by Central Marine Fisheries Research Institute, Cochin at various coastal places in India and they were successful [29-30]. Perusal of literature showed that much work has been conducted on biochemical composition of various bivalve species [31-32]. Due to lack of detail information about nutritional status of Perna viridis from Cox's Bazar coastal area the present study was undertaken.

Materials and Method

Sample collection: The sample (cultured) were collected during the season of monsoon (July-20219), Post-monsoon (December-2019) and pre-monsoon (May-2020) from the intertidal muddy shore of Maheshkhali estuary, Cox's Bazar which is predominately influenced by riverine water from Matamuhuri and Bakkhali river.

Cultured green mussels were stripped from the rope. All samples after cleaning of fouling organism were immediately transported to the laboratory in an ice box. The samples of P. viridis were measured for their biometrical parameters-namely, length, width and thickness. The entire amount of pooled edible portion was thereafter ground in a mincer and packed in insulated containers at -20°C before being used for biochemical analysis with respect to protein, fat, carbohydrate, vitamin and mineral composition.

Proximate composition: Moisture was determined by oven drying at 105°c to constant weight (AOAC, 1990) [33]. Dried samples were used for determination of crude fat, crude protein and ash contents. All analysis was done in triplicate. The crude protein was determined by Kjeldhal method

Figure: Study area

(AOAC, 1990) [33]. Crude fat was extracted from the dried tissues using Bligh and Dyer (Bligh and Dyer, 1959) [34] method. The fat content was gravimetrically determined. Ash was determined gravimetrically in a muffle furnace by heating at 550°c constantans weight (AOAC, 1990) [33]. The estimation of minerals was carried out by atomic absorption spectrophotometer (AAS) following the di-acid (HNO_3/$HClO_4$) digestion method with suitable modification [35].

Statistical analysis: Statistical evaluation was carried out with the statistical program for social sciences 16.0 (SPSS Inc. Chicago, USA, Ver.16.0) and Microsoft Excel 2010.

Seasonal Consideration:

Monsoon : June, July, August, September
Post-monsoon : October, November, December, January
Pre-monsoon : February, March, April, May

Results

Seasonal variations in proximate biochemical composition during the period of study in the raft grown green mussel P. viridis are shown in Table 1.

Table 1: Proximate composition of Perna viridis

parameters	Season			Mean	STD	Mean±STD
	monsoon	post monsoon	pre monsoon			
Ash (%)	2.10	2.25	2.46	2.27	0.18	2.27±0.18
Carbohydrate (%)	4.46	4.75	4.82	4.68	0.19	4.68±0.19
Moisture (%)	74.89	74.15	74.54	74.53	0.37	74.53±0.37
Protein (%)	13.30	13.52	13.72	13.51	0.21	13.51±0.21
Fat (%)	5.25	5.33	5.44	5.34	0.10	5.34±0.10
Iron (mg/100g)	5.81	11.90	12.32	10.01	3.64	10.01±3.64
Calcium (mg/100g)	85.00	205.59	227.36	172.65	76.68	172.65±76.68
Zinc (mg/100g)	2.90	6.23	7.12	5.42	2.22	5.42±2.22
Magnesium (mg/100g)	656.39	702.39	778.52	712.43	61.68	712.43±61.68
Phosphorus (mg/100g)	560.00	317.54	286.44	387.99	149.77	387.99±149.77

Protein: The protein content of P.viridis was 13.51±0.21 (Table1). The highest value (13.72%) was found during the pre monsoon season and lower value (13.30%) at monsoon period. An increase in protein from february to may was observed to coincide with maturation of gonad. From june onwards the protein level decreased, indicating that much of the energy contributed by protein was used for maturation and spawning.

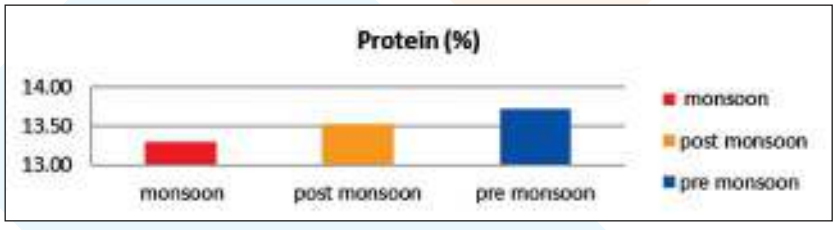

Figure 2: Seasonal protein value of P.viridis

Carbohydrate: The carbohydrate content of P.viridis was 4.68±0.19 (Table1). The highest value (4.82%) was found during the pre monsoon season and lower value (4.46%) at monsoon period. During pre-monsoon period, just prior to peak spawning period, high carbohydrate content was observed which coincided with higher protein content. However, during spawning period, the carbohydrate content values were low. In general, carbohydrate values observed were higher in immatre mussel which declined in mature mussels.

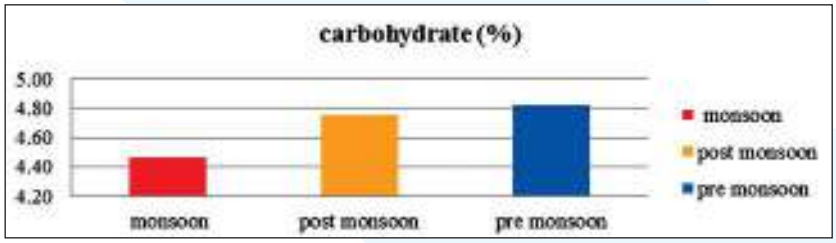

Figure 3: Seasonal carbohydrate value of P.viridis

Fat: The fat content of P.viridis was 5.34±0.10 (Table 1). The highest value (5.44%) was found during the pre monsoon season and lower value (5.25%) at monsoon period. The study showed that during maturation the lipid content was low as compared to early stages of life with an average value of 5.34%. The lipid content was reported to be comparatively high during prespawning period. Soonafter spawning the lipid content declined.

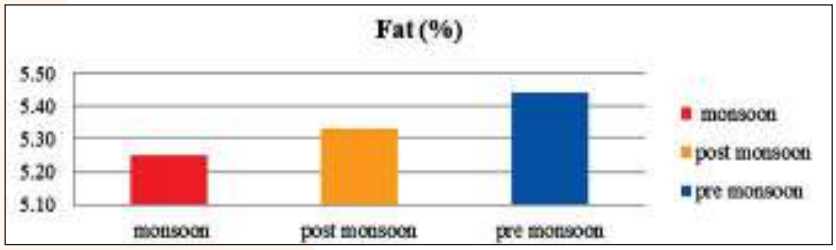

Figure 4: Seasonal fat value of P.viridis

Ash: The ash content of P.viridis was 2.27±0.18 (Table 1). The highest value (2.46%) was found during the pre monsoon season and lower value (2.10%) at monsoon period. During the early stages of growth, the ash content showed higher values which declined sharply registering a values in november. Lower values of the ash content during monsoon period were found to coincide with low values of lipids and proteins, whereas higher values of ash content coincided with higher values of carbohydrates during the early stages of growth.

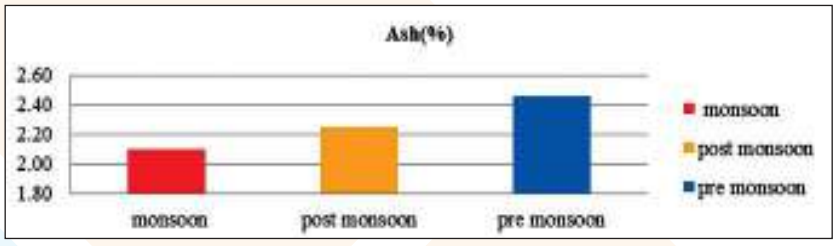

Figure 5: Seasonal ash value of P.viridis

Moisture: The moisture content of P.viridis was 74.53±0.37 (Table 1). The highest value (74.89%) was found during the monsoon season and lower value (74.15%) at post monsoon period.

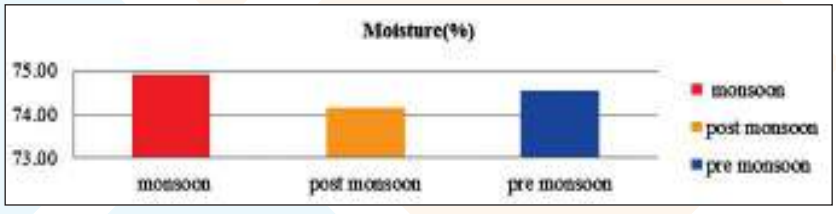

Figure 6: Seasonal moisture value of P.viridis

Calcium: The calcium content of P.viridis was 172.65±76.68 (Table1). The highest value (227.36mg/100g) was found during the pre monsoon season and lower value (85.00 mg/100g at monsoon period.

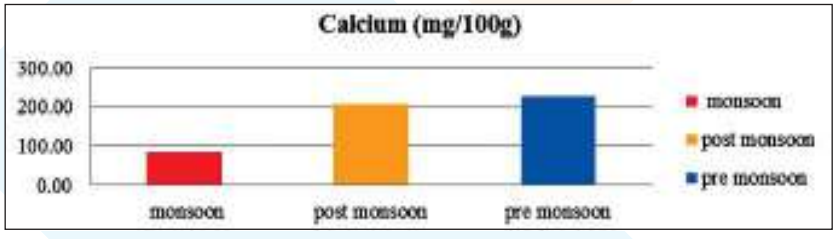

Figure 7: Seasonal calcium value of P.viridis

Magnesium: The magnesium content of P.viridis was 712.43±61.68 (Table1). The highest value (778.52mg/100g) was found during the pre monsoon season and lower value (656.39 mg/100g at monsoon period.

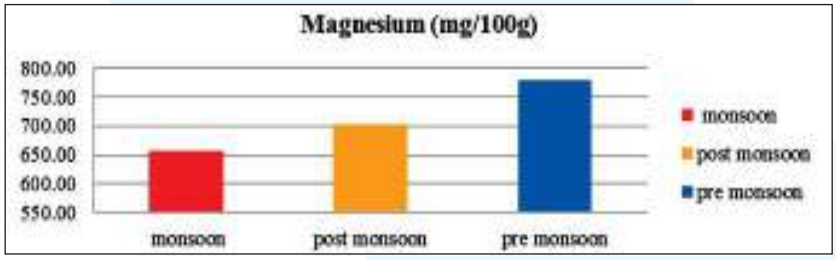

Figure 8: Seasonal magnesium value of P.viridis

Iron: The iron content of P.viridis was 10.01±3.64 (Table 1). The highest value (12.32mg/100g) was found during the pre monsoon season and lower value (5.81mg/100g) at monsoon period.

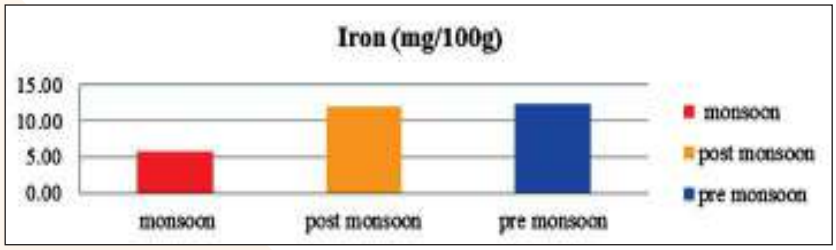

Figure 9: Seasonal Iron value of P.viridis

Zinc: The iron content of P.viridis was 5.42±2.22 (Table 1). The highest value (7.12mg/100g) was found during the pre monsoon season and lower value (2.90 mg/100g) at monsoon period.

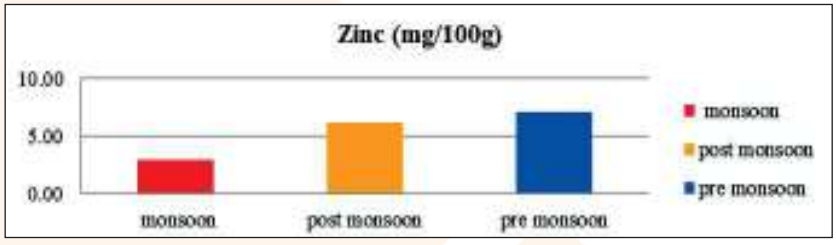

Figure 10: Seasonal Zinc value of P.viridis

Phosphorous: The phosphorous content of P.viridis was 387.99±149.77 (Table 1). The highest value (560.00 mg/100g) was found during the monsoon season and lower value (286.44 mg/100g) at pre monsoon period.

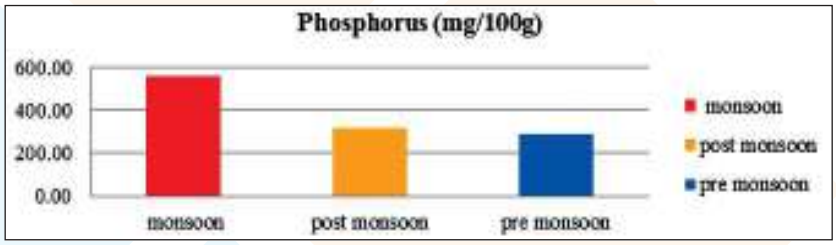

Figure 11: Seasonal phosphorous value of P.viridis

Table 2: Seasonal hydrological parameters of the Maheshkhali Estuary (July 2019-June 2020)

Station: Maheshkhali													
SI	Name of the parameter	July	August	September	October	November	December	January	February	March	April	May	June
1	Water Temperature	28.90	29.50	27.21	29.10	26.60	27.30	26.30	27.90	28.10	33.80	33.10	30.30
2	Water P^H	7.56	7.60	7.76	7.74	7.85	7.64	7.89	7.91	7.95	7.97	8.09	7.84
3	Salinity	7.40	11.62	9.00	5.70	18.60	24.90	25.50	27.90	28.10	29.10	30.10	24.80
4	Conductivity	8.62	19.61	12.53	24.48	26.51	40.98	41.38	42.54	43.38	53.00	49.30	38.44
5	TDS	5.21	10.84	8.77	13.57	16.70	25.48	24.67	26.73	28.42	29.50	27.67	22.67
6	Transparency	1.11	1.22	1.29	2.02	2.13	2.12	2.15	2.16	2.22	2.23	2.20	1.25

Discussion

The present study provided a detailed seasonal nutritional status profile of the green mussel Perna viridis collected from the cultured condition of the Maheshkhali estuary, Cox's Bazar. The data provide useful information for food industries and green mussel fishery. The meat content of green mussels was registered to be affected by a variety of environmental and endogenous factors-viz., water temperature, salinity, food availability and gametogenic cycle of animals [36]. Bivalve molluscs were reported to provide an inexpensive source of lipid and protein with high biological value [35]. Perna viridis from both seasons were found to be rich in proteins with a low fat content; they may therefore form an essential part of a healthy diet. It is generally accepted that water temperature and differences in salinities are principal environmental factors affecting growth and gonadal development of marine bivalves [37], which is major reason for the differences in lipid and minerals content. Available

literature on the biochemical composition of green mussel from tropical waters [38-45] suggest that information on biochemical composition is essential as it reflects directly on the nutritive value, thereby enabling to establish an ideal time of harvest. Further, it reveals that the changes in biochemical constituents depend on the phases of reproductive cycle. In coastal waters of Cox's Bazar, the growth of raft-grown green mussel Perna viridis L. was very rapid due to the abundance of food material and ideal environmental conditions and the mussels adapt biochemically to wide ranging external conditions and also respond appropriately to rapid and irregular variations in these conditions.

Minerals are nutrients that are conserved by the body and play a significant role in metabolism in the human body. The present investigation shown that Ca and Mg were higher than those reported in the literature for bivalve molluscs [46]. Zn was found to be the second most abundant trace element in Perna viridis and its role in the pathophysiology of disease is stimulating a great deal of interest [47]. The marginal variability in fatty acid composition is due to the fact that the lipid levels and composition of marine bivalves depend on the biochemical and environmental conditions of seed development including the phytoplankton resources available [48]. It is understandable that nutritional status are influenced by spatial variation apparently due to differential microalgal diversity and primary flora in the coastal food web and this might be the reason for getting the minor seasonal variations.

Conclusion

The green mussel Perna viridis has been found to be a rich source of protein. It also contains carbohydrates, lipid, Minerals and Vitamins. In conclusion, the present investigation provides insights in different seasonal biochemical composition of Perna viridis collected from the cultured farm of the Maheshkhali estuary, Cox's Bazar. No significant differences in different seasonal nutritional status and biochemical parameters under observation were apparent from season to season. The minor differences in biochemical indicators could be attributed to the differential feeding patterns of Perna viridis grown under cultured conditions. In summary, no statistically significant inter-seasonal differences in basic chemical parameters and fat quality indices descriptive of an edible part of the green mussels were determined. Finally we can conclude that culture of green mussel Perna viridis at Maheshkhali estuary exhibit a natural biological performance and emphasizing their suitability as estuarine aquaculture candidates.

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Skills	: Marine Multimeter, Primer, SPSS, Spectrophotometer, PCR etc

Chapter 6

Biological Oceanography Division

2017-2018

Preliminary taxonomic checklist of marine algae (seaweed) around St. Martin's Island Bangladesh- A baseline survey

Abstract

The present study was conducted around the St. Martin's Island to prepare a taxonomic checklist of seaweed. The study was executed into three phases, viz: phase 1: 25 February to 2nd March; phase 2: 28 March to 1st April; and phase 3: 9 April to 12 April. From the findings of the present study, it is revealed that a total of 72 species were found at 10 sites around St. Martin's Island. 41 species were identified among the 72 species and reported as a checklist. Among 41 identified species, 16 species belong to Phaeophyceae, 13 species belong to Rhodophyta and 12 species belong to Chlorophyta. The occurrence of seaweed in the study area varied due to spatial and temporal impacts. Rhodophyta was the dominant group in the south (Site 1 and site 2), southeast (Site 3 and site 4), north (site 6 and site 7) and northwest (site 8) sites. The taxonomic checklist provides preliminary information on the species that is important to conserve these species in that specific area.

Key words: Taxonomic checklist, Seaweeds, Species, Spatio-temporal, St. Martin's Island

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2018-2019

Study on seaweed Biochemical composition with references to physico-chemical parameters of water, bottom sediment and continuation of taxonomic identification of seaweeds around St. Martin Island, Bangladesh

Abstract

The present study was conducted around the St. Martin's Island to prepare a taxonomic checklist of seaweed. From the findings of the present study, the depth of sampling sites ranged from 1.2-10.0 m. Transparency of water fluctuated between 1.5 - 12.5 m. Surface water temperature, salinity, pH, DO, Conductivity and FNU ranged for 22.6-32.1^{o}C, 25.16-33.89‰, 6.67-8.6, 3.90-6.91 mg/L, 41064-52435 µS/cm, 2.4-18.4 respectively whereas bottom water temperature, salinity, pH, DO, Conductivity and FNU varied for 21-31.2^{o}C, 28.09-35.81‰, 6.3-8.8, 4.22-6.73 mg/L, 47605-54642 µS/cm, 2.3-41.1 respectively. The concentration of nutrients in surface water recorded 0.0-19.93 mg/l for PO_4-P, 0.0-2.5 mg/l for NO_3-N, 0.0-5.43 mg/l for NO_2-N, 0.0-10.0 mg/l for SiO_3 and 0.96-12.55 mg/l for NH_3 while the concentration of nutrients in bottom water were recorded in the range of 0.03-20.74 mg/l for PO_4-P, 0.0-2.1 mg/l for NO_3-N, 0.0-7.0 mg/l for NO_2-N, 0.0-3.0 mg/l for SiO_3 and 1.32-12.8 mg/l for NH_3. Sediment temperature and pH varied from 20.0-32.0^{o} C and 5.3-7.9. Gravel, shell, sand and silt+clay ranged for 0.0-12.62%, 0.0-86.22%, 9.25-99.33% and 0.03-23.0% in the study area. The concentrations of heavy metals in water found below the detection limit at all stations during all month. sediment varied from BDL-8.6 mg/kg for Pb; BDL-940 mg/kg for Mn; BDL-22.31 mg/kg for Cr; BDL-49.2 mg/kg for Zn; BDL-42.6 mg/kg for Ni; BDL-316.0 mg/kg for Cu. A total of 84 seaweed species were recorded at 10 sites around the St. Martin's Island. Among 84 species, 19 species belong to Chlorophyta, 44 species belong to Rhodophyta and 21 species belong to Phaeophyceae.

Key words: Seaweeds, Physico-chemical parameters, Taxonomic identification, St. Martin's Island.

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Potential Nutritional Evaluation of some seaweed and experimental extraction of phycocolloid from seaweeds available around St. Martin's island and continuation of taxonomic base line study.

