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Research Article

RELATION BETWEEN MICROBIAL LOAD AND NUTRIENT ALONG THE COASTAL WATER OF COX'S BAZAR, BANGLADESH

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Abstract

The sea beach is the most visually appealing and popular tourist destination in Bangladesh, and it makes a significant economic contribution to both the local and national economies. But this coastal water is polluting with solid and liquid water which discharge directly or indirectly through land wash or drainage system to the coastal water of Cox's Bazar. This waste and waste water carry excess nutrient and pathogenic microbe and pollute coastal water. For that this study was conducted at Teknaf, Himchori, Kolatoli, Laboni, Bakkhali sites of Cox's Bazar Districts to understand the status and relation of nutrients and microbial load and coastal water pollution which is very important for tourism, health and safety. For sampling, preservation and analysis APHA (1999) methods were followed. According to the study, the microbial load was too high for swimming and bathing. There was some significant relation among nutrient, seasons and microbes in the study areas. In Premonsoon, the highest level of Total Viable Count (TVC) had shown at Bakkhali site (336 cfu/ml) and lowest level of Total Viable Count (TVC) had shown at Himchary site (116 cfu/ml) whereas the, standard value of TVC was only 10 cfu/ml. Noticeably, the standard value of Faecal coliform and streptococcus was simply 1 cfu/ml but our received results from different five sites were exceptionally high. However, in case of pathogenic bacteria Salmonella and Vibrio the standard value was 2.7 cfu/ml and 7 cfu/ml respectively. The fascinating information was that, the Laboni (0 cfu/ml) and Himchary (2 cfu/ml) site had shown less number of Salmonella than the standard value (2.7 cfu/ml). In addition, Kolatoli (1 cfu/ml) and Laboni (6 cfu/ml) site had shown less number of Vibrio than standard value (7 cfu/ml). In Monsoon, it also shown immense deviation. Especially at Himchary site, TVC (764 cfu/ml) and Steptococcus (761cfu/ml) were noted. On the other hand, Kolatoli site had demonstrated highest number of Fecal Coliform (258 cfu/ml) and Salmonella (104 cfu/ml). But in Postmonsoon it had represented the greatest deviation from standard data. Among the three season, the higher level of Total Viable Count (TVC), Fecal Coliform, *Salmonella, Vibrio Chlorella, Streptococcus* had shown at all the sites in Monsoon season and lower level of Total Viable Count (TVC) had shown in Pre monsoon and Post monsoon. In respect of nutrient NH_4-N, NO_2-N, SiO_3-Si were higher in Monsoon but PO_4-P value were lower in Monsoon and higher in Pre monsoon and Post monsoon.

Introduction

The main driver of the Cox's Bazar economy is tourism, as it is one of the most stunning and well-known tourist destinations in Bangladesh. Every year, millions of visitors from Bangladesh and other countries come to this metropolis. The winter months continue to see the highest volume of visitors. In the city and along the coast, numerous hotels, guest homes, and motels have been constructed as a result. Businesses focused on hospitality and customer service employ a large number of individuals. However, it should also be taken into account whether the beach is unclean due to careless waste and the water quality is subpar, which could deter visitors from returning. Unchecked human activity and its interference with nature may negatively affect the biological and environmental domains that require investigation.

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Common occurrences in the beach region include the absence of a contemporary waste converter, a lack of environmental awareness among the local population, and tourists throwing trash into the ocean. Unfortunately, rain and wind are causing the garbage and other harmful materials to mingle with the sea water.

From Laboni Point to Himchary National Park, the majority of tourists congregate. Numerous user groups have made the area their home, including residential hotels, motels, restaurants, souvenir stores, transportation equipment, municipal buildings, and numerous commercial facilities including shrimp hatcheries and nurseries. Daily production of urban garbage and organic litter is enormous, and a sizable portion of these wastes may have the potential to contaminate the coastal ecosystem. There are roughly 56 tiger shrimp hatcheries in the Kalatoli hatchery zone, from which thousands of liters of waste water are immediately released into the sea, potentially posing a serious health risk to visitors (Shahidullah, 1985).

Because of this, there is a risk to the beach environment, its biodiversity, and the general health of visitors. The pollution load in beach waters, rivers, and estuaries has increased dramatically due to the global tourism industry's rapid growth. Numerous studies have been carried out worldwide to evaluate the detrimental risks to human health. As a result, this research work gathers environmental safety data in Bangladesh's Cox's Bazaar for the first time.

Amongst the various human activities found in the coastal zone, beach tourism represents one of the most important uses, given its economic significance. Consequently, effective management of touristic beaches and their related environmental services requires an up to date knowledge of coastal water quality. It was designed for a good reference work to assess the water quality of Cox's Bazar beach areas to assess the relation between microflora (fecal coliform, vibrio, streptococcus, staphylococcus, salmonella and nutrient along the coastal beach water of Cox's Bazar.