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Abstract

Seaweed assemblages with notes on ecological conditions around Saint Martin's island were investigated in the present year for the month of January, February, and only 2 days in March before the COVID-19 lockdown situation. Bangladesh Navy diving unit was involved in sampling in the cruises. A total of 28 seaweed species were sampled; among them, 11, 10, 7 species belong to Phaeophyceae, Rhodophyta, and Chlorophyta respectively. During the cruise, between the target seaweeds for potential nutritional evaluation; only the Caulerpa racemosa, Halymenia dilatata, Halymenia floresii and Hypnea valentiae were collected but in a very small quantity than that of the requirement. On the other hand, none of the target seaweeds for experimental phycocolloid extraction were sampled. Some of the physicochemical parameters were recorded during the cruise. The water parameters of the study area ranged for Depth (3 ± 1.188664) m, Secchidepth (3 ± 0.640949) m, temperature (23.5 ± 0.410745) °C, salinity (34.444 ± 0.523256), pH (8 ±0.098303), DO (5.997449 ±0.466367) mg/l, phosphate (0.89 ± 0.566498) gm/l, nitrate (0.02 ±0.013847) mg/l, nitrite (0.005 ± 0.004347) mg/l, silica (0.275 ± 0.487108) mg/l, ammonia (2.25 ± 0.490689) mg/l. the bottom sediment temperature and pH were (23 ±0.75735) °C and 6.6 ±0.268475 respectively.

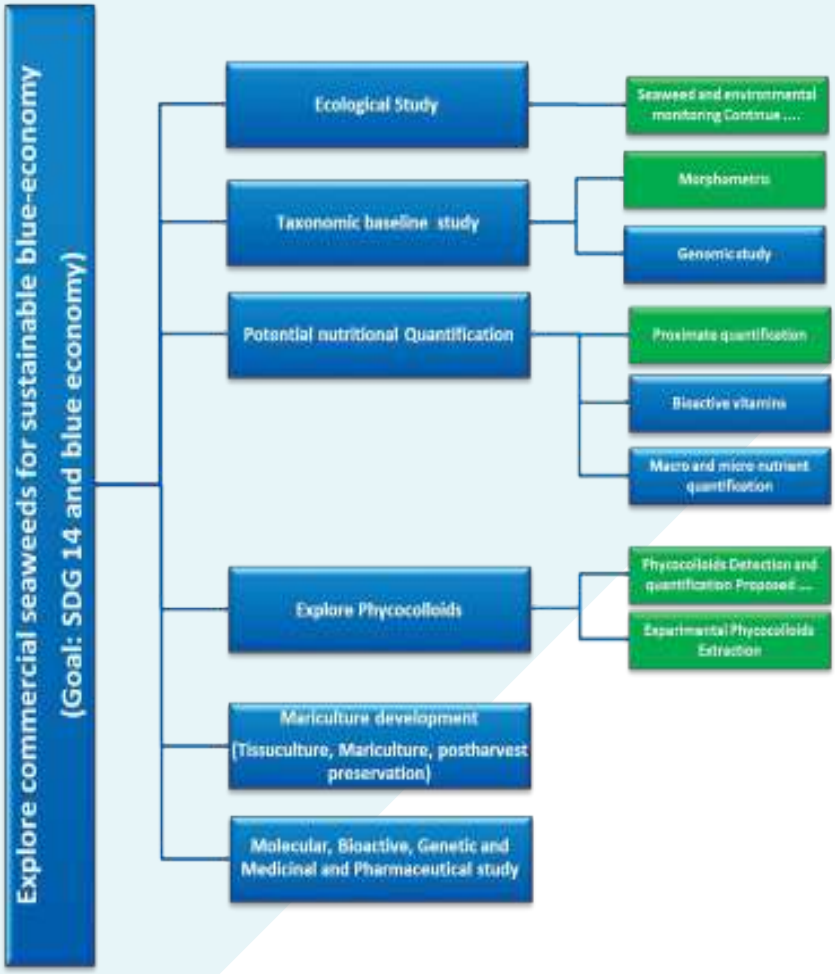
Key words: Seaweed; water and bottom sediment; Physico-chemical property; water nutrients; St. Martin's Island.

Introduction

Seaweed, or macroalgae refers to the macroscopic, multicellular, marine algae that have no true roots, stems, or leaves (Apayd n et al. 2009) which grow on substratum in their suitable environmental conditions. To attaché on the substrate they usually have a holdfast rather than the root system. The term includes three types like Rhodophyta, Phaeophyta, and Chlorophyta. Seaweed is photosynthetic and needs sunlight for its growth. Seaweed is widely distributed in the coastal seas; attached to substrates such as sand, mud, rocks, shells, coral inter alia, shells, and on other plants like mangroves (Cadar et al. 2016; Apayd n et al. 2009). Some seaweed grow floats, or air-filled pockets, that positioned them upright to be closer to the surface for increasing photosynthesis. All the parts of a seaweed touch the water, so it doesn't need an internal nutrition transport tissue system as terrestrial plants do; they absorb what they need directly from the water through surface tissues. The web, tide, and current makes continuous water flow- transports fresh supplies of nutrient and gas for them.

Seaweed provide essential food, shelter, and nursery habitat for diverse marine species including fishes. It is a renewable liveliness that regenerates from natural processes frequently and restocks. It is bio-renewable energy used as a source of nutraceutical, biofuel, bio-fertilizer, and manufacturing many industrial products. Seaweeds are rich in proteins, carbohydrates, vitamins, and minerals required for human nutrition (Pise and Sabale, 2010) as well as fodder, poultry, and aquaculture. Seaweed supplies biochemical composition, nutrients, and calories for the human diet (Holdt and Kraan, 2011; K l nç et al. 2013; Nunes et al. 2017). The concentration of some carbohydrates in seaweed is higher than that of terrestrial plants (Arasaki and Arasaki, 1983). The most common uses of seaweeds can be categorised into (1) source of food, nutrient, and minerals, (2) aquaculture feed, (3) food and beverage, (4) cosmetics and toiletries production, (5) environmental and ecological health improvement and remediation, (6), thickener and binder (7) health, thalassic and wellness, (8) different industrial raw material, (9) pharmaceutical and pharmacology and, (10) herbal and biomedicine (Apayd n et al. 2009). Several species are extensively used as food (humans and livestock), for the extraction of agar and carrageenan, in traditional medicine, or as bio-fertilizer (Huynh and Dinh, 1998; Dang et al. 2007). In many Asian countries, seaweed is consumed in different forms like vegetable, soup, Nori, Kombu, Wakame, Salad. Calcium that comes from seaweed is useful for expectant mothers, adolescents, and the elderly all exposed to a risk of calcium deficiency. The extract of seaweed contains antibiotic, antifungal, aesthetics, anticancer, anti-oxidant, antidiuretic, anti-diabetic, moisturizing, anti-obesity, pesticide, insecticide properties also.

Water quality plays an important role in the seaweed ecosystem. Different physicochemical parameters like salinity, temperature, pH, DO, turbidity, and depth have an enormous



Flow Chart 1: Showing short-mid-long term plan of Bio-OD

effect on the total seaweed ecosystem (Dang et al. 2007). Along with physicochemical parameters, nutrients also exert great influence on its growth.

Geographically the Saint Martin's Island in Bangladesh is the most suitable habitat for seaweed. These occurs naturally surrounding intertidal, subtidal, and shallow neritic areas on rocks and corals from October/November to May/June when the environment becomes favorable (Islam and Aziz, 1976). About 177 species of seaweeds have been recorded in the coastal and estuarine areas of Bangladesh (Islam 1976; Islam and Aziz, 1987). Former National Professor Dr. A K M Nurul Islam, regarded as the 'Father of Phycology and Limnology in Bangladesh' conducted a massive study from early 1970 to 1978. In the next, Dr. Md Zafar (former professor, Institute of Marine Sciences) first explored seaweed culture in 2003 for Hypnea and Caulerpa in Bangladesh.

Bangladesh Oceanographic Research Institute (BORI) started its journey in 2018; the Biological Oceanography Division (Bio-OD) is working aiming some short-mid-long term sustainable exploration and exploitation of seaweed (Flow Chart 1). In the year 2018-19 and 2019-20 the BORI Seaweed Research Team (SRT) were assisted by Oceanica (a private professional diving/snorkeling team) for seaweed, water, and bottom sediment sampling. The present R&D 2019-20 was designed and submitted including logistic support from Oceanica for their know-how reef diving talent, professional underwater photography skill, and experienced expertise in seaweed distribution. The BORI R&D technical expert instructed the Bangladesh Navy diving units for such sampling.

Aim and objectives

- Experimental trial to uncover phycocolloid (agar/carrageenan) content from selected seaweed.
- Proximate analyses of selected seaweeds to determined nutrition value.
- Record Physico-Chemical parameters of water and bottom sediment to understand specific seaweed habitat.
- Capture both underwater and laboratory images of seaweeds as a part of BORI taxonomic baseline for a reference Rook.

Materials and Methods

Sampling Design: Seaweed, surface & bottom seawater and bottom sediment samples were designed to collect from 10-12 sites by diving around the island. The considerations for sampling were; (1) collect all the available seaweeds samples from each sits covering around 200sqm area, (2) Mass collection of 5/6 targeted seaweeds for phycocolloid study, and 20 targeted seaweeds for nutritional content evaluation, (3) Capture all the seaweeds (both the still and video) in detail for the documentation and as a part of book publication.

Sampling sites: The study was designed to collect samples from 10 sites around the island at a depth of 1.5m to 8 m. The coordinates of each site were recorded (Map-1). Surface and bottom seawater, bottom sediment, and seaweed samples were collected from all sites. Again wave-driven beach samples were also collected from the Ease, North, and East beach and from the Cheradia shoreline.

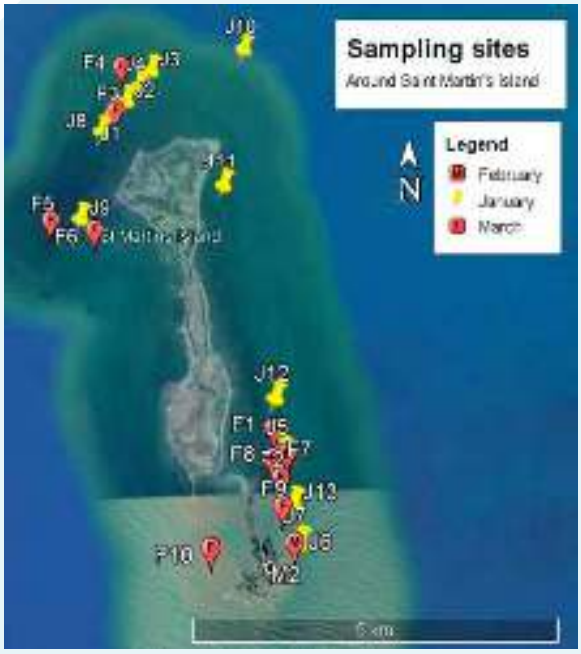
Seaweed sampling: Seaweed was sampled by diving and snorkeling around the selected sites by the Bangladesh Navy diving unit support. The collected seaweeds were initially sorted on board and transported to the temporary lab (at a local hotel, Saint Martin's Island) using zip lock. In addition, web-driven intertidal samples were also collected by the team members sorted and transported to the temporary lab as well.

The samples were sorted again, cleaned, and washed to remove impurities. Some parts of the samples were preserved in 90% alcohol for genetic study, and then stored in an icebox; some parts were preserved in 6-7% formalin; the rest were placed in a drier for air dry. All the samples were then transferred to the BORI laboratory for further study. A representative of each sample collected every day were photographed in different condition for documentation.

Surface, bottom water and bottom sediment sample: Surface and bottom seawater and bottom Sediment samples were collected by sample bottles and Ziploc accordingly by the divers. The Physico-chemical parameters of surface and bottom seawater (Depth, Secchi-depth, Salinity, Temperature, pH, DO, FNU, conductivity, Nitrate, Nitrite, Phosphate, Silicate, and Ammonia) and bottom sediment parameters (temperature and pH) were immediately recorded.

Quantification of Physico-chemical parameters: A five kg weight and a rope was used to measure the water depth and a 30cm Secchi disc for Secchi-depth. ProDSS Multi-parameter Water Quality Meter (USA) was used to determine seawater temperature (ºc), pH, DO (%), FNU, conductivity (mho/cm), calculated TDS (mg/l), and Salinity. The water temperature, conductivity, and depth factor (from https://www.mt-oceanography.info/Utilities/salcon.html). Seawater Nitrate, Nitrite, Phosphate, Silicate and Ammonia was determined using Hatch kit by Hach DR900 Portable Colorimeter (USA), absorbance principle.

Identification of Seaweed: The detailed and scaled image of each seaweed samples were captured in different condition. The morphological identification of seaweed were followed by the algaebase.org, marinespecies.org, Macroalgal Herbarium Consortium Portal, high impact journal articles and identification manuals.

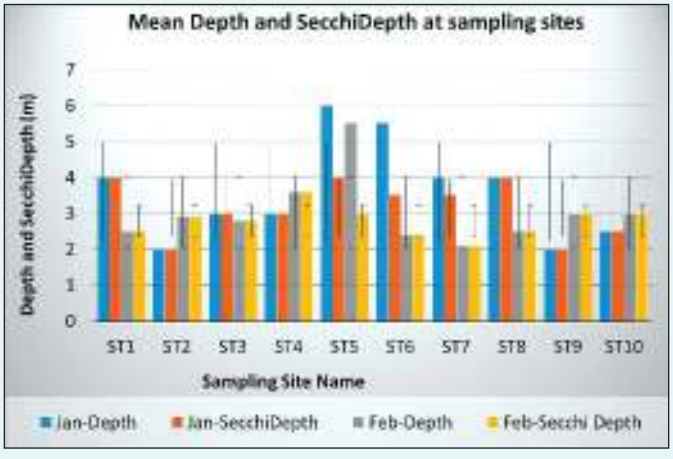


Map 1: Sampling sites around the island

Results and Discussion

The current study is a part of vision 2031 "exploration of commercial seaweed for the sustainable blue economy", which started from 2019-2020. The present investigation was designed to explore seaweed and their ecosystem at 10-12 nearshore sites (covering an area of about 200 sqm each) around Saint Martin's Island for each month from January to May 2021. These sites ranged from 2m to 8/9 m depth and 0.5 to 3km distance from the shoreline. Seaweed samples were also discovered by snorkeling from the south Cheradia, Chiradiar ghola, North, and North-East part at a depth of 1-2m. Other than these intertidal coasts were also surveyed at the North, East, South, and West zone which were mostly driven by waves or attached to the surface of the rocks.

The average depth and Secchidepth of 10 sampling sites show (Figure 1a, 1b) that the maximum depth was at site-5 (6m) in January and the minimum was 2m at site-2 and site-9 in January. The average Secchi depth was about 4m and the sites less than 4m were all most visible to the bottom. It is important to mention that the tidal fluctuation was about 2.8 m and 3.2m (new moon/ full moon) and 0.8m and 1.1m (first/ third quarter moon) during January and February respectively. The samples were collected between 10 am to 3 pm (not following the tide chart).



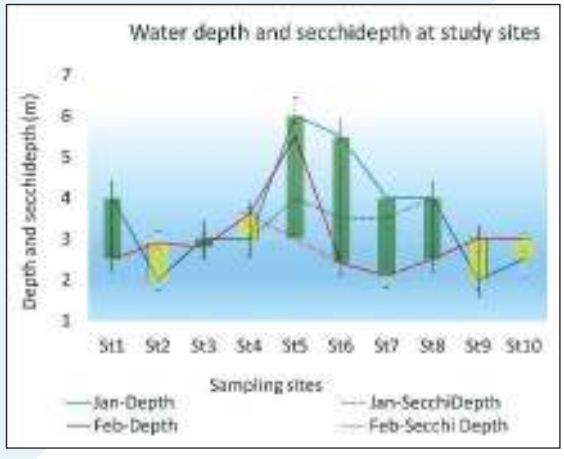
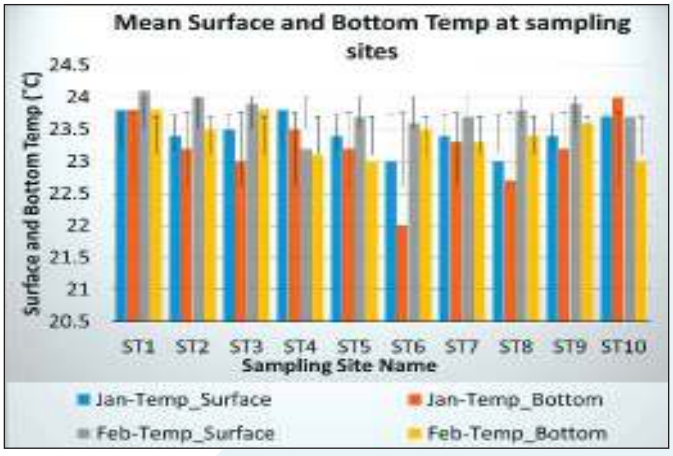


Figure 1a, 1b: Mean Depth and Secchi-Depth at sampling sites during January and February

The mean surface temperature was a little higher than that of the bottom temperature for all sites (Figure 2a, 2b). The overall surface temperature was about +1°C more in February than that of January as well. It ranged from 23 to 23.8°C in January and 23.2 to 24.1°C in February at surface.



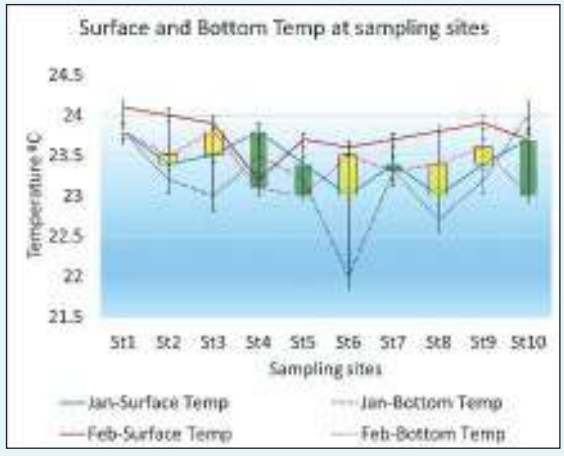
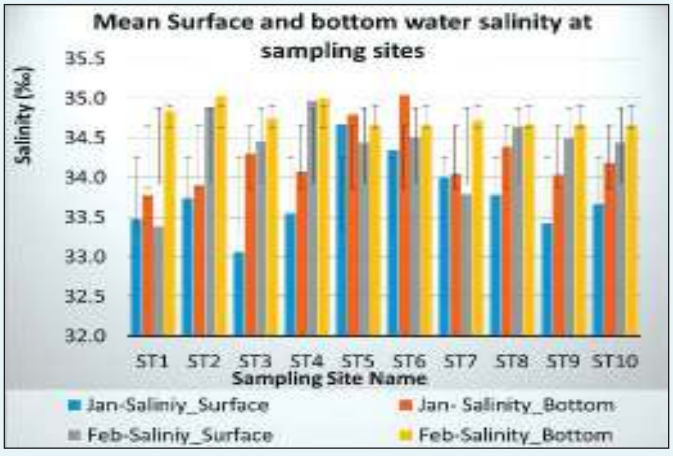


Figure 2a & 2b: Surface and bottom water temperature status at sampling sites

On the other hand, bottom water salinity was a little higher than that of the surface (Figure 3a, 3b) at all stations during the period. The maximum surface temperature during January and February months was 34.7$^{o}/_{oo}$ at site-5 and 35$^{o}/_{oo}$ at site-4 respectively. Whereas it was minimum in January and February at 33.1$^{o}/_{oo}$ at site-2 and 33.4$^{o}/_{oo}$ at site-1 respectively. It was also observed that both the bottom salinity was influenced with tidal period and it was recorded grater during high tide period than that of low tide hour.



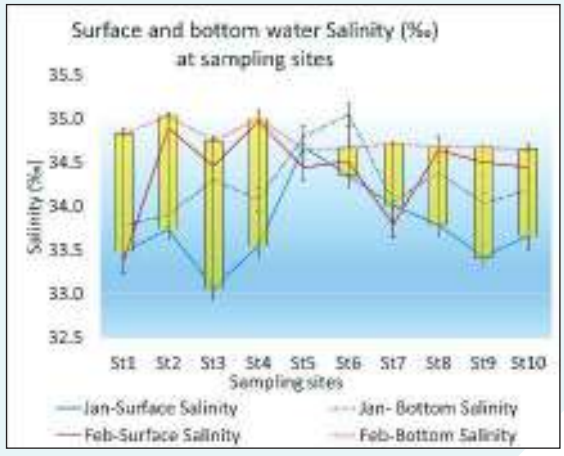
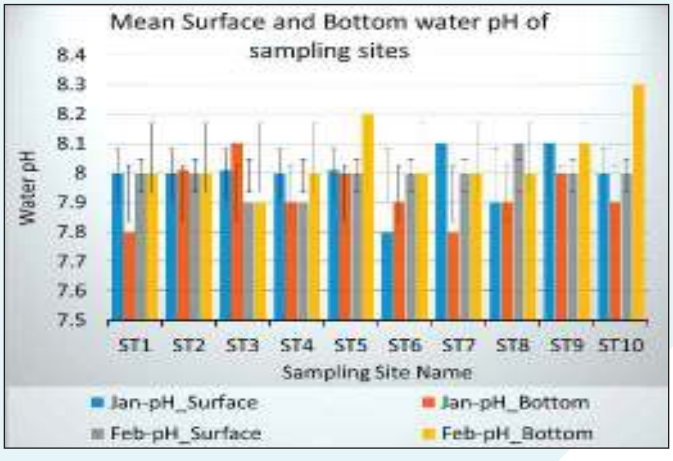


Fig 3a, 3b: Surface and bottom water salinity at sampling sites

The pH around the study sites was moderately alkaline which ranged from 7.8 to 8.3 (Figure 4a and 4b). The maximum and minimum surface pH in January were 8.1 (site7) and 7.8 (site6), and in February were 8.1 (site8) and 7.9 (site3 and site4). In the case of bottom water maximum and minimum surface pH in January were 8.1 (site3) and 7.8 (site1 and site7).



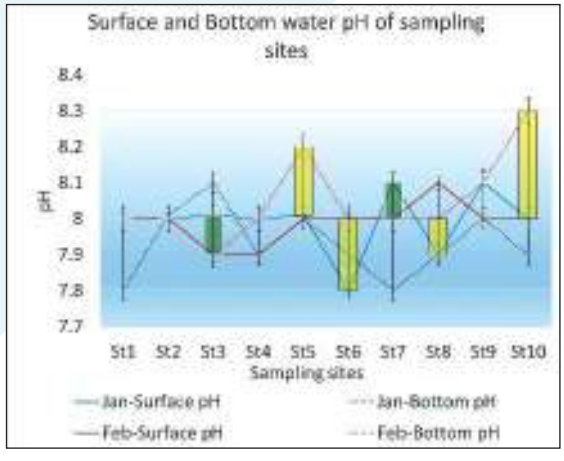
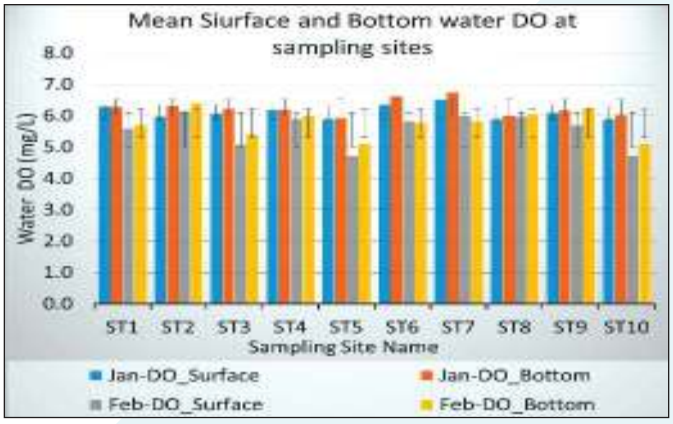


Fig 4a, 4b: Surface and bottom water pH at sampling sites

The surface DO range 5.9 to 6.6 mg/l in January 4.7 to 6.1mg/l in February whereas the bottom DO were 6.7 to 6.0mg/L in January and 6.4 to 5.1mg/L (Figure 5a, 5b). It was observed that the bottom DO was the same as that of the surface or a little more in some sampling sites. It can be said that the seaweed growing in the bottom responsible for the increased DO at the Bottom area.



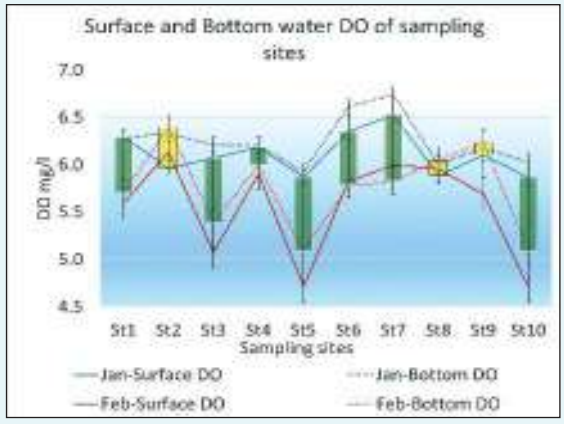
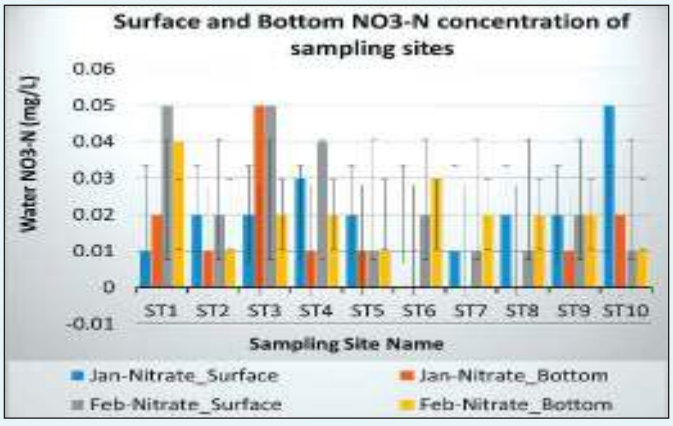


Figure 5a, 5b: Surface and bottom water Dissolved Oxygen concentration at sampling sites

The concentration of NO_3^-N, NO_2^-N, PO_4^-P, SiO_3, and NH_4^+N of surface and bottom water were recorded for both months. The concentration of these nutrients NO_3^-N, NO_2^-N, PO_4^-P, SiO_3 and NH_4^+N in the study area ranged 0.0 to 0.05 mg/L, 0.0 to 0.014mg/L, 0.035 to 2.52 mg/L, 0.02 to 1.99 mg/L and 1.32 to 3.18 mg/L respectively (Figure 6a, 6b, 7a, 7b, 8a, 8b, 9a, 9b, 10a, 10b). It was also observed that the concentration of NO_3^-N, NO_2^-N, PO_4^-P, and SiO_3 were recorded relatively low at the stations where seaweed abundance and growth is high. It explains nutrient uptake was more in those regions, on the other hand, the NH_4^+N concentration was a little more near the bottom than that of the surface.



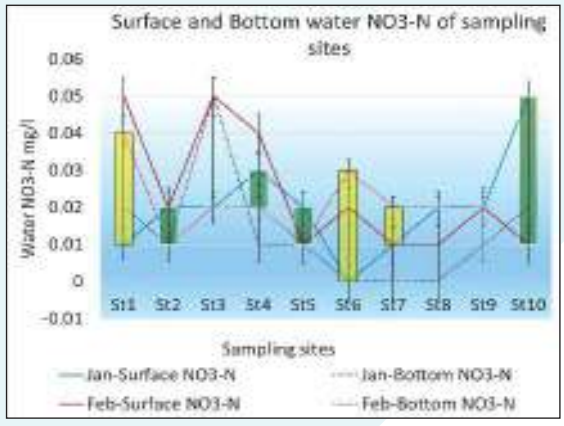
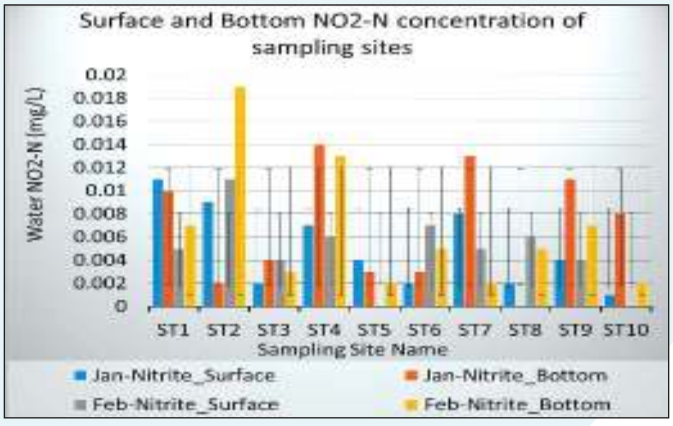


Figure 6a, 6b: Surface and bottom water Nitrate concentration and range at sampling sites



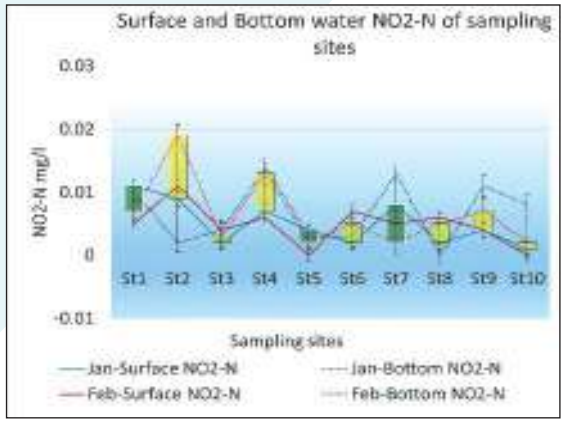
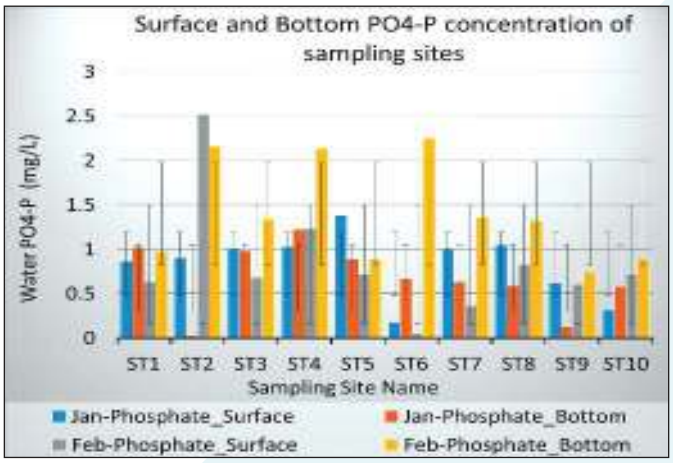


Figure 7a, 7b: Surface and bottom water nitrite at sampling sites



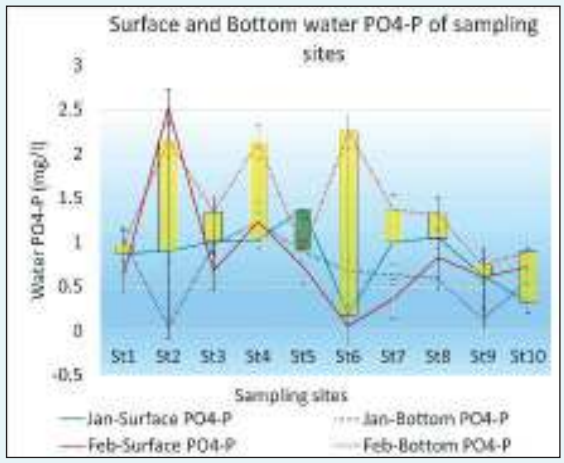
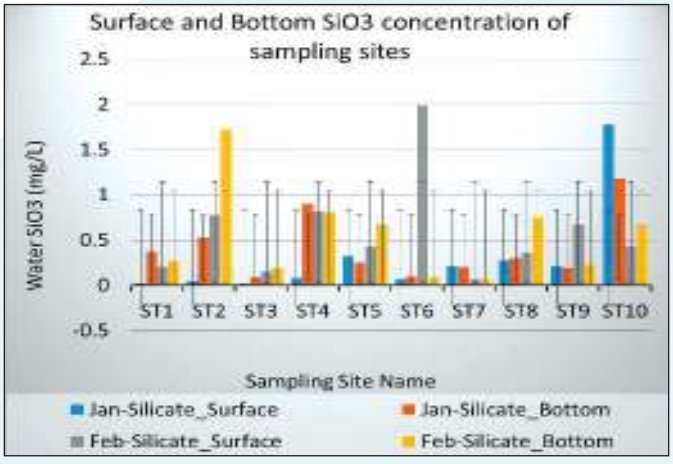


Figure 8a, 8b: Surface and bottom water phosphate concentration at sampling sites



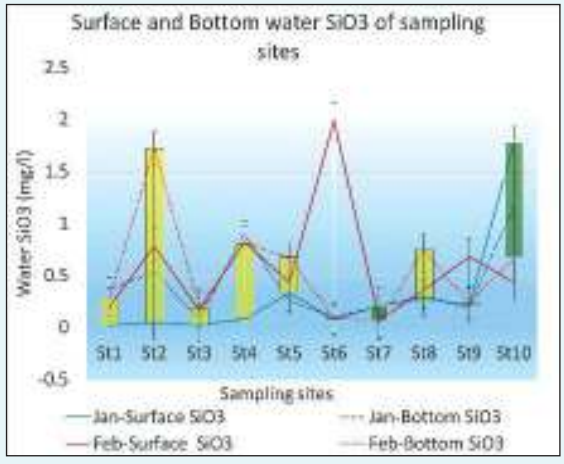
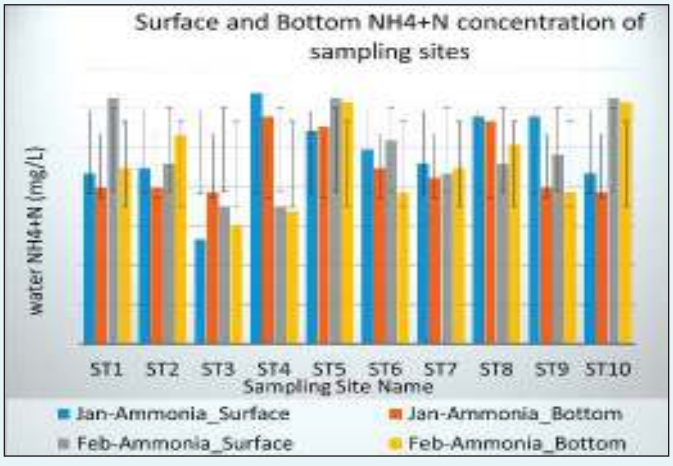


Figure 9a, 9b: Surface and bottom water silicate at sampling sites



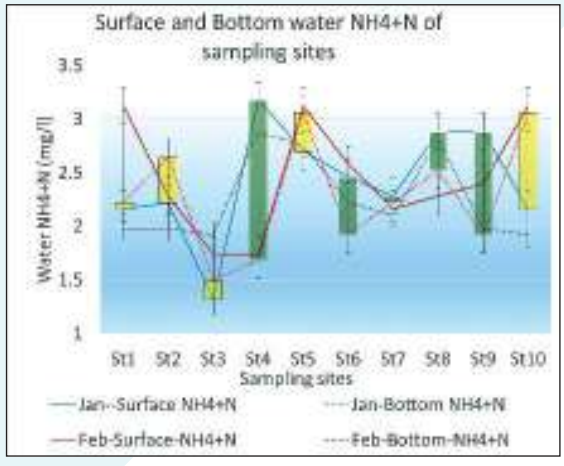
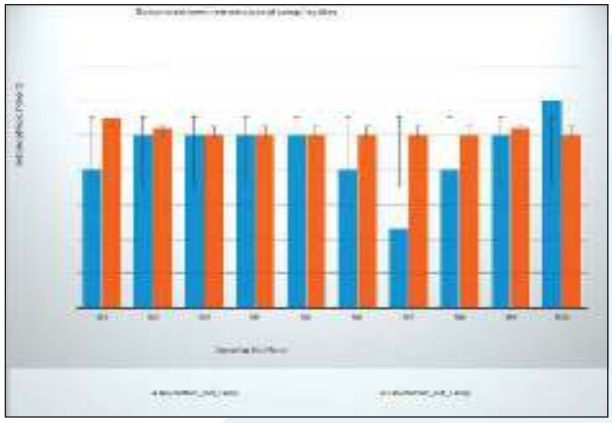


Figure 10a, 10b: surface and bottom water Ammonia concentration at sampling sites a, 10b

It was a little difficult to collect bottom sediment from sites. Sometimes the divers had to search for the rock pocket. The bottom sediment was sandy all around the sites. The bottom sediment pH and temperature were recorded on-board immediately after collection (Figure). The bottom sediment temperature was 1-2°C lower than that of bottom water samples in both months. The sediment pH was also recorded. It was a little acidic all around the sites in both seasons. Between the seasons it ranged 6.2 to 6.9 in January and 6 to 6.8 in February.



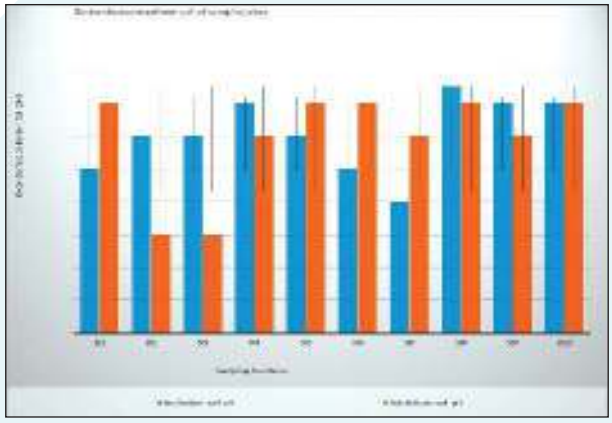


Figure 11a, 11b: Bottom sediment temperature and pH status at sampling sites

The Northern Bay of Bengal has the distinctly tropical marine ecosystem, and copious river drainage into the northern part of the bay and the profusion of wetlands, marshes, and mangroves increase the productivity of nearshore.

The water quality of coral-associated rocky coasts of Saint Martin's Island is influenced by the discharge of the Naf River and the coastal vegetation of Myanmar. Seaweed growth is significantly related to nutrient supply. During late monsoon and/or early winter seaweed starts to grow around the intertidal and subtidal rocks of Saint Martin's island. The highest assemblage occurs from February to April. In the present study, a total of 28 seaweed species were collected of which 7 Chlorophyta, 11 Rhodophyta, and 12 Phaeophyta (Table 1).

Table1: Seaweed recorded around saint Martin during January and February

Chlorophyta	**Rhodophyta**	**Phaeophyta**
Caulerpa chemnitzia	*Asparagopsis taxiformis*	*Padina boergesenii*
Caulerpa cylindracea	Halymenia dilatata	*Padina gymnospora*
Caulerpa fergusonii	Halymenia venusta	*Padina tetrastromatica*
Caulerpa racemosa	Halymenia floresii	*Spatoglossum asperum*
Caulerpa taxifolia	*Hypnea valentiae*	*Sargassum aquifolium*
Halimeda opuntia	*Nemalion elminthoides*	*Liagora viscida*
Halimeda discoidea	*Peyssonnelia squamaria*	*Sargassum oligocystum*
	Tricleocarpa cylindrica	*Rosenvingea intricata*
	Vanvoorstia coccinea	*Colpomenia sinuosa*
	Neurymenia fraxinifolia	*Chnoospora implexa*
		Dictyota dichotoma

It was unfortunate that the divers involved in the sampling were very unfamiliar with seaweed and its types. They just collect the samples which were most available, larger, and comparatively grows on the surface of the bottom rocks. The divers were shown detailed images of the target seaweeds for phycocolloid and nutritional quantification before going into water. Between the target samples Caulerpa racemosa, Halymenia dilatata, Halymenia floresii, and Hypnea valentiae were collected (photo plate 1) but in a very small quantity than that of the requirement. On the other hand, none of the target seaweeds for experimental phycocolloid extraction were sampled. Some of the physicochemical parameters were recorded during the cruise.

The tropical warm temperate coastal rocky shore is rich in seaweed occurrence and distribution. Tropic, warm temperate, cold temperate, subarctic, and arctic regions are characterized and the delineations between these regions are identified (Michanek 1979). In the present study area, Chlorophyta mostly dominated in the shallow zone (some also grows between intertidal rocks or beach) whereas Rhodophyta mostly occurs in the deeper area (or between rock patch) where about 40% sunlight was reduced. Water and bottom sediment samples were collected at a maximum depth of 6m. Secchi depth, surface, and bottom water temperature, pH, salinity, DO concentration status. During January and February, the FNU was less (2-6) on the South and west coast of the island whereas it was higher (4-13) on the east and northeast coast. From the study, it can be said that the Secchi depth (3 ± 0.640949) m, temperature (23.5 ± 0.410745) °C, salinity (34.444 ± 0.523256), pH (8 ±0.098303), DO (5.997449

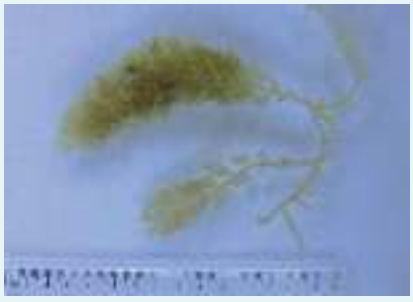
Photoplate 1: Some photoplates captured from samples

Caulerpa chemnitzia

Caulerpa cylindracea

Caulerpa fergusonii

Caulerpa racemosa



Asparagopsis taxiformis

Caulerpa taxifolia

Halimeda discoidea

Neurymenia fraxinifolia

Halymenia floresii

Halymenia dilatata

Photoplate 1: Some photoplates captured from samples

Halymenia venusta

Dictyota dichotoma

Peyssonnelia squamaria

Hypnea valentiae

Tricleocarpa cylindrica

Padina boergesenii

Sargassum aquifolium

Colpomenia sinuosa

Chnoospora implexa

Liagora viscida

±0.466367) mg/l, phosphate (0.89 ± 0.566498) gm/l, nitrate (0.02 ±0.013847) mg/l, nitrite (0.005 ± 0.004347) mg/l, silica (0.275 ± 0.487108) mg/l, ammonia (2.25 ± 0.490689) mg/l. the bottom sediment temperature and pH were (23 ±0.75735) °C and 6.6 ±0.268475 suitable for seaweed growth.

The use of seaweed as food has been traced back to the fourth century in Japan and the sixth century in China (Dennis 2003). Except a few tribal community seaweed is not popular as food in Bangladesh. In recent years few NGOs and Bangladesh Bank is financing for its promotion. In the present study was designed to evaluate the nutrition quality of some common edible seaweed. Seaweeds as a source of these hydrocolloids dates back to 1658. It was not until the 1930s that extracts of brown seaweeds, containing alginate, were produced commercially and sold as a thickening agent and gelling agent (Hoek, 1984). Next the present proposal was designed to explore Phycocolloids dorm some selected seaweed. But it was very unfortunate that the COVID situation and involvement of a fresher diver group made it difficult to collect the target specimen.

Conclusion

There is huge potential for seaweed in Bangladesh. BORI is working to explore commercially valuable seaweed containing phycocolloid and commonly used as seafood. COVID alert for lockdown hampered the sampling activity. So it was not possible to complete all the target activities according to the proposed research objectives. Hope next year the rest of the investigation will be completed.

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Chapter 7

Environmental Oceanography and Climate Division

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

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Sultan Al Nahian
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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 µS/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.

Key words: Temperature, Salinity, Conductivity, Dissolved Oxygen, Coastal water & Saint Martin's Island.

Seasonal Variation of Seawater Quality around 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. Seawater 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. Physico-chemical parameters were determined the coastal waters and offshore water around the Saint Martin's Island. All the physico-chemical parameters such as sea surface temperature, salinity, pH and dissolved oxygen were studied for a period of 3 months (07 to 10 January 2019-08 to 10 March 2015). The coastal and offshore seawater around the Saint Martin's Island where sea surface temperature varied from 22.6 to 29.6 °C and 22.7 to 25.90 °C, salinity varied from 31.12 to 33.8 and 31.05 to 33.9 ppt, hydrogen ion concentration ranged between 7.9 to 8.29 and 7.95 to 8.24, variation in dissolved oxygen content were from 6.16 to 7.94 and 5.17 to 6.5 mg l^{-1} and also varied independently.

Key words: Sea Surface Temperature, Salinity, pH, Dissolved Oxygen and Saint Martin's Island.

Mapping marine litters and find the Clean Coast Index (CCI) of Saint Martin's island coastline

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Abstract

This study examines marine litters in the using geographic information systems (GIS) & GPS, Clean Coast Index (Alkalay et al., 2007) and OSPAR guideline to develop a detailed map of intensity and distribution of marine litter results of baseline clean coast index (CCI) a complete outline for a spatial database of shoreline litter of Saint Martin's island. A total of 72 sampling units (100-150 m transects approx.), covering 12 kilometers of coastline in Saint Martin's Island were surveyed by 12-15 volunteers. In total, over 840 volunteer hours were spent detecting and recording around 50,000 pieces of litter. As per clean coast index rate Saint Martin's Island can be measured as "Moderate" (>5.2 plastic pieces/m^2).

Key words: Marine litters, Clean Coast Index (CCI), Saint Martin's Island.

Occurrence and identification of Micro-plastics in the beach sediment of Saint Martin's Island

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Abstract

The existence of micro-plastic particles (particles size 5mm) is assessed on beaches along the Saint Martin's Island coast from 14 different locations. Density separation method was adopted for isolation of micro-plastics from beach sediment using Zinc chloride (1.5 g cm^{-3}). Micro-plastics were categorized into two size classes (1-5mm and<1mm). In this study, only 1-5mm range of micro-plastic particles was considered for analysis. Identification of the 1-5 mm category micro-plastics type as foam, filament, fragment, line and pellet was done visually and they were counted. Concentration of micro-plastics in beach sediment varied from 9 particles kg^{-1} to 181 particles kg^{-1} of dry sand. The most frequent micro-plastics dimensions ranged from 1.0 to 2.0 mm, and fragments were predominant. Polymer type identification was conducted using Fourier-transform infrared spectroscopy (FT-IR). The abundance of plastic polymer type was polyethylene (45%), polypropylene (38%) , polystyrene (15%) and polyurethane (2%) and very similar profile was observed for all locations. Density of Polymer appears an important factor influencing micro-plastics dispersion. Low density plastic debris usually recirculates between beach sediments and seawater in a greater extent than higher density debris. Density of polymer assumed as significant findings of qualitative research of micro-plastics which provide the basis for conclusions about the sources of micro-plastics in the marine environment.

Key words: Micro-plastics, Beach sediment, Saint Martin's Island.

Determination of Marine Pollution by Assessing Seasonal Water Quality in Moheshkhali Channel, Cox's Bazar, Bangladesh

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Scientific Officer

Abstract

Moheshkhali Channel is a dynamic and economically viable channel in Bangladesh. The channel is so long, its upstream is connected to net of the Matamuhuri River and Bakkhali River. And downstream of the channel is falling to the Bay of Bengal. There are many aquaculture activities are happened in the channel. On the other hand, different type human activities are occurred in there. Moheshkhali Island is a beautiful tourist destination for tourists in Cox's Bazar. This channel is the only navigation rout for Moheshkhali Island from Cox's Bazar Sadar Upazila. The channel water shows more salinity as like as the polyhaline estuary during high tide in winter season. The channel water is polluted by fishing trollers, fisherman's boats, and passenger engine boats, different types of business boats, gumboots, speed boats and other activities e.g. drainage system, fertilizer, sewerage line etc. In the present study, assessing the physicochemical parameters of the channel water such as air temperature (AT), wind speed (WS), surface water temperature (SWT), surface water salinity (SWS), pH, total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO) and 5 days of biological oxygen demand (BOD_5) in months of January, February and March 2020 were 19.82 to 21.72°C, 21.1 to 23.6°C and 24.68 to 27.67°C for water temperature, 29.38 to 32.62, 29.43 to 32.85 and 30.05 to 33.40 ppt for salinity, 1 to 3, 0.5 to 3 and 1 to 2.8 feet for transparency, 7.53 to 8.06, 7.46 to 8.10 and 7.56 to 8.19 for pH, 38960 to 47182, 38740 to 48610 and 39760 to 47550 mg/L for TDS, 0.04 to 0.15, 0.02 to 0.22 and 0.021 to 0.095 mg/L for TSS and 4.07 to 6.05, 3.98 to 6.53 and 3.21 to 5.6 mg/L for DO and 7.34 to 33.43, 9.08 to 37.7 and 11.23 to 40.23 mg/L for BOD_5 respectively. The lowest DO & WS and highest BOD_5 & TDS were found in 06 No Ghat (Jetty Ghat) due to presence of polluted water. The water quality of 06 No Ghat (Jetty Ghat) is highly polluted, Badarkhali Jetty Ghat is polluted and downstream of the Channel water is slightly polluted.

Introduction

The coast of Bangladesh is known as a zone of multiple vulnerabilities as well as opportunities. It is prone to severe natural disasters like cyclones, storm surges, floods, erosion, soil salinity etc. Main rivers and lake of this region are the Karnaphuli, Halda, Sangu, Matamuhuri, Bakkhali, Naf, Kasalong, Chingri, Mayani and Kaptai Lake. A large number of chemical and fertilizer industries have been established on both the banks of the Bakkhali River. Effluents from these industries are reportedly being directly discharged from river to sea. A number of industries namely fertilizers, cement, pulp and paper, food processing, pharmaceuticals, metal, textile, chemical, petroleum, lubricant plants, etc. discharge heavy metals into the coastal water (Shyamol, N., 2012). Plastic bottles and other plastic products are most common forms of litter in the coastal water. The rapid and unplanned increase in shrimp culture is also becoming a concern. The use of antibiotics and other chemicals used in shrimp fields is causing pollution in the water, which may harm other aquatic lives. Shrimp culture in Cox's Bazar uses 620 tons of urea annually. It also generates 15 tons of waste daily, which comes into sea (Mizanur, M.R. 2006).

Dissolved oxygen (DO) is one of the most important indicators of water quality. It is essential for the survival of fish and other aquatic organisms. Oxygen dissolves in surface water due to the aerating action of winds. Oxygen is also introduced into the water as a by-product of aquatic plant photosynthesis. When dissolved oxygen becomes too low, fish and other aquatic organisms cannot survive. DO depends on the biochemical oxygen demand (BOD) (deoxygenation), nitrification, aeration, sedimentation, photosynthesis and algae respiration (Sakalauskiene 2001; see Figure 1 below). BOD is the good indicator of the water pollution. Sources of DO in a waterbody are primarily the atmosphere and photosynthetic activity, with the latter being more important for lentic-type systems and the former more important for lotic systems (Andrews and McEwan 1987; Radwan et al. 2003; Correa-Gonzalez et al. 2014).

Surface and ground water resources are highly sensitive aquatic systems to contaminants due to their accessibility to multiple-point and non-point sources of pollutions. Microorganisms (e.g. aerobic bacteria) use oxygen in the oxidation of organic matter, as part of metabolism and nitrification processes, which directly affect oxygen concentration (USEPA 2012). When Natural process and human pollution such as household, industrial, septic system and farm wastes are discharged into water, organic matter and nutrients are present in them. In an aeration system, these wastes are oxidized by bacteria and other biological species such as algae which can cause oxygen depletion (Misra et al. 2006). Dissolved oxygen depletion has shown lethal effects on physiological and behavioural changes in variety of organisms (Hughes and Ballintijin 1968).

Objectives

- To determine the other physicochemical properties such as air temperature (AT), wind speed (WS), transparency, surface water temperature (SWT), surface water salinity (SWS), pH, total dissolved solids (TDS) and total suspended solid (TSS) in high and low tide at the Channel.
- To investigate the variation of water quality parameters in low and high tide.
- To assess the pollution status based on the analyses of water quality physicochemical parameters.

Study Area

Maheshkhali Channel

Moheshkhali Channel is an economically important channel in Bangladesh. Geographically Moheshkhali Channel is located in between 21.745 and 21.470 north latitudes and in between 91.939 and 91.936 east longitudes. The Channel is approximately 30 km long. The upstream of the Channel is connected with nets of the Matamuhuri River and the downstream of the Channel is directly connected with the Bay of Bengal. It is bounded by Maheshkhali Upazila on the west side of the Channel, Chakaria Upazila on the north, Cox's Bazar Sadar Upazila and Bay of Bengal on the south. Different nets of Bara Matamuhuri River are located on the north-east side of the Channel and Kennel of Dulahajra and Bakkhali River are located on the east side of the Channel. The Moheshkhali Upazila and Cox's Bazar Sadar Upazila is separated by the Maheshkhali channel. There is water way in the Channel: 06 Ghat of Cox's Bazar to Moheshkhali Island.

Materials And Methods

Water samples were collected from twelve sites in the Moheshkhali Channel and one water sample was collected from the Jetty Ghat of the Bakkhali River and another sample was collected from mouth of Bakkhali River by niskin water sampler (Figure 1) from 12 to 14 January 2020, 15 to 18 February 2020 and 14 to 17 March 2020. These sampling stations included upstream and downstream of the Channel, mid-channel, Badarkhali Jetty ghat, Mouth of Bakkhali River and 06 No Jetty ghat of Bakkhali River.

The air temperature and wind speed was measured by the digital anemometer (Handheld Wind Speed Meter). The physicochemical properties of the surface water samples (0-0.5m) were collected by niskin water sampler and analysed directly in the field at each sampling stations were temperature, salinity and pH, by using an YSI water quality multi-probe, digital Refractometer, pH meter (Figure 2) and DO was analysed by in-situ DO meter (Figure 2). When doing the measurements, the probe was submerged fully into the water at least around 30 cm from the water surface and collecting water samples. From each sampling stations, 500 ml of water were 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.

Figure 1: Map showing the water samples collecting station in the Moheshkhali Channel.

Figure 2: (a) Multi-water analyzer (YSI Professional Series-626909-4, Made in USA); (b) In-Situ DO meter (SmarTROLL RDO CA30, Made in USA); (c) Seawater Refractometer (HANNA: HI 96822); (d) Niskin Water Sampler (Hydrobius, Made in Germany); (e) pH Meter (HANNA: HI 8424) and (f) Secchi Disk

Hydrochloric acid was used as preservative in these sample bottles and containing samples were sealed immediately to avoid exposure to air and placed into the safe place. A total of three replicates were taken for each

parameter at every sampling station. The sample bottles were screwed carefully and marked with the respective identification number. Surface water samples (0-0.5m) were collected for TDS & TSS analysis and those were determined by gravimetric method and EPA 02 respectively. Water samples for DO and BOD were preserved in BOD bottle for further lab analysis. Biological oxygen demand (BOD_5) was determined using the incubation method at 20ºCfor five days (APHA, 1995).

Results And Discussion

Assessment of physicochemical properties:

The study was conducted in winter season (January and February 2020) and early spring season (March 2020). From the observation of three months data, comparatively the air temperature was maximum in March 2020 than the January & February 2020 in high & low tide (Figure 03), wind speed was minimum in March 2020.

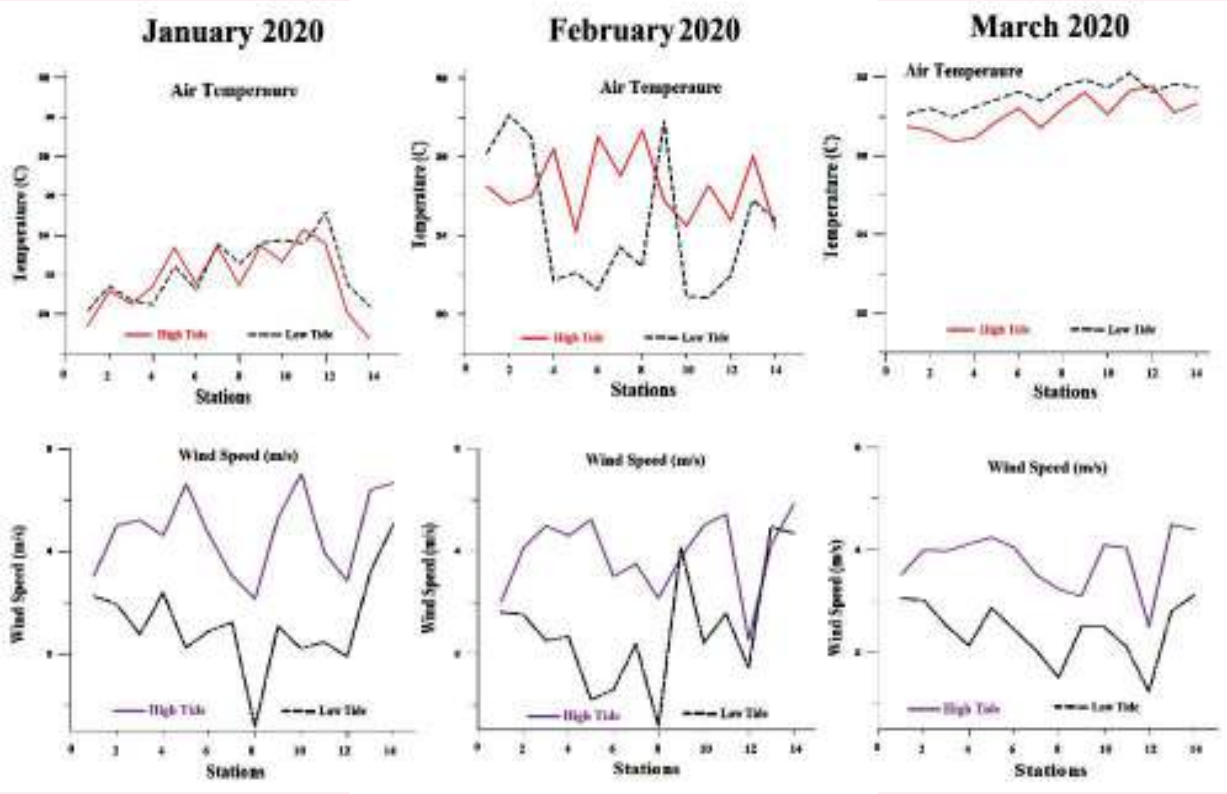

Figure 03: Difference of Air Temperature (AT) and Wind Speed (WS) among January, February and March 2020 in Moheshkhali Channel

The maximum wind speed was found in January 2020 in high tide. From the observation, wind speed was higher in high tide than the low tide condition (Figure 03). Concisely the water temperature (WT) was high in March 2020 than the January and February 2020 where cold WT was found in January 2020. The observation of WT data, the WT is higher in low tide than the high tide condition (Figure 04). Reversely, transparency of the Channel water was much more depth in high tide condition (Figure 04). The low water salinity was found in the Badarkhali Jetty ghat (St. 01) and 06 No. Jetty ghat of Bakkhali River (St. 12) respectively (Figure 05). The high water salinity was found in the downstream of the Channel. On the other hand, the water salinity of February 2020 was also higher than the water salinity of January and March 2020 due to less fresh water influx happen from the upstream of the Channel which connected with nets of Matamuhuri River and may cause of evaporation. From the observation of salinity data, the higher salinity is distinguished in high tide condition (Figure 05).

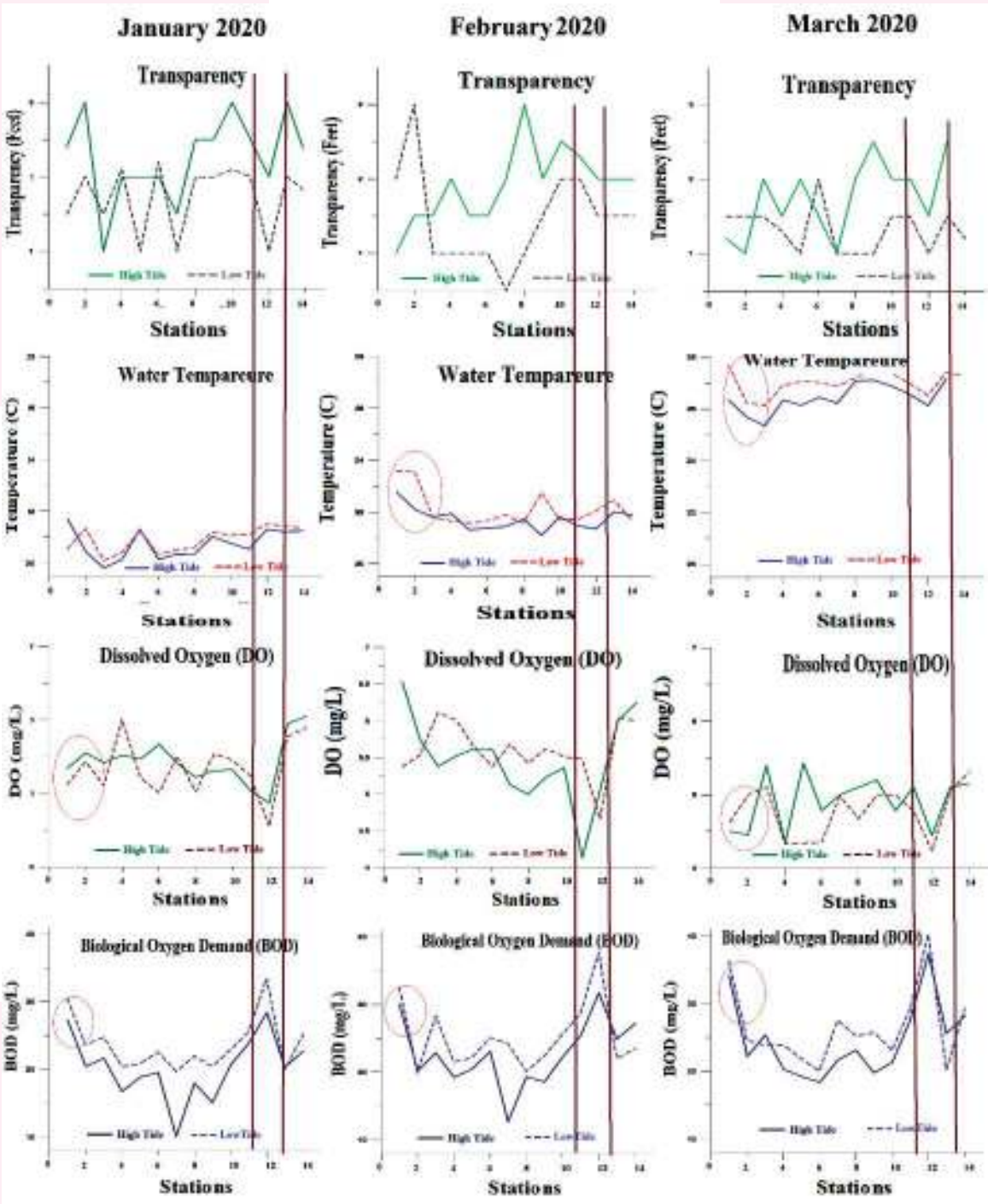

Figure 4: Difference of Transparency, Water Temperature, Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD) among January, February and March 2020 in Moheshkhali Channel

The lower pH was found in the Badarkhaki Jetty ghat, 06 No. Jetty ghat, and upstream of Moheshkhali Channel respectively. On the Contrary, the higher pH was observed in the downstream of the Channel which is connected to the open sea. From the observation, pH is also showed the similarity to salinity: pH is higher in high tide than the low tide condition (Figure 05). The lowest pH was observed in upstream of the channel which connect to the net of Matamuhuri River. The higher TDS were observed in the downstream of the channel especially St. 09, St. 10, St.13, St. 14 & St.03 (upstream of the channel) and 06 no Jetty ghat of Bakkhali River. The St. 13 &14 is

connected to the open sea and seawater contains more different kinds of inorganic salt ions and dissolved organic materials. The St.10 is located in the near downstream of the Channel. There is existing in high salinity water. The St. 03 and St.12 where surface water was not high saline as like as St. 05 but TDS was high due to anthropological activity (Figure 05). From the observation of TDS data, the higher TDS is found in high tide time than the low tide condition. Comparatively, higher total suspended solid (TSS) was found in the low tide condition in February 2020 except St.02 where TSS was maximum in high tide time (Figure 05).

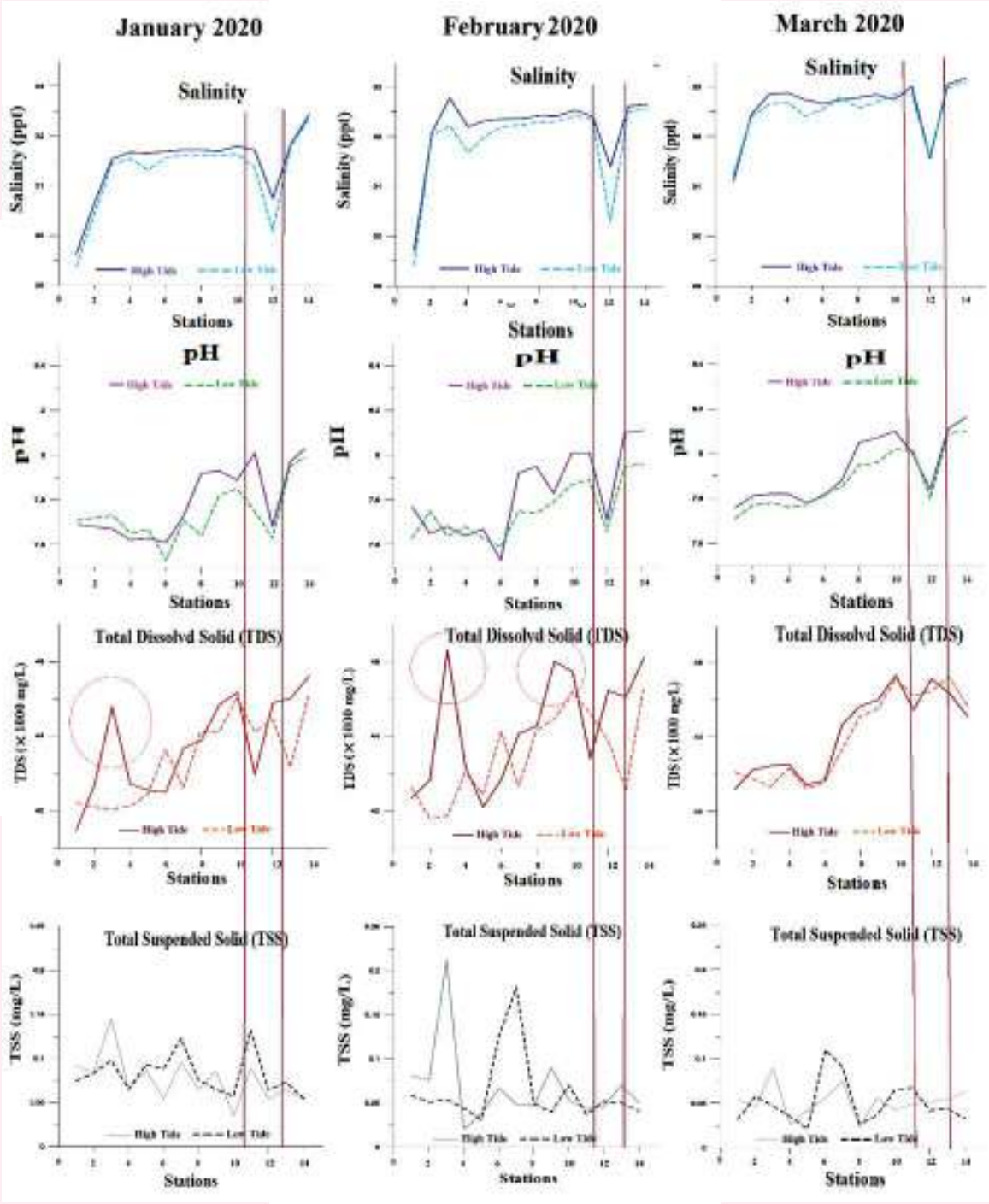

Figure 5: Difference of Salinity, pH, Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) among January, February and March 2020 in Moheshkhali Channel

The DO of January, February and March 2020 were fluctuated over the study period due to the abnormal north-east wind activity. The highest DO were found in St. 01 and St. 13 & 14 during February 2020 due to water sample was collected from the St. 01 in afternoon (4.05 pm) and basically DO in the normal water body, DO in the afternoon is higher than morning and noon of a normal day because of more photosynthesis activities happened in afternoon time of a day. In St. 13 & 14, DO were high in January and February 2020 due to presence of strong wind that help to well mixed the upper surface water. The lowest DO was found in St. 12 due to presence of polluted waters and low wind activity (Figure 04). From the observation of three month data of DO, the minimum DO was observed in the March and another observation is mostly higher DO was found in high tide condition. The BOD_5 of March 2020 is higher than the BOD_5 of January & February 2020. The highest BOD_5 were found in St. 12 and St. 01 during March and February 2020 due to these two stations are the Jetty Ghat where the of BOD_5 exists the tolerance level and considered as the polluted areas. There are existing different kind of human activities on the based on fishing trollers and boats. The lowest BOD_5 were found in St. 07 in January and February 2020 except March 2020. Mostly BOD_5 of March 2020 was higher than other two months (Figure 04). From the observation, the higher BOD_5 was found in low tide condition. Assessment of water quality data, channel water quality is going to pollute in some areas.

Conclusion

Moheshkhali Channel is economically important channel. Water quality of the channel play an important role for the channel ecosystems. The present study attempted to assess the water quality level of the channel. The Channel water is degraded by over fishing trollers, unplanned aquaculture, over practicing fisherman's boats, and passenger engine boats, different types of business boats, gumboots, speed boats and other activities e.g. drainage system, fertilizer, sewerage line etc. The finding of the research are:

- The air temperature and water temperature were high in March than January & February 2020.
- The wind speed (north-east direction) was high in January and February 2020 and high wind speed was observed in high tide period.
- The Channel water reveals polyhaline estuary in winter season.
- High water temperature & BOD_5 were observed in low tide than the high tide.
- High salinity, pH, TDS, DO were observed in high tide than the low tide.
- The water quality of 06 No Ghat (Jetty Ghat) is highly polluted, Badarkhali Jetty Ghat is polluted and downstream of the Channel water is slightly polluted.

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Occurrence and distribution of marine plastic debris on beaches in the coastal area of Cox's Bazar

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Abstract

Marine plastic pollution is one of the most severe problems in the marine environment. The purpose of this study was to estimate the spatial distribution, types, and characteristics of macro, meso, and microplastic in 17 location of Cox's Bazar Coastline. All surveys performed based on the guideline NOAA Marine Debris Program. This study examines marine debris mostly plastics in the using geographic information systems (GIS) & GPS, Clean Coast Index (Alkalay et al., 2007) and NOAA guideline to develop (1) a detailed map of intensity and distribution of plastic debris (2) results of baseline clean coast index (CCI) (3) a complete outline for a spatial database of shoreline plastic pollution of Cox's Bazar coastline. The mean abundances of large micro (1-5 mm), meso (5-25 mm) and macroplastic (>25 mm) along the strandlines of 17 beaches in cox's bazar coastline were 142, 25.64, and 0.276 items/m^2. As per clean coast index rate Cox's Bazar can be measured as "Moderate" (>6.055 plastic pieces/m^2).

Introduction

Marine litter or debris is a growing environmental problem worldwide (NOAA, 2014). According to National Academy of Sciences, USA marine litter is defined as "solid materials of human origin that are discarded at sea or reach the sea through waterways or domestic and industrial outfall". Basically There are two sources of marine litter: sea-borne and land based such as industrial wastes and litter originating from human activity on the beach (UNEP, 2005). According to the US Department of Commerce and the US Navy, approximately 80% of litter is washed off the land, blown by winds, or intentionally dumped from shore (The Ocean Conservancy, 2005). Plastic debris is one of the most challenging problems for marine environment because one of its features is that it can be degraded into smaller particles (less than 1 to 5 mm), referred to as microplastics, that even small organisms can ingest (Barnes D K A et al., 2009). Cox's Bazar coast is characterized by a rich diversity of natural, environmental, ethnic and economic resources and is among the country's most valuable assets. The quality of Cox's Bazar coast has deteriorated significantly over the last decade as a result of heavy tourist activity, heavy marine vehicle transportation and over population. In order to provide information regarding plastic waste contamination around Cox's Bazar coast, here we report findings from the first study on the distribution of macro, meso and large microplastic debris on 17 location in Cox's Bazar coastline.

Materials and Methods

Bangladesh is one of the largest deltas in the world, with a coast line of 710 km. Cox's Bazar is the southernmost part of Bangladesh which has an unbroken 120km sandy sea beach with a gentle slope) and is the tourist capital of Bangladesh. This study was conducted in Cox's Bazar coastline, 17 location/beaches were selected as sampling sites in Cox's Bazar coastline through purposive sampling (Figure 1). According to NOAA the plastic marine debris collected was classified into three size classes: large microplastics (1-5 mm), mesoplastics (5-25 mm) and macroplastics/debris (>25 mm) (Lippiatt et. al., 2013). Depending on the shores transects in each sampling unit (macroplastics/debris) covered approximately 50m of coastline and width covers approximately 20m or recent high tide line (along the strandline). For meso and micro plastics sampling, we placed small quadrats (1m x 1m), from which we collected sand to a depth of top 2-3 cm and sieved the sand sequentially with a 1 mm^2 stainless steel sieve. The sieved materials were stored in zipper bags and brought to the laboratory. The meso and microplastics were then identified and sorted using the naked eye. Field data collection occurred January over 2 weeks in the winter. Tools used consisted of a GPS handheld unit (Garmin e-trex 10), a 100-m engineer tape, four red surveying flags, and approximately 20 kg size transparent trash bags for collection of litter from the survey sites. Collecting complete and detailed data on a study sample site ranged about 2-3 hours, depending on intensity of debris.

Figure 1: Study area Cox's Bazar Coast

Results and Discussion

Macroplastics: The collection of 17 sampling unit around the coastline of all locations revealed multiple items of debris per data point throughout the entire study. Most of the collected plastic debris from all beaches fell within the size range of ~1-50 mm. Approximately 15 thousand pieces of debris was counted during the survey where more than 10899 counted plastic materials. The highest number of macrodebris/plastics found in fishing activity area where all boats and fishing net repaired. Most of the tourist found moderately clean because beach cleaning workers clean the coast whole day. According to Alkalay et al. the calculation of the CCI is presented in the following equation:

Clean Coast Index (CCI) = (Total litter on sampling unit/total area of sampling unit) x K,

Where CCI is the number of litter items per m^2, the total area of the sampling unit is generated by multiplying the sampling unit's length with the width and K is a constant that equals to 20 (Alkalay et. al., 2007).

In order to make the picture clearer for the public, results for appearance of litter on the coasts were graded as follows:

0-2 : very clean-no litter is seen
2-5 : clean-no litter is seen over a large area
5-10 : moderate-a few pieces of litter is detected
10-20 : dirty-a lot of debris on the shore
20 + : extremely dirty-most of the beach is covered with plastic debris.

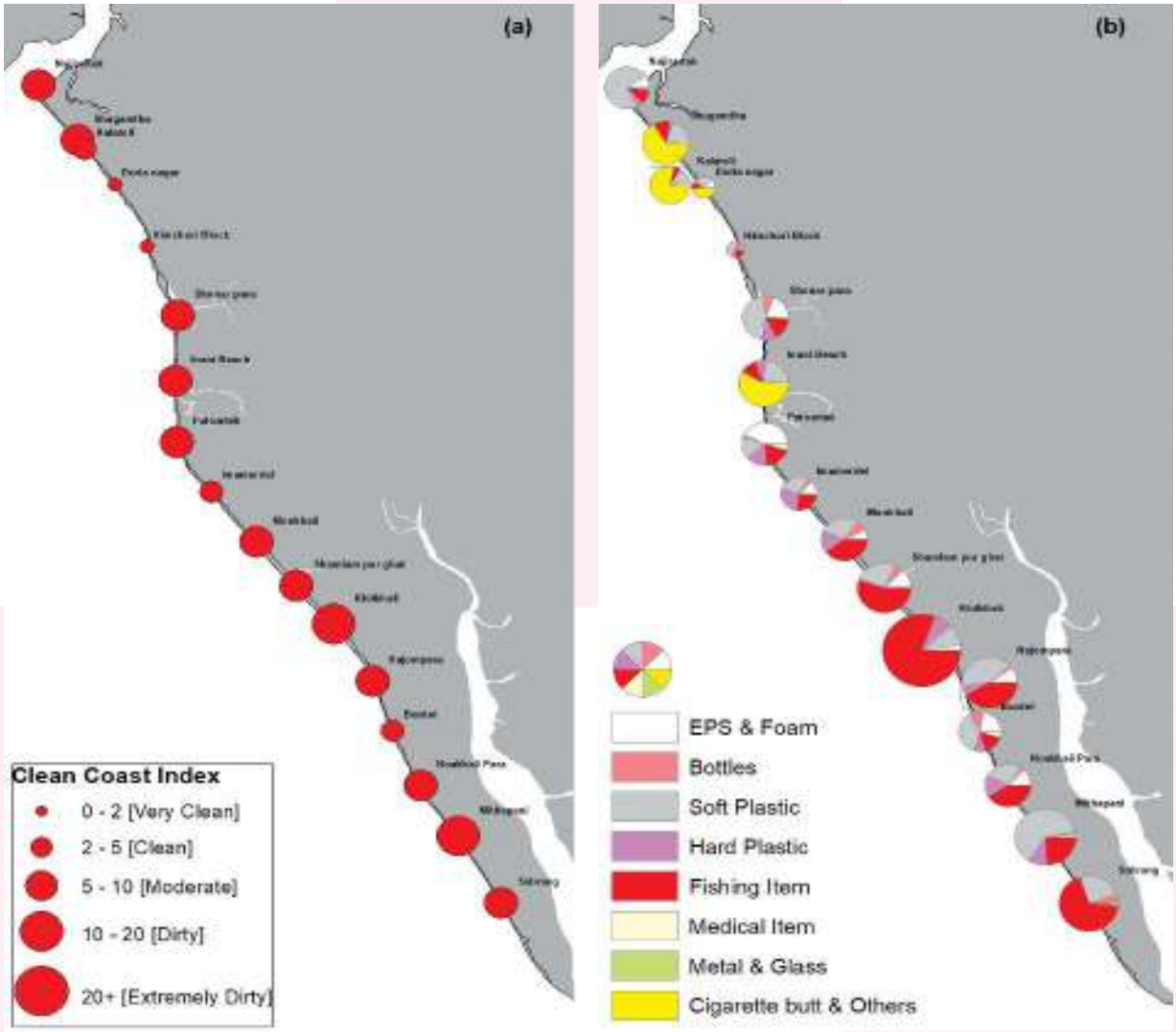

Figure 2: (a) Pollution status of cox's bazar coastline according to the clean coast index (CCI);

(b) distribution of macroplastics based on groups.

Usually marine litter is affected by the waves, tidal and wind effect its distribution is not constant. After storms, litter is usually found at the highest watermark or strandline also reaching the edge of the beach. During the tourist season, distribution of litter is affected mainly by tourist and local activity (Alkalay et al., 2007). Figure 2 map illustrated the results of baseline clean coast index (CCI) (figure 2a) and distribution of macroplastics (Figure 2b) of Cox's Bazar Coastline. According to clean coast index (CCI) 15% and 25% of the beach was very clean and clean respectively which is northern portion of Cox's bazar where tourist activity is quite high. 50% and 10% of the beach found moderate and dirty respectively which is southern (gently sloped sandy beaches) and south part (narrow rocky shores with beach rocks) of the Cox's bazar Coast. Most south part (sandy beach with dunes) of the coast locally named Shamlapur found close to extremely dirty (2% CCI) where tourist activity very limited but local bazar, fish market, fishing net repairing and others activity is very prominent. Southern part of the coastline mostly polluted by reared fishing net, rope and others fishing related things.

Litters intensity found highest southern coastline of the Cox's bazar. At Southern part where Fishing, fish market, local bazar are situated which dispose tons of waste in the open coast. Northern part of the coast appearances very low litter intensity, thousands of drinks bottles, chips, candy, pickle wrappers and polybags were thrown by beachgoers but all the waste were cleaned by Beach Cleaner.

Mesoplastics: Mesoplastics classification system was in 25 categories 4 groups (Foam, Hard Plastics,

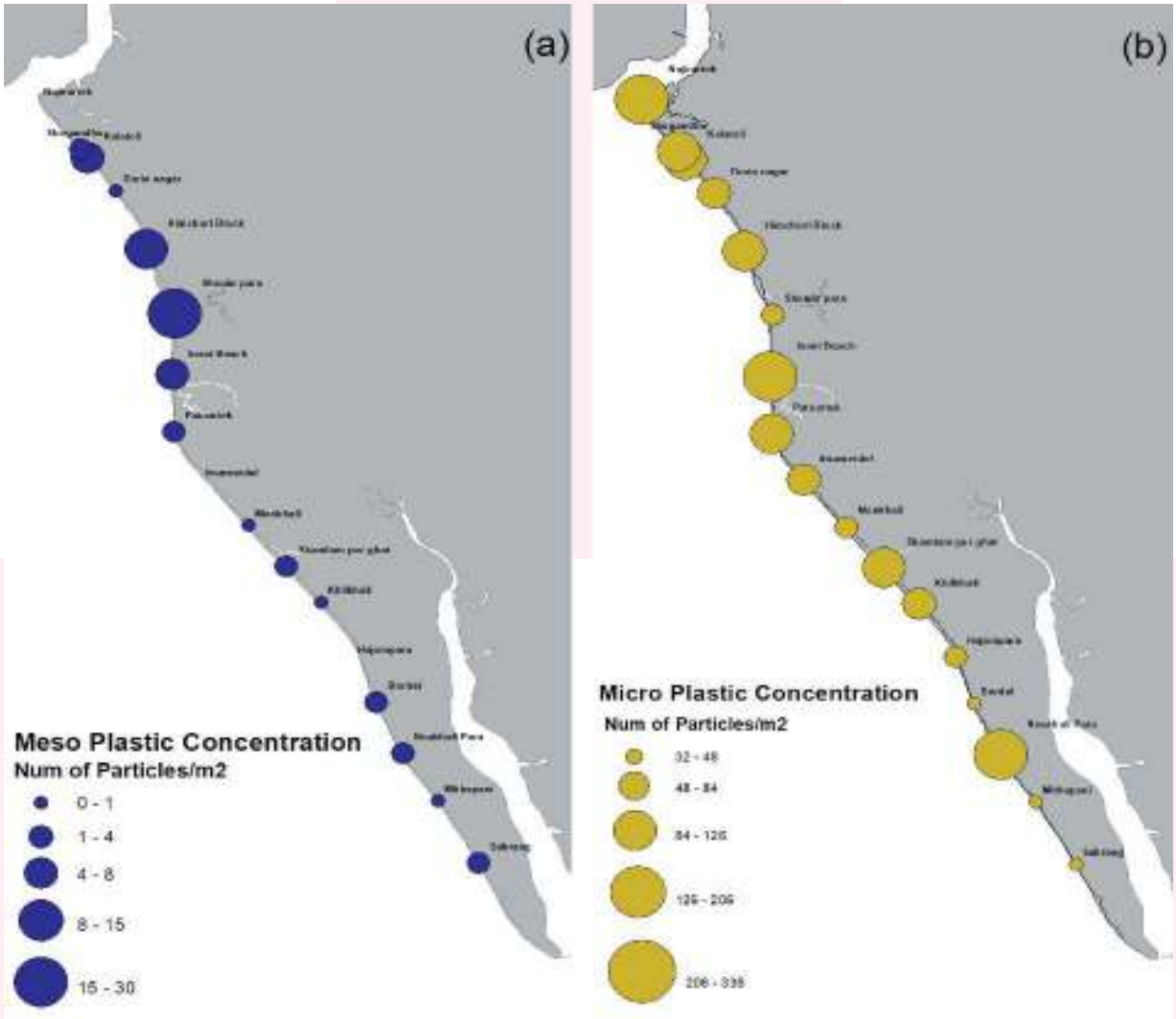

Figure 3: Spatial distribution of (a) mesoplastic and (b) microplastic density

Films/Soft Plastics and Line/Rope). This classification system has low error rate and more consistency in data analysis and therefore allows easy identification of changes in debris composition, source, and usage of items. A total of 584 mesoplastic items were classified into 25 categories and 4 major groups. Hard Plastics were the dominant mesoplastic category. Compositional profile by major groups revealed the following the order of abundance Hard Plastics 44% > Foam 21% > Lines/Ropes 17% > Flims/Soft Plastics 16%. All mesoplastics combined totaled an average of 25.64 items/m^2. Figure 3a map illustrated the spatial distribution of mesoplastics of Cox's Bazar Coastline.

Microplastics: A total of 2414 micro plastic particles were sampled in this survey. The identifiable micro-plastics (diameter 1–5 mm) were sorted into six groups: (1) Fragments; (2) Foam; (3) Filaments; (4) Line; (5) Primary Microplastics/Pellets and (6) Expanded Polystyrene (EPS). Among the identifiable micro-plastic fragments and Expanded Polystyrene (EPS) were the most commonly found, which contributing to 54% and 19% of the total observed microplastics. Line, Filaments, foam and Primary Microplastics/Pellets accounted for the remaining 11%, 9%, 4% and 3% respectively. Figure 3b map illustrated the spatial distribution of microlastics of Cox's Bazar Coastline.

Conclusion

The intentions of this work were to gain a baseline understanding of marine debris or litters in cox's bazar beach and to deliver a preliminary outline for future actions to address such issues in the country as well as add to global studies of marine debris in demonstrating the utility of GIS-based research. A total of 17 sampling units, covering 100 kilometers of coastline in Cox's Bazar were surveyed by 12-15 volunteers. In total, over 120 volunteer hours were spent detecting and recording around 15000 (including macro, meso and microplastics) pieces of plastic litter/debris. The mean abundances of large micro- (1-5 mm), meso- (5-25 mm) and macroplastic (>25 mm) along the strandlines of 17 beaches in cox's bazar coastline were 142, 25.64, and 0.276 items/m^2. Using the data collected in this study as a starting point offers a scientific basis for the country regarding marine debris issues and can encourage local community, students and researchers involvement through beach surveys and cleanup program. Marine litter/debris is a human caused problem, but it can be better managed if we know the locations of problem hotspots and if we learn ways to successfully promote proactive plastic pollution programs.

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Chapter 8

Oceanographic Data Center

Trend detection of temperature and rainfall in coastal region of Bangladesh

Mst. Tania Islam
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Preface

To identify and quantify the impact of climate change on socio-economic sectors and ecosystems, many global studies have been carried out and policy changes for mitigation and adaptation were recommended. In order to investigate the behavior of climatic and hydrological variables, several statistical and stochastic techniques are currently applied to time series.In the present study a statistical analysis of annual rainfall, maximum temperature, minimum temperature has been performed 69 years of data observed in 16 coastal area of Bangladesh. The research was aimed at addressing the national coastal area issues of climate change and was done by analyzing trend analysis of maximum temperature, minimum temperature and rainfall trends of 16 coastal areas of Bangladesh.

2018-2019

At a Glance

With the establishment of Bangladesh Oceanographic Research Institute (BORI), Oceanographic Data Centre (ODC) has been established as a countries first Oceanographic data centre. Oceanographic Data Centre of BORI is serving as a "data-primer" for students and those in other fields of research who are interested in carrying out research involving the analyses of data in the oceanographic sciences. The datasets include observations from conventional oceanographic sources such as stations and ships, from satellites, and analyzed grids produced at operational weather forecast centers. Rather, the focus is upon the broad characteristics of the data sources and the datasets. The characteristics of ODC are not only including the observed variables and their spatial and temporal extent but also common problems, data limitations and sources of error of oceanographic data.

Statistical Analysis and Future Prospecting of Non-conventional Marine Fisheries Resources in the Cox's Bazar District of Bangladesh

Mst. Tania Islam
Scientific Officer

2019-2020

General

In Bangladesh, discussions on blue economy started after the settlement of maritime boundary delimitation dispute with Myanmar and India. The award helped Bangladesh establishing sovereign rights over the living and nonliving resources of the Bay of Bengal in the Exclusive Economic Zone within 200 nm and in the continental shelf beyond 200nm. The concept of blue economy in our country can be developed as emerging sectors. Bangladesh has received entitlement to 118,813 sq. km in the BoB comprising her territorial sea and Exclusive Economic Zone (EEZ) (MoFA, 2014). Taking into account major river inlets and estuaries, which are together very much a part of the marine ecosystem, the total marine waters of Bangladesh stands at 121,110 sq. km of which coastal waters and the shallow shelf sea constitute about 20% and 35% respectively, the rest (45%) lying in deeper waters (Chowdhury 2014a). Within the BoB, Bangladesh has the widest shallow shelf region and providing a greater shallow bottom fishing area per unit length of coastline than its neighbors. The fisheries resources play a significant role in fulfilling the demand of animal protein and socio-economic development of the country. For example, more than sixteen million people (about 11% of total population) of Bangladesh directly or indirectly depend on the fisheries sector for their livelihood. The BoB of Bangladesh is blessed with rich coastal and marine ecosystems, hosting a wide range of biodiversity, such as fishes, shrimps, molluscs, crabs, mammals, seaweeds, etc. (Table 1). A number of surveys examined the status of marine fisheries resources between 1970s and 1980s (Table 2), but no recent and comprehensive knowledge is available on the fisheries stocks, systematics, biological and ecological aspects of the coastal and marine fisheries of Bangladesh (Hossain D.M.H et al, 2015).

Over the last 10-15 years, live giant mud crab (Scylla serrata) and estuarine eel (Muraenesox bagio) have been exported to East Asian countries. Less than 20% exported live crab come from crab fattening by the marginal farmers of Satkhira, Bagerhat and Cox's Bazar coasts. Moreover, the harvest of young and undersized sharks and rays are dried, while the large sharks are dumped overboard after removing their fins and some other body parts. The majority of phaisa (Setipinna phasa) caught in the coast are used to make fermented fish product.

A number of surveys conducted since 1958 to 1986, proved the potentialities of demersal fish, pelagic fish and shrimp stocks, but no survey was done since then. Detail survey for pelagic fish resources have not yet been carried out in Bangladesh marine waters.

There are many potentially important species for mariculture such as, seabass, grouper, pomfret, mullets, edible oysters (Crassostrea sp. Saccostrea sp.), pearl oyster, (Anadrasp.), green mussel (Pernaviridis), clam (Meretrixmeretrix, Marcia opima), sea snails, swimming crab, squid, cuttle fish, sea weeds, sea cucumber, star fish, etc (Hossain 2004). However, due to the lack of technologies and adverse nature of the weather and coastal topography the possibility of maintaining rafts, pens and cages in the marine waters seems bleak. Hence the above species may be adapted for coastal aquaculture.

Various frozen and dried marine products are produced and exported to many countries. Frozen products includes, mainly black tiger shrimp (P. monodon), some other shrimp and various white fish mainly Hilsa and pomfrets. Some value added frozen shrimp products like ready to eat and ready to cook products also produced and exported. Various dried and semidried products includes, ribbonfish, Bombay duck, croackers, pomfrets, air-bladder of various fish, shark fins and skin of skates. Some other products include shark liver oil, fish scale, dried sea weed, ornamental shells of molluscs and corals. Moreover, export of lives crabs are increasing day by day. The quality improvement and quality control as well as development of various new and new value added products targeting the national and international markets are the main issues in these fields.

Many species of fish have export potential. Product diversification and value addition in fish and shrimp processing and exploring new markets and consolidating the existing ones may form the core strategy to increase exports.

According to the United Nations Department of Economic and Social Affairs (UN-DESA 2009), the world population is expected to grow from the present 6.8 billion people to about 9 billion by 2050, mostly in developing countries (5.6–7.9 billion). With a growing world population and recurrent problems of hunger and malnutrition plaguing many communities, e.g. in South Asia and Sub-Saharan Africa, food security is of major societal and international concern. Marine fishery resources are an important source of proteins, vitamins and micro nutrients, particularly for many low-income

populations in rural areas, and their sustainable use for future global food security has garnered significant public policy attention. In the context of variable and changing ecosystems, and despite some progress, the challenges of maintaining or restoring fisheries sustainability and stock sizes, reducing environmental impact and degradation, and improving local and global food security remain immense. Marine capture fisheries are a critical component of this picture. Their production is close to the maximum ecosystem productivity (NRC 2006), cannot be increased substantially in the future and could decline if not properly managed, leaving the world to solve a significant new food deficit. The 2002 World Summit on Sustainable Development (WSSD) called on States to 'maintain or restore stocks to levels that can produce the maximum sustainable yield with the aim of achieving these goals for depleted stocks on an urgent basis and, where possible, not later than 2015'. The world is far from meeting this target, and this paper addresses the underlying issues and considers the future implications.

Objectives

- To accumulate the data of historical production of Non-conventional marine fisheries & algae production in Bangladesh for data center.
- To identify and quantify the total yield and harvest of non-conventional fishery by products.
- To find out present production status of Non-conventional marine fisheries & algae production in Cox's Bazar region .
- To determine their potential economic importance.
- Future direction and prospecting trend of Non-conventional marine species of the study area.

Data Sources

Primary data is collected from 6 stations in Cox's Bazar, Moheshkhali, Teknaf, Reju khal, Shahporir dwip and Shamlapur areas.

Secondary data is collected from Fisheries Department, BFRI, Scientific journals and reports. Long time historical data such as the data from the period of 1948 to present time will be collected for the fisheries resources production of Bangladesh. It will be stored as a part of data centre activity for further application of such data.

Methodology

Research Approach and Technique: The quantitative data were collected by structured survey while qualitative information was explored by case studies and observations as the primary tools following Blaxter et al. (1996).

Sampling: The survey was conducted in the fisherman, local bazaar and fishery firm of 6 study areas. Purposive random sampling technique was applied in collecting the data.

Quantification and Value Estimation: The non-conventional marine fish by products were assessed for a period of one year. Value of the byproducts were estimated in local currency Bangladeshi taka (BDT) was converted into US dollar (US$).

Data Entry, Editing and Analysis: The questions were post coded when needed, entered on the computer using Microsoft excel. Checked after entry and analyzed using statistical software SPSS version 10.0. Descriptive statistics was used in analysis and graphical representation of non-conventional marine species.

A catch assessment survey is formulated to catch of the different sectors of fisheries to estimate yearly total nonconventional marine fish production for Statistical purposes in Bangladesh.

- Each of the catch assessment surveys is designed as a sample survey of simple random sampling for estimating total catches (production) on the basis of sample catch data.
- For selecting the sampling units such as sample fisherman and for calculating raising factors for estimating total catches by 6 stations, a frame survey has been conducted in advance of the initiation of each catch assessment survey to provide a complete list of the sampling units such as fisherman together with basic information such as the number of fishing boats.

This research will be divided into two categories. Such as statistical research and prospecting research. Samples will be collected into 3 groups. Such as fisherman, local bazar and fishery firm. Sample will be selected using simple random sampling and with a pre-tested interview schedule.

Result and Discussion

Species	Total production (kg)	Income (tk)
Octopus	126585	63292500
Crab	390041	117057050
Musseles & abalones	4745	1423500
scallops	1255	89900
Ray fish	4584840	1583307500
Squids	863201	211127850

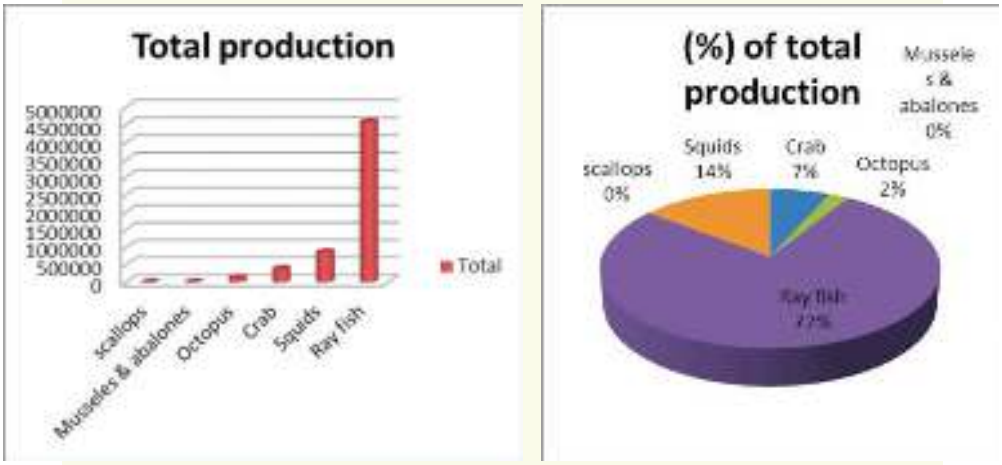

Figure 1: Species wise total production of nonconventional marine species

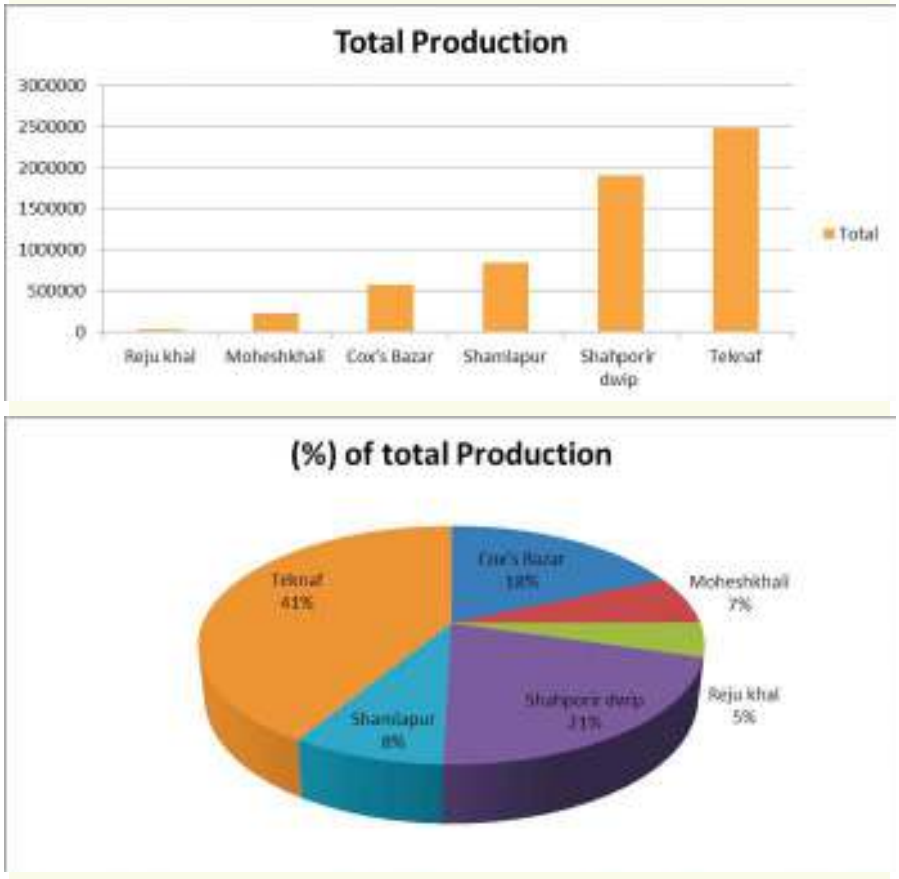

Figure 2: Station wise total production of nonconventional marine species

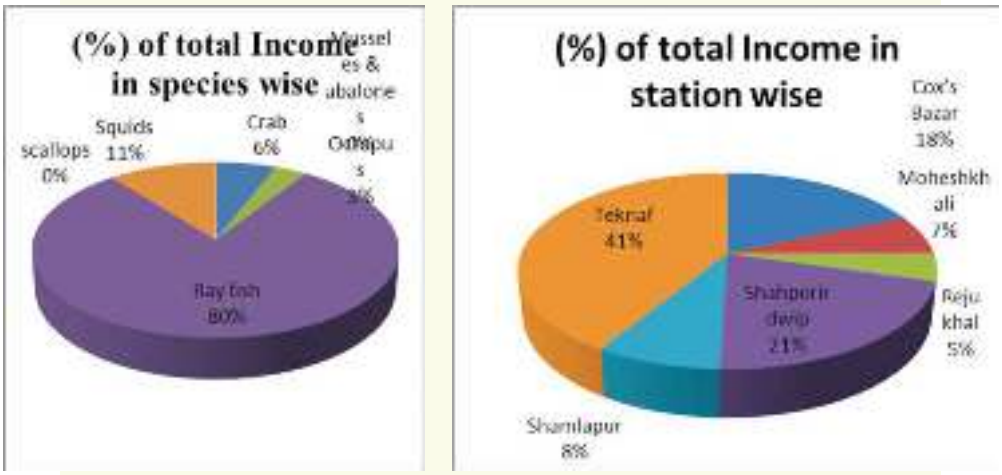

Figure 3: Total Income of nonconventional marine species

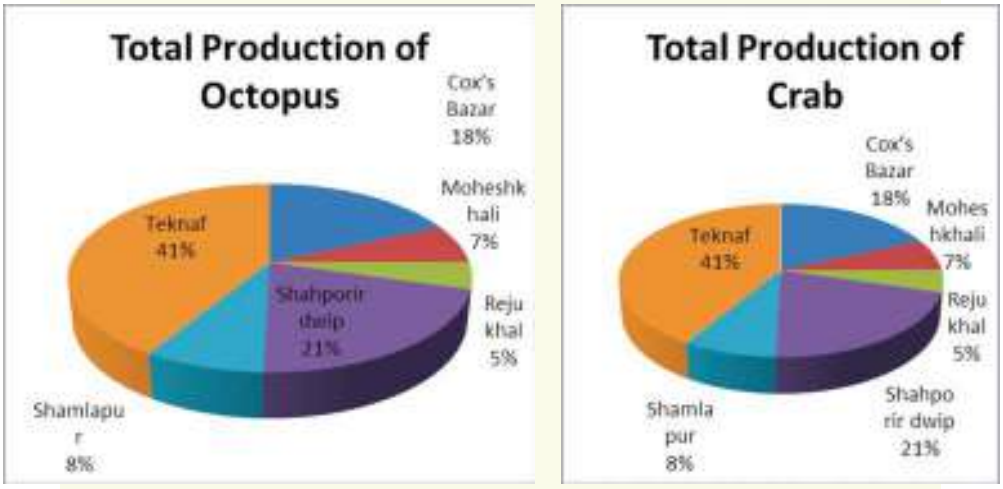

Figure 4: Total production of octopus & crab

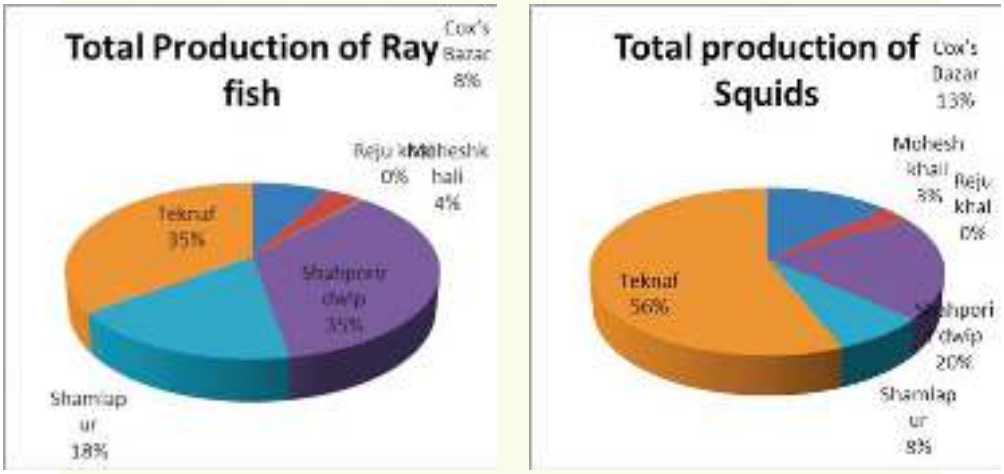

Figure 5: Total production of Ray fish & squids

Results and Discussion

Current yield of total catch production of Octopus is 126.585 mt, crab 390.041 mt, squids 863.201 mt, Musseles & abalones 4.745 mt, scallops 1.255 mt, Ray fish 4584.84 mt per year respectively as observed in this study in the 6 stations of the Cox's Bazar. However, the total income of Octopus is 63292500 tk, crab 117057050 tk, squids 211127850 tk, Musseles & abalones 1423500 tk , scallops 89900 tk , Ray fish 1583307500 tk per year respectively. Above the figure we see that the percentage of octopus is only 2%. Because maximum fishermen don't know that it is a food item. Maximum fishermen know that it is prohibited for Islam. And they have not proper fishing net to catch Octopus. Musseles & abalones only see in Moheshkhali station. That's why its amount low than other item. Because most of the persons don't know used of it. From the figure we see that, percentage of crab is 7%. Reason of this low percentage is maximum fisherman cannot sell accurate price. They sell it at low price than other conventional fish. And most of the place fisherman cannot get dealer to sell this item. That's why most of the time they waste it. From the figure we see that maximum production comes from Ray fish. Because one Ray fish size average 14 kg. So the Ray fish carry most percentage of production and economic value. We also see that maximum production lies in Teknaf station. Number of boat is high in Teknaf than other 5 stations. And minimum production lies in Reju khal station. Because here number of boat is minimum than other station and they have not those type of fishing net by which catch non-conventional marine species. Cost for marine fish production are grouped into two categories as operating cost and fixed cost. The cost of fuel was the major factor contributing to the high running cost in this sector. Running cost is the largest portion accounting to the operating cost as well as total cost. The crews per trip are 6 for fishing board. They stay in the sea average 6 hours. They go into the sea average 22 km in winter season. Annual fishing days was found to be 179 days in fishing crafts. Those are the cause of minimum catch of our marine food. Another causes is maximum people in coastal areas don't know those items are food items. Maximum people know that these items are prohibited for Muslim people. That's why they are not interested in catch these item. Total production and Income will be increase if all fishermen specially involved in this sector in which non-conventional fishery by products. Therefore, the prospect of improving the livelihoods through increased boat and learning about nonconventional marine species and income by selling those item by products is vivid.

Summary and Conclusion

In conclusion, the Bangladesh marine non-conventional fisheries item have ample scope of development to strengthen the national economy. The fisheries resources play a significant role in fulfilling the demand of animal protein and socio-economic development of the country. For example, more than sixteen million people (about 11% of total population) of Bangladesh directly or indirectly depend on the fisheries sector for their livelihood. The crews per trip are 6 for fishing board. World population is a key driver of seafood demand and fisheries development. The projected increases in global population also suggest continued migration to coastal areas with accompanying development pressures, and increasing gaps between wealthy and poorer nations and peoples. Half of the world population lives within 60 km of the ocean and three-quarters of the large cities are located by the coast. By 2020, it is projected that some 60 per cent of the world population (about 6 billion) will live in coastal areas (Kennish 2002, in UNEP 2007). By 2050 it is expected to reach 9 billion (UN-DESA 2009) and according to UN-Habitat (2009), globally, 70 per cent of this population will live in urban centres. Most of the megacities (over 20 million inhabitants) will be in the coastal zones, looking for food and livelihoods. Demand for fish as food is particularly high in the wealthier parts of society and demand increases with the economic level of development and living standards. This demand has been rising in both the developed and developing world at more than 2.5 per cent per year (Peterson & Fronc 2007), and as wealth increases in highly populated countries such as China and India, demand levels are likely to rise more strongly. To realize the potential, there is a need to adjust the existing laws and legislation of the country for integrated resource management and for conservation of the non-conventional marine fisheries resources. Fishermen, fish farmers, traders, processors, and general people of Bangladesh as a whole need to understand these issues, to be involved in the formulation of management plans, and to benefit from the whole process. The management measures should include regulating non-conventional marine fishing intensity at a sustainable level, implementation of those plan, and allocation of resources (finance, manpower) for fishermen. Well-trained, skilled and educated human resources are the driving force of the

development of an economy, who can participate in the globalization of business and the accompanying technological revolution. Dynamic and sustainable development is not possible without skilled work force. Having assessed the need of world market and local industry, appropriate courses on marine science/oceanography, ocean and coastal engineering, maritime education and trade are essential to introduce at tertiary education system. Concerned government departments, development partners, researchers and non-government organizations can play important role in the wide-ranging advancement of the non-conventional marine fisheries sector.

Recommendations

1) Information asymmetry. At present, there are no reliable monitoring data on stock status or catch by type and volumes to allow for identify accurately.

2) Lack of access to reliable infrastructure and equipment to transport and catch of nonconventional species.

3) The lack of access to responsible finance is also closely linked to the absence of postharvest value added in the domestic market.

4) Lack of knowledge and proper training of the Coastal areas people.

5) There was no long time non-conventional data that's why we can't proper future forecast of estimation.

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Scientist

Name	: **Mst.Tania Islam**
Designation	: Scientific Officer
Education	: BSc. (Hons) & MSc-Statistics
Trainings	: • Training Course on Oceanography: Principle & Application-National Oceanographic And Maritime Institute (NOAMI), Bangladesh. • Introduction to data science. • Data analysis with MATLAB and its applications in ocean modelling. • Data analysis using python. • Training on machine learning. • Training course on 'New Rhythms in the Tropical Indian Ocean'. • Training course on 'Deep data'. • Understanding Sea Level: Data analysis and applications. • Master class on Deep Learning. • Study and development of mineral resources of the oceans. • Training on GIS and Remote Sensing.
Research Interest	: Oceanographic Data Analysis, Data Management, Ocean Modeling, Ocean Monitoring & Forecasting, Statistical Analysis, Remote Sensing (RS) and Geographic Information System (GIS), Data science: Machine Learning, AI
Skills	: Fortran, Python, SAS, R, MATLAB, SPSS, Minitab, Stata, XlSTAT, Arc GIS 10.2.

Chapter 9

Blue Economy

Plans of BORI for Blue Economy (2018-2020)

Bangladesh Oceanographic Research Institute (BORI) is working to conduct all the activities as a focal point of Bangladesh at national and international levels in the field of oceanography and Blue Economy in the context of research and development. BORI developed different types future plan based on Election Manifesto, 2018 (Chapter 3.22), Short-mid-long term plan based on Blue Economy and future plan based on the year of 2021, 2030 and 2041.

Terms	Plan	Program Description	Time Period (Fiscal Year)	Probable Budget	Source of Budget	Present Achievement (up to December, 2020)	Required Component
Short Term	Identification of Geologically important areas and possible resources by collecting baseline data in the south part of eastern coast.	Coastal areas of Bangladesh are divided into 3 zones namely Eastern, Middle and Western. Identify existing resources by determining geological parameters as well as analysis of sea water sample & bottom sediment of near-shore and coastal areas of the eastern part (from Cox's Bazar to Saint Martin's Island) in these three zones.	Short term (2 years) 2018-2019 to 2019-2020	40 Lac	Revenue Budget (Special Allocation)	According to research results 8-18% heavy minerals have been found in the Cox's Bazar sea area. Technical report has been sent mentioning research results. **Progress: 100%**	
	Determination of Baseline data related to Biological Oceanography	Identify seaweed samples collected from the coast of St. Martin's Island of Bay of Bengal. Publish taxonomic book with images- "Marine Algae (Seaweed) of Bay of St. Martin's Island, Bangladesh".	Short term (2 years) 2018-2019 to 2019-2020	50 Lac	Revenue Budget (Special Allocation)	Sample collection and sea cruise have been done by R&D projects in 2018-19 and 2019-20 fiscal years. Already 72 species of Seaweed is identified by sample analysis. Publish taxonomic book with images- "Marine Algae (Seaweed) of Bay of St. Martin's Island, Bangladesh" is on progress. **Progress: 95%**	
	Identify the quantity of zooplankton in the Bay of Bengal and publish book.	Identify zooplankton by collecting samples from the coast of Bay of Bengal to deep sea area.	Short term (2 years) 2018-2019 to 2019-2020	20 lac	Revenue Budget (Special Allocation)	BORI scientists collected samples of zooplankton from deed sea jointly with Fisheries Research Institute using RV Dr. Fritjof Nansen Ship of Norway. Zooplankton is identified by analysis from those samples of Bay of Bengal. Publish taxonomic book with images is on progress. **Progress: 80%**	
	Aquaculture	Select places for aquaculture (cage culture) by identifying different areas and implement a pilot culture.	Short term (2 years) 2018-2019 to 2019-2020	20 lac	Revenue Budget (Special Allocation)	Planning is in progress to convert this program into midterm.	
	Baseline data enrichment related to Chemical Oceanography	Baseline data enrichment of Chemical Oceanography in the coastal and near-shore area of eastern part.	Short term (2 years) 2018-2019 to 2019-2020	20 lac	Revenue Budget (Special Allocation)	Sample collection for this research is completed on October to December, 2019 and January to March, 2020 from eastern coast of St. Martin's to Moheshkahli Island. Due to COVID-19 situation sample collection is hampered for May & June, 2020 time period. A new proposal is sent for 2020-21 fiscal year. **Progress: 70%**	
	Reduce pollution of the coastal areas	Prevent plastic and waste material pollution of 250 km eastern coastal area of 720 km long sea beach of Bangladesh. To prepare marine litter action plan and implement it. To prevent ocean and coastal pollution of Bangladesh, national and international laws and regulations are to be implemented and save the ocean environment in a sustainable manner.	Short term (2 years) 2018-2019 to 2019-2020	20 lac	Revenue Budget (Special Allocation)	Related projects have been implemented from St. Martin's to Moheshkahli island in 2018-19 and 2019-2020 fiscal years. Sea cruse is done for sample collection in February, 2020 of 1st phase and March, 2020 of 2nd phase. Due to COVID-19 situation sample collection is hampered for May & June, 2020 time period. Report preparation is in progress. A new proposal is sent for 2020-21 fiscal year. **Progress: 70%**	

	Data collection in a test basis for proposed Data Center and regular update program	Forecasting by data collection and analysis of coastal weather.	Short term (2 years) 2018-2019 to 2019-2020	10 lac	Revenue Budget (Special Allocation)	Data collection and analysis is completed. Report writing is in progress. Two research papers published in international journal already. Research result presented in international seminar. **Progress: 100%**	
		To start data collection by setting up at-least one Data Buoy as a pilot project in Rezu khal beside marine drive road.	Short term (2 years) 2018-2019 to 2019-2020	30 lac	Revenue Budget (Special Allocation)	Specification and possible budget to collect these equipments in 2019-20 fiscal year has been prepared.	Budget allocation to set up Buoy
	Marine affairs related skilled manpower development with sea related awareness program	To develop skilled manpower, road map preparation with implementation approaches for national and international trainings and seminars will be programmed for the scientists.	Short term (2 years) 2018-2019 to 2019-2020	100 lac	Revenue Budget (Special Allocation)	12 scientists of BORI got 15 days training from NIO, India. DG, BORI attended oceanography related seminar at TIO, China; TIO agreed to train BORI scientists. 3 scientists got RS training. 5 scientists got training from NOAMI. Beside these, 15 officers got foundation training from NAPD. Discussion with NAHRIM and other oceanographic institutions is in process to train scientists. In this regard, a team from Malaysia visited BORI and proposed to sign MOA.	To sign co-operational MOA with experienced and skilled countries of oceanographic research.
Mid Term	Establish marine aquarium	To establish a modern research oriented aquarium in BORI.	Mid term (4 years) 2018-2019 to 2021-2022	39,577 crore	Annual Development Program (ADP Budget)	A PEC meeting is conducted in Planning Commission on 25/03/2018. According to the recommendations of PEC a revised DPP is sent in the Ministry. Information of this DPP is uploaded in AMS/RAMS of the ministry. Now the DPP is in planning commission for subsequent review work. Regular communication is going on for updated information of approval.	To approve DPP
	BORI Project (2nd Phase)	Development of physical structure with other facilities, warehouse and workshop set up, establish oceanographic data center, procurement of research ship and scientific laboratory equipments for BORI.	Mid term (4 years) 2018-2019 to 2021-2022	750 crore	Annual Development Program (ADP Budget)	Research and development expenses are estimated in the 2nd phase DPP of BORI. Proposed DPP is sent to planning commission after PSC meeting. Planning commission advised to attach PCR of 1st phase and resubmit with amendment. After refinement, the DPP is sent to the ministry on 03/01/2019. In this regard, a PSC meeting is held in the ministry. According to PSC decision, 10 recommendations are noted. Following this, a letter was sent to BCC. BORI got draft of data center already. Beside this, according to recommendation specification, primary design and estimation compilation are completed for 30 meter long research ship from Khulna Shipyard. Design compilation is on going in the department of Architecture. Information of this DPP is uploaded in AMS/RAMS of the ministry.	To complete architectural design compilation from the department of architecture

	Physical and Space Oceanography related Base Line data determination.	Base line data collection of physical parameters (ex- wave data, tide data, current data; other data of temperature, salinity, depth etc.) from the coastal and near-shore area of east and west zone of the 3 coastal zones of Bay of Bengal.	Mid term (5 years) 2018-2019 to 2022-2023	200 lac	Revenue Budget (Special Allocation)	Most of the physical parameters are determined from the near-shore of the east coast of the 2 coastal zones. Rest of the samples is collected from Moheshkhali and Kutubdia in 2019-2020 fiscal year. 45% research activity is already completed.	Ship from NAVY/DOF Set up one tide gauge in the coastal area
	Determination of biochemical composition of non-conventional animals	Determination of biochemical composition of non-conventional animals of coastal area of Bangladesh such as-snail, oyster, crab, kuchia etc. Technological innovation of sustainable and easy culture system and disseminate it widely in the field level.	Mid term (5 years) 2018-2019 to 2022-2023	100 lac	Revenue Budget (Special Allocation)	Project related to culture of non-conventional sea invertebrate (oyster) and marine invertebrate near rezu khal has been approved in BORI. Sampling is going on. Report writing is in progress. **Progress: 45%**	
	Identification of Geologically important areas and possible resources by collecting baseline data in the eastern coast.	Identify existing resources by determining geological parameters (ex-mineralogical data, sediment character, geological map, tectonic movement, erosion & deposition, valuable ore related baseline data) of near-shore and coastal area of eastern zone (from Feni to Saint Martin's Island) of three coastal zones.	Mid term (5 years) 2018-2019 to 2022-2023	80 lac	Revenue Budget (Special Allocation)	Half of the works (about 3100 sqkm) of sample collection and analysis is completed of three coastal zones.	Research vessel or boat management
	Checklist of important animals and ocean biodiversity by collecting baseline data related to biological oceanography	Quantify the amount of agar & carrageenan and analyze biochemical composition of seaweed by collecting samples from St. Martin's island of Bay of Bengal. Seaweed identification for agar & carrageenan production and work for techniques to culture and produce in the field level.	Mid term (5 years) 2018-2019 to 2022-2023	80 lac	Revenue Budget (Special Allocation)	BORI approved project related to this research works in 2019-2020 fiscal year. From 86 identified seaweed species, 20 species are commercially important. BORI approved research project for commercial use and culture of 6 seaweeds. **Progress: 45%**	Analytical service from BCSIR/BAEC
	Aquaculture	Implement pilot project of Cage Culture in specified areas	Mid term (5 years) 2018-2019 to 2022-2023	200 lac	Revenue Budget (Special Allocation)	BORI is planning to run this project form development sector.	Need technical consultation
	Identify the areas of oil spill and ways to come out from its impact	Determine the effect of oil spill in the coastal and near-shore area among the three coastal zones	Mid term (5 years) 2018-2019 to 2022-2023	100 lac	Revenue Budget (Special Allocation)	Preliminary steps are taken for this kind of project	Ship from NAVY/DOF
	Marine affairs related skilled manpower development with sea related awareness program	Awareness raising programs to save coastal forest and coastal animals. It will ensure tourism development with environmental condition.	Mid term (5 years) 2018-2019 to 2022-2023	100 lac	Revenue Budget (Special Allocation)	Training program is ongoing for scientists and officers. Already got training form NIO, Goa, India. Discussion with NAHRIM and other oceanographic institutions is in process to train scientists. Travel report and results are sent to the ministry.	

Long Term	Determination of water quality, productivity and location of fishes based on physical and space oceanography baseline data.	Develop local algorithm by collecting chlorophyll data and other physical data. By this process, using satellite image water quality, productivity and location of fishes will be determined.	Long term (above 5 years) 2018-2019 to 2027-2028	500 lac	Revenue Budget (Special Allocation)	Planning for related project is accepted. Long term project activity through short term is ongoing. **Progress: 25%**	Collect satellite image. Ship of NAVY/DOF
	Determination of Geological Oceanography related baseline data.	Identify existing resources by determining geological parameters (ex-mineralogical data, sediment character, geological map, tectonic movement, erosion & deposition, sub-surface core data, valuable ore related baseline data) of near-shore and coastal area of three coastal zones.	Long term (above 5 years) 2018-2019 to 2027-2028	500 lac	Revenue Budget (Special Allocation)	Long term project activity through short term is ongoing. **Progress: 25%**	Ship of NAVY/DOF Collect Gravity Corer
	Baseline data collection of biological and chemical oceanography in the port areas	Monitoring real status of ballast water management in the port of mongla and chottogram. Identify invasive species and take timely sustainable steps to block their entrance.	Long term (above 5 years) 2018-2019 to 2027-2028	100 lac	Revenue Budget (Special Allocation)	Related project adoption planning is completed.	Approval from port authority
	Magnetic Survey	Magnetic survey in the territorial sea & EEZ of the Bay of Bengal and identify areas of Iron bearing mineral resources. By this process, magnetic minerals with economic minerals will be identified.	Long term (above 5 years) 2018-2019 to 2027-2028	100 lac	Revenue Budget (Special Allocation)	Expense estimation is incorporated in the BORI 2nd phase DPP. Reformation of DPP is ongoing. DPP will be sent in the ministry within January.	Ship of NAVY/DOF Marine magneto-meter
	Gravity Survey	Collect economic and scientific information, determination of Geod and know geological history by using gravity survey in the territorial sea and EEZ of the Bay of Bengal	Long term (above 5 years) 2018-2019 to 2027-2028	100 lac	Revenue Budget (Special Allocation)	Expense estimation is incorporated in the BORI 2nd phase DPP. Reformation of DPP is ongoing according to PEC. DPP will be sent in the ministry within January.	Ship of NAVY/DOF Marine Gravity-meter
	Determination of Biological Oceanography related baseline data.	Coral rehabilitation and production in the St. Martin's island which will increase biodiversity index of that area. This project will be expanded upon its success. It will also increase tourism.	Long term (above 5 years) 2018-2019 to 2027-2028	100 lac	Revenue Budget (Special Allocation)	Long term project activity through short term is ongoing. **Progress: 20%**	

	Oceanographic Data Center	Ocean related information and technology enrichment with data and development expansion.	Long term (above 5 years) 2018-2019 to 2027-2028	4000 lac	Annual Development Program (ADP Budget)	Expense estimation is incorporated in the BORI 2nd phase DPP. Reformation of DPP is ongoing according to PEC. DPP will be sent in the ministry within January.	Approve DPP
		Develop ocean observation system by establishing data buoy in different areas of ocean. Real time ocean monitoring by setting up at-least 8 data buoy in the ocean.	Long term (above 5 years) 2018-2019 to 2027-2028	200 lac	Annual Development Program (ADP Budget)	Expense estimation is incorporated in the BORI 2nd phase DPP. Reformation of DPP is ongoing according to PEC. DPP will be sent in the ministry within January.	Approve DPP
	Awareness Raising Program	According to the road map of awareness raising, 50% people of the coastal areas will be under this program	Long term (above 5 years) 2018-2019 to 2027-2028	500 lac	Revenue Budget (Special Allocation)	Related project adoption planning is ongoing for long term.	

Potential Research Sector for Blue Economy Support of Bangladesh:

There are six major research field in oceanography can be revealed in Bangladesh for Blue Economy development is summarized below-

- Physical and space oceanography branches have very potentiality to monitor physical parameter such as sea surface temperature, tide, wave, current, nutrition, chlorophyll etc. to find out potential resource of fisheries and renewable energy from ocean sources. Space oceanography can be applied to measure potential fishing zone identification in Bay of Bengal.
- Geological oceanography research activity can done to find out marine mineral resources as well as source of industrial materials such Bay of Bengal have the potential zone for Phosphorite and Yttrium deposit which is very important source of Rare Earth Element (REE), the coastal and nearshore area have potentiality of heavy mineral deposit. Besides Lime Mud, Carbonated sand and construction sand can be collected form Bay of Bengal. There have possible source of Gas Hydrate in the Bay of Bengal (assumed 300 TCF reserve present in the continental shelf and continental slope zone of Bay of Bengal.
- Chemical oceanography branch is very potential sector for the development of ocean based medicine, cosmetics and minerals in Bay of Bengal. Besides several service such as oil spill management, chemical pollution and ocean acidification measurement and monitoring can be done in this field.
- Biological oceanography is most potential sector in the oceanography field of Bangladesh. Because of river discharge lots of nutrition comes with the sediment in the Bay of Bengal, which can be used for the potential development of mericulture in the coastal and nearshore area. Besides biochemical composition of marine organism, fisheries development, seaweed culture (marine algae) field have very potentiality in this area.
- Environmental measurement and monitoring of ocean, plastic and microplastic pollution monitoring, EIA support etc. can be taken under controlled by environmental oceanography research. Besides Oceanographic data management, application, dissemination and ensure the information of ocean baseline data can be arranges. Ocean observation system (data buoy) and monitoring of ocean can give us surveillance opportunity of ocean parameter and change.

Chapter 10

Admin Planning & Finance

Administrative Division

The administrative division is involved in managing overall activities of the organization and also makes plans through comprehensive strategies. It incorporates national policies that substantiate the purposes and objectives of the establishment of this research institute. Since from its origin, it strives for blue economy through its own time-bound organizational plan (Short Term, Mid Term and Long Term Plan for Blue Economy). The Election Manifesto-2018 that mostly strives for blue economy of the incumbent government is going to be accomplished through our plan.

The administrative division implement and co-ordinate the overall activities of this institute. Its activities include:

- R&D project management
- Document management
- Correspondence management
- Procurement activities
- Controlling inventory
- Ensuring security
- Human resource management & recruitment activity
- Conducts meetings, workshops, seminars, conferences
- Communicating with different national, government, non-government and international bodies.

Human Resource Management

Manpower

Sl	Approved post	Appointed manpower				Total	Progress
		1st class	2nd class	3rd class	Out-sourcing		
1	1st phase =137 (2015-2017 fiscal year)	18	24	12	49	103	Completed
2	2nd phase =31 (2017-2019 fiscal year)	34	-	-	-	34	On going
3	3rd phase =55 (2019-2021 fiscal year)	-	-	-	-	-	-

Trainings

To motivate and build up skillful human resources Bangladesh Oceanographic Research Institute (BORI) emphasizes on customized training programs and developed different training modules. The scenario of training programs is given below:

Foreign Trainings: BORI arranged some foreign training to get hands on experience.

Title of the training	Participants	Date	Country
China-Bangladesh cooperation training workshop	04	Apr, 2018	China
Training program co-ordinate with CSIR-NIO	12	Aug, 2018	India
Techniques for coastal mapping and monitoring using QGIS	01	Nov, 2018	India
Training program co-ordinate with CSIR-NIO	08	Mar, 2019	India

Local Training

The employees of BORI are participating to different training program to enhance their skill at particular subject. They are being trained as per the Annual Performance Plan, Annual Innovation Plan and National Integrity Plan activities. BORI regularly arranges and manages training for its employees different types of training programs:

(a) General/Technical Trainings

Office Management, Public Service Innovation, Internal Audit, EIA and DPP, PPM, APAMS, iBAS^{+}, ADP/RADP, CompTIA A+ Hardware maintenance and Trouble shooting, Welding Technology (Level-II) Training, Plumbing Technology and Marine Robotics.

(b) Scientific Training

Research Methodology, Marine Spatial Planning, Observational Physical Oceanography, Laboratory Safety Measurement, heavy mineral separation, CTD Operation, HPLC operation, Goggle Earth Engine Operation, Weather & Research Forecasting (WRF), Remote Sensing, GNSS, Drone Technology, Sub-soil investigation etc.

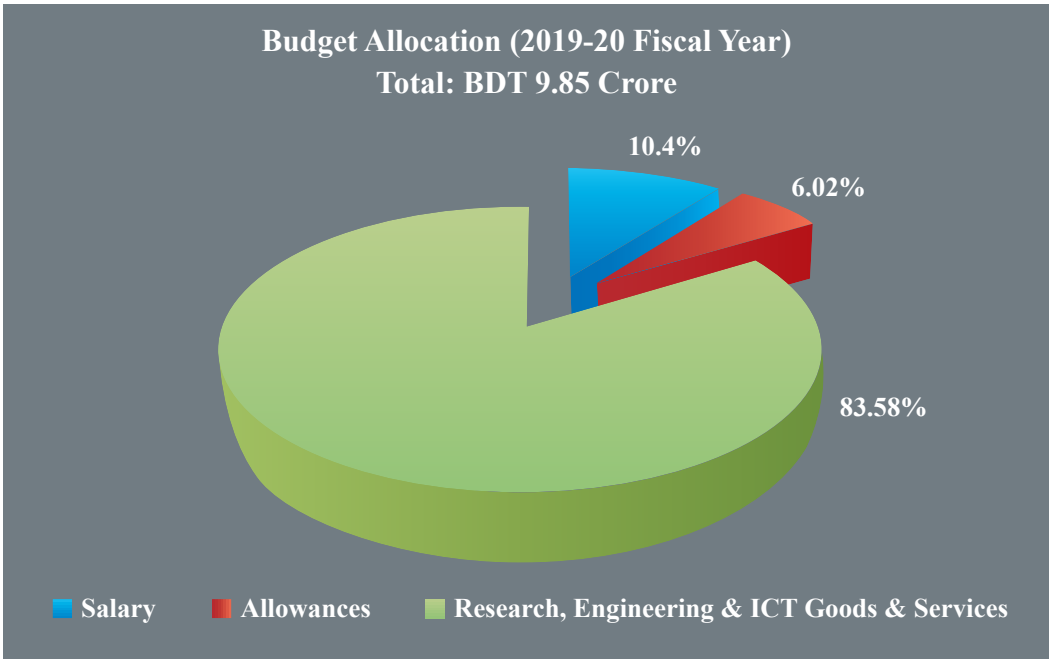
(c) Software Training

It also arranges regular training programs for researchers and engineers like basic software: FORTRAN, Java, C/C^{++}, MATLAB and Pythons etc., analytical & application software: R, SPSS, GIS Basics, GIS Advance and some other customized software designed for laboratory equipment.

Accounts & Finance Division

Budgeting & fund management

The overall outline of the financial costs of BORI for the last 2019-20 fiscal's years is given below.



Audit

Bangladesh Oceanographic Research Institute has an internal auditing system. The auditor audits all kind of purchases to ensure transparency and accountability. Besides auditors from Comptroller and Auditor General Office periodically conducts auditing of BORI accounts in each year.

Engineering Division

At a Glance

Engineering Division has been established along with other divisions at BORI realizing the importance of scientific research through instrumentation, managing research fleets, development works and maintenance purposes. Engineering division is responsible for valuable utility services, maintenance of buildings, renovation and construction works for various tasks to the scientific effort for strengthening and expanding research and development activities in BORI.

General Services/ Maintenance Works

- Civil Works
- Plumbing Works
- New Construction
- Design & Planning
- Hill protection & Guide Wall
- Electrical & Electronic Repair/ Maintenance
- Look after a permanent sub-station inside Institute Campus
- Regular maintenance of electric power management and solar system

Research Fleet Services (in near future)

- To assess and execute all the necessary work of repairing and maintenance for ship, boats, jetty/mooring facilities.
- To estimate and accomplish the annual budget for ship, boats and jetty repairing and maintenance, voyages and fleet staffs.
- To co-ordinate the vessel operation team (outsourcing), BORI scientists and administration during voyages.
- To plan for voyages with BORI Research Wing.
- To prepare the vessel for voyages ensuring fuel, freshwater, fooding and other requirements for the voyage with the approval from administration.

Figures: Proposed Research Vessel & Jetty of BORI

Other Responsibilities

- To plan for the development activities along with the administrative division.
- To assist administration through procurement activities, quality assurance, project management and other necessary activities.
- Enhancing the Marine Instrumentation capacity of BORI.
- Engineering Workshop to assist scientists and for other domestic engineering services.

Recent Activities

- Makes plan for the development activities like preparation of Development Project Proposal (DPP) along with the administrative division.
- Provides Preliminary/Conceptual Design & technical specification, cost estimation for Research Vessels, Boats, new buildings etc.
- Assisting administration through procurement activities, quality assurance and other necessary activities.
- Ensures all the utility facilities like uninterrupted electricity, water supply, sewerage management etc. and liable for repairing of pumps, valves, generators, machineries and lab equipment.
- Establishes of dedicated feeder line from REB to reduce load shedding.
- Carries out maintenance and repairing work.
- Manages solar energy to lessen load shedding problem.
- Assists scientists regarding their electric equipment.

Medical Center

Bangladesh Oceanographic Research Institute has a Medical Center with preliminary treatment facilities for all the employees of the organization. The clinic has Ultra Sonogram, ECG and other equipment as well. At present, there are one medical technician and one medical attendant giving services. The recruitment of Medical Officer is under process.

- Complete & Comprehensive Safety Plan for its employees for the ongoing Pandemic COVID-19 response.
- Distribute Corona safety items such as handrub, surgical mask and hand gloves etc.
- Manage Corona Quarantine and Isolation Area for internal patients.
- Technical support with RT-PCR as a COVID-19 response to Cox's Bazar Medical College to detect SARS-CoV-2 virus in nasal swab sample.

Information Management Division

ICT Cell

ICT Cell is responsible for directing, planning and implementing a global Information Technology (IT), information systems and communication strategy to assist the Organization to achieve its goals and objectives. ICT Cell coordinates IT and communication development initiatives in all levels, ensuring consistency with the Organization's overall strategy. ICT Cell conceptualizes implements and delivers IT projects and establishes strategic relationships with key suppliers and external partners. ICT Cell provides technological solutions that enhance the Organization's effectiveness. Where necessary, ICT Cell develops and provides training to users to ensure the effective use of existing and new technologies, while continuing to explore and identify opportunities to increase productivity and efficiency.

Daily Activities

- Develop Ideas to digitalize manual system and develop the system by an efficient vendor with proper monitoring.
- Monitor and ensure round-the-clock Internet and Telephone facility.
- Monitor, Maintenance, Troubleshoot Servers, Workstations, Routers, Network switch and all other IT accessories.
- Needful IT support for CCTV.
- Keep tracking of IT assets.
- Assist scientific officers to process data using programming language, big data set analysis etc.
- Monitor e-filing activities in regular basis. Organize in house training on e-filing.
- Prepare tender document for procurement, publish the tender in E-GP website, complete the whole procedure in timely manner.
- Maintaining E-hazira for all employees of the institute, take report in daily basis and backup E-hazira database daily.

Video Conferencing System

There is a Video Conferencing System in the conference room of BORI. It is now used as and when necessary. This facility is used to conduct training sessions remotely. An important government officer such as Ministry Office is communicated by using Video Conferencing.

Computer Training Lab

BORI has established a computer training lab with all facilities under the supervision of ICT cell. This lab contains 10 Computers with network printer and scanner wherein 10 (Ten) trainees can use computer at a time. Different Types of IT related training Such as : Data analysis with Python, Data analysis using MATLAB, R, FORTRAN, Microsoft Ofiice Training and many other different types of training are conducted in the lab all over the year.

Future Plan of ICT Cell

- Design and develop central Local area Network for whole institute.
- Design and develop central PABX system for whole institute.
- Implement Active directory, Application Server, File server by creating domain network to monitor and provide any types of IT support to any workstation centrally.
- Develop user friendly and efficient web/Desktop application for office's day-to-day activities depends on users' requirement to reduce bulk use of paper.

Library Cell

Keeping up with modern technology, Bangladesh Oceanographic Research Institute (BORI) has a Library with rich collection of books, journals. Every year more than two hundreds of new books are added into the library depending on the needs of various research purposes. Now, BORI library has more than 600 hundreds of books of different categories including Physical, Chemical, Biological, Geological and Environmental Oceanography.

'COVID-19' Combat Plan of BORI

Bangladesh Oceanographic Research Institute (BORI) took various preventive measures to combat Corona Virus (COVID-19) world pandemic. At present BORI have different plans to reduce transmission, spreading and redress from COVID-19 along with future plans as well.

SL	Subject	Activity
1	Preventive Measures	· BORI produced hand rub called "Aegis" in the laboratory which is regularly distributed it to the employees. · BORI gave a RT-PCR to Cox's Bazar Medical College Authority for this hazardous time period. · Mask, Gloves, Head Cap is regularly distributed in the institute. · "No mask, No Service" sticker is affixed in the institute and wearing mask and gloves is made compulsory while entering the campus. · Body temperature of all employees and service receivers is being measured by thermal scanner upon entry. · "3 Feet Distance" system has been put on during office work. · All are being encouraged to clean hands frequently using soap water or hand sanitizer and wearing mask is obligatory in the office. · Places of frequent use such as door locks, handles, railings are disinfected regularly. · Government rules and regulations are being pursued in this COVID-19 situation.
2	Service Institute	· Bangladesh Oceanographic Research Institute, Cox's Bazar
3	Beneficiary	· All the officers/Employees, their families, service receivers or guests.
4	Limitations and Recommendations	· Those who come from outside to stay in BORI campus must be in quarantine for 14 days abide by health regulations. · To ensure proper management of quarantine and isolation. · Ensure liquid dispenser in every entrance of all buildings. · Travelling of officers/employees has to be maintained by time table/roaster process developed in the transport pool of BORI. · Directory of health regulations and keeping safe distance notice have to be demonstrated while travelling. · Remind the officers/employees about the general preventive rules and regulations of Corona Virus. · Monitor through vigilance team whether they are following the health regulations or not.
5	Future plan due to increased Transmission	· Quick response team has been developed. Identify "Do's and Don'ts" coordinating with Vigilance Team. · If any officer/employee becomes affected then management of isolation has to be done rapidly. And help to ensure medication. · Required Technical support has to be provided by BORI to implement National Work Plan to get rid of COVID-19 corona virus. Scientists of Biological Oceanography division will participate in joint research if it needed. · Take necessary steps to pay special honorarium/incentives to scientists for time-worthy innovation to deal with pandemics/Hazards.

Mr. Abu Sayeed Muhammad Sharif and Mr. Md. Zakaria, Senior Scientific Officers of BORI are handing over PCR machines to the officers of Cox's Bazar Medical College on behalf of BORI for providing assistance in combating Covid-19 pandemic.

Chapter 11

Guardian of BORI

Standing Committee on Ministry of Science and Technology visits BORI

Honorable Director General of BORI Mr. Md. Shafiqur Rahman greeted the Chairman of the Standing Committee on Ministry of Science and Technology and Honorable Member of Parliament Mr. A.F.M. Ruhal Haque along with other Standing Committee members with bouquets of flowers on 10 March 2020.

Members of Standing Committee on Ministry of Science and Technology, exchanging views with scientists & officers of BORI.

Honorable President of Standing Committee on Ministry of Science and Technology, Mr. A.F.M. Ruhal Haque is given creast by the DG of BORI, Mr. Md. Shafiqur Rahman.

Mr. Md. Shafiqur Rahman, DG, BORI handed creasts to the Members of Standing Committee on Ministry of Science and Technology.

Honorable Members of Standing Committee on Ministry of Science and Technology visited different laboratories during BORI visit.

Standing Committee on Ministry of Science and Technology visits BORI

Honorable Members of Standing Committee on Ministry of Science and Technology visited different laboratories during BORI visit.

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Honorable President of Standing Committee on Ministry of Science and Technology planted trees in BORI campus.

Honorable President of Standing Committee on Ministry of Science and Technology planted trees in BORI campus.

Honorable Members of Standing Committee on Ministry of Science and Technology with DG, BORI (front row) and BORI Officers (back row).

Architect Yeafesh Osman, Honorable Minister, Ministry of Science & Technology at BORI

Architect Yeafesh Osman, Honorable Minister, Ministry of Science and Technology attended the seminar on "Results of BORI's completed research projects and progress of ongoing research activities" as Chief Guest in the Round Conference Room at BORI on 23 October 2019.

Architect Yeafesh Osman, Honorable Minister, Ministry of Science and Technology visited "Ekattor Photo Gallery" of Bangladesh Oceanographic Research Institute on 23 October 2019.

Architect Yeafesh Osman, Honorable Minister, Ministry of Science and Technology visited different laboratories of BORI and discussed various scientific issues with the scientists.

Architect Yeafesh Osman, Honorable Minister, Ministry of Science & Technology at BORI

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Architect Yeafesh Osman, Honorable Minister, Ministry of Science and Technology delivered speech at an exchange meeting at BORI and after the meeting he was given creast by the DG of BORI on 23 October 2019.

Mr. Md. Anwar Hassain, Honorable Senior Secretary, Ministry of Science & Technology at Cox's Bazar

BORI Officers conveyed warm welcome to Honorable Senior Secretary Mr. Md. Anwar Hassain, Ministry of Science and Technology at Cox's Bazar Airport on 21 December, 2019.

BORI Scientists with Honorable Senior Secretary, Mr. Md. Anwar Hassain, Ministry of Science and Technology during his visit to Institute of Nuclear Medicine & Allied Sciences, Cox's Bazar.

BORI Scientists with Honorable Senior Secretary, Mr. Md. Anwar Hassain, Ministry of Science and Technology visits Institute of Nuclear Medicine & Allied Sciences, Cox's Bazar.

Chapter 12

National Days At BORI

National Mourning Day-2019

Mr. Md. Shafiqur Rahman, Director General of BORI was present in the discussion meeting for National Mourning Day organized by Bangladesh Oceanographic Research Institute on 15th August 2019. All the officials of BORI were also present in this 44th Martyrdom Anniversary of Father of the Nation Bangabandhu Sheikh Mujibur Rahman.

Mr. Md. Shafiqur Rahman, Director General of BORI along with other officials visited "Ekattor photo gallery" on the occasion of National Mourning Day, 44th Martyrdom Anniversary of Father of the Nation Bangabandhu Sheikh Mujibur Rahman at BORI.

Victory Day-2019

To celebrate the great Victory Day on 16 December 2019, the Director General and other officials of Bangladesh Oceanographic Research Institute visited "Ekattor photo gallery" of the institute.

Picture of lighting of Bangladesh Oceanographic Research Institute to celebrate the great Victory Day on 16 December 2019.

Mr. Md. Shafiqur Rahman, Director General of BORI and all other officials were present at the discussion meeting organized by Bangladesh Oceanographic Research Institute to celebrate the Great Victory Day on 16 December 2019.

Victory Day-2019

Victory Rally led by the Director General of Bangladesh Oceanographic Research Institute Mr. Md. Shafiqur Rahman to celebrate the Great Victory Day on 16 December 2019.

Mr. Md. Shafiqur Rahman, Director General of BORI and other officials enjoyed the cultural program at Bangladesh Oceanographic Research Institute to celebrate the Great Victory Day on 16 December 2019.

Victory Day friendly football match was held between Research Wing (Green Jersey) vs Admin Wing (Red Jersey) on 16 December 2019 at the playground of Bangladesh Oceanographic Research Institute.

International Mother Language Day-2020

Rally organized at Bangladesh Oceanographic Research Institute on the occasion of Great Martyrs Day and International Mother Language Day-2020 leading by Honorable Director General of BORI Mr. Md. Shafiqur Rahman.

Honorable Director General of BORI Mr. Md. Shafiqur Rahman with officials and employees paying rich tributes to the martyrs of the 1952 historic Language Movement at BORI Shaheed Minar on the occasion of Great Martyrs' Day and International Mother Language Day-2020.

Honorable Director General of BORI Mr. Md. Shafiqur Rahman (middle) with other officers were present at the discussion meeting organized on the occasion of Great Martyrs Day and International Mother Language Day 2020.

National Children's Day-2020

March 17, 2020 On the occasion of the birth centenary of Father of the Nation Bangabandhu Sheikh Mujibur Rahman and National Children's Day, children's drawing competition is organized at Bangladesh Oceanographic Research Institute, Cox's Bazar.

March 17, 2020 On the occasion of the birth centenary of Father of the Nation Bangabandhu Sheikh Mujibur Rahman and National Children's Day, a discussion meeting is organized at Bangladesh Oceanographic Research Institute, Cox's Bazar.

Chapter 13

Seminar Training Learning

Delegates from Geological Society of Malaysia visited BORI

Delegates from Geological Society of Malaysia visited BORI on 04 February, 2020. Having fruitfull discussion on scientific cooperation, Honorable Director General of BORI, Mr. Md. Shafiqur Rahman, presented creasts as a memento to the visiting delegates.

BRRI organized seminar at BORI

A seminar of BRRI on "Application of Seasonal and Sub-seasonal Forecasts in advisory generation for scientist of Agromet Lab" was held at BORI. Dr. Md. Shahjahan Kabir, DG, BRRI was the chief guest in that seminar. After the seminar, BRRI officials visited different laboratories of BORI.

Internal "Training on Microsoft Word" Held at BORI

Internal "Training on Microsoft Word" was held for the employees of BORI from 17-23 February, 2020 in the Training room of BORI.

Md. Zakaria, Senior Scientific officer is with tranning participants during Internal "Training on Microsoft Word" at BORI

Sonet Barua Emon, Assistant Programmer is with tranning participants during Internal "Training on Microsoft Word" at BORI

Md. Mahbub Kibria, Senior Scientific officer is with tranning participants during Internal "Training on Microsoft Word" at BORI

Mst. Tania Islam, Scientific officer is with tranning participants during Internal "Training on Microsoft Word" at BORI

Honorable Director General of the organization Mr. Md. Shafiqur Rahman is distributing certificates to the trainees after the training.

Internal training on "e-filing" and "Good Governance, Efficiency and Office Management" held at BORI

Internal "e-filing" training held in the presence of the Director General of BORI Mr. Md. Shafiqur Rahman in the round conference room of Bangladesh Oceanographic Research Institute on 14 December, 2019.

Internal training on "Good Governance, Efficiency and Office Management" training of 10th/16th grade officers/staff was held in the presence of the Director General of BORI Mr. Md. Shafiqur Rahman in the round conference room of Bangladesh Oceanographic Research Institute on 15 December, 2019.

Teachers & Students form various universities frequently visit BORI

A Group of Teachers & Students from Daffodil International University, Bangladesh visited Bangladesh Oceanographic Research Institute on 06 October, 2019.

Department of Geography, Rajshahi University Visited Bangladesh Oceanographic Research Institute on 16 October, 2019.

A Group of Teachers & Students from Bangabandhu Sheikh Mujibur Rahman Maritime University visited Bangladesh Oceanographic Research Institute, on 21 October, 2019.

Teachers & Students form various universities frequently visit BORI

A Group of Teachers & Students from the Department of Food and Nutrition Sciences, Maulana Bhashani Science and Technology University visited Bangladesh Oceanographic Research Institute on 16 November, 2019.

A Group of Teachers & Students from Bangladesh University of Professional (BUP) visited Bangladesh Oceanographic Research Institute on 10 December, 2019.

A Group of Teachers & Students of Bangabandhu Sheikh Mujibur Rahman University of Science and Technology visited Bangladesh Oceanographic Research Institute on 17 February, 2020.

1st Class Officers of BORI- 16 January, 2018
(1st Recruitment of BORI)

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