Vishnupriya Sowjanya *et. al*, 2015 reported on the study area of Visakhapatnam Coast of Bay of Bengal, located in North Eastern part of Andhra Pradesh between17^{0}15' and 18^{0}32' Northern latitude and 82^{0}54' and 83^{0}30' in Eastern longitude. The waters are distinctly characterized by an overall range of (median values) high temperature (32.8^{0}C – 33.6^{0}C), pH (7.8-8.7), high turbidity (36.2-47.5 NTU); low dissolved oxygen (2.26-3.8 mg/l). Sridhar *et al*., 2006 conducted a study on Kattumavadi (Lat. 10º4'N; Long. 79º12'E) coastal village in the Palk Bay region of the Pudukottai district of Tamilnadu state. The sea in this area appears calm during most of the months with lesser tidal influence. There are no major river discharges expect that of a small river, Narasinga Cauvery, which brings water only during the rainy season. Air and surface water temperatures varied from 28ºC to 32.50ºC and from 27.5 to 32.0°C while light extinction coefficient (LEC) varied between 0.95 and 1.85. Salinity ranged from 26.0 to 34.5‰ and the pH ranged between 7.95 and 8.35. Variation in dissolved oxygen content was from 4.15 to 7.18 ml/l.

Santosh *et al.,* 2007 performed a study on River Ganges, known as Hugli (ca. 280 km) and reported that Hugli estuary is a typical example of tide-dominated sink for contaminants from multi-farious sources. This major important river is subjected to anthropogenic stress due to the socio-economic importance of these areas based on growth of industry, agriculture, aquaculture, port activities, fishing and tourism. The living resources have been degraded recently due to increases in population pressure, pollution and natural resource consumption to the extent of overexploitation. The study examined the physicochemical characteristics at three ecologically distinct zones along the course of the river Babughat located in the eastern part of the metropolitan megacity Calcutta (140 km upstream from seaface), Diamond Harbor (70 km upstream from sea face) and Gangasagar positioned at the mouth of the Ganges estuary. Physicochemical characteristics of this partially mixed estuary are largely influenced by the interaction of seawater and discharge off riverine freshwater, annual precipitation and surface runoff. The levels of salinity, total dissolved solids, hardness and conductivity showed an increasing downward trend. Marked increase in biochemical oxygen demand (BOD) values (2.20-5.95 mg/l) was recorded in Babughat whereas correspondingly low values (0.75-2.82 mg/l)

were noticed at Gangasagar.

Palleyi *et al.,* 2011 conducted a study on Dhamra River Estuary of Odisha Coast, Bay of Bengal and reported that diversity and abundance of phytoplankton are related to the physico chemical parameters in general and more particularly to temperature, DO, BOD, salinity and nutrient availability.

Abhijit et al., 2009 presented the evidence that the Indian Sundarbans is experiencing the effects of climate change over the last three decades. Observations of selected variables, such as the surface water temperature, salinity, pH, dissolved oxygen, and transparency show significant long-term variation over a period of 27 years (1980– 2007). Specifically, the temperature in these waters has risen at the rate of 0.5°C per decade, much higher than that observed globally or for the Indian Ocean. Increasing melting of Himalayan ice might have decreased the salinity at the mouth of the Ganges River, at the western end of this deltaic complex. At the same time, salinity has increased on the eastern sector, where the connections to the melt water sources have become extinct due to heavy siltation of the Bidyadhari Channel. The long-term changes in dissolved oxygen, pH level, transparency and water quality are also examined.

Some information from home is available on the hydro-metrological aspect of the coastal region of the Bay of Bengal. Laford (1958), Islam & Aziz (1975,a,b), Ahmed (1989), Khan (2002) etc. are notable studies in this regards. Hossain (1988) and Jashimuddin (1993) worked on the Water quality of the Karnafully river estuary. Ali *et al*. (1985) studied the physio-Chemical aspect of Moheskhali Channel.

Some works were done in the Indian side of the Bay of Bengal by Sankarnarayan and Reddy, 1967; Shirwaiker *et.al.*1987; Rhadhakishna *et al.* 1982; Sarma and Rao 1989; Devassy and Bhattactiri 1981; Satyanarayan *et al.* 1992; Sousa *et al.* 1981 a, b ; Selvam *et al.* 1992; Venugopalan *et al.* 1981; Ramanadham *et al.* 1986, Church MJ. (2008), Gilbert *et al* . (2009). Tariq (2017) conducted a case study on Destination competitiveness: Attributes affecting tourist decisions. Kingsley et al. (2000) worked on impact of horizontal gene transfer on evolution of Salmonella pathogenesis.

However, the Cox's bazar coastal water resources and biodiversity have been facing threats of pollution due to various anthropogenic activities. It is thus urgent to initiate the collection of data on the microbe and nutrients and to observe their relation along the coastal water. This will facilitate the subsequent proper management of the trourism site eater water quality under the DoE and international standard.

Materials and Methods

Sampling design

In this study areas have been divided into five sites in relations to tourist density. Samples were collected from 2018 to 2019 in five different sites Teknaf (N 20^0 50′ 38.93″ E 92^0 16′ 25.29″), Himchori (N 21^0 21′ 15.59″, E 92°1′25.47″), Kolatoli (N 21°24′53.01″ E 92°59′1.18″), Laboni (N 21°25′33.87″ E 91°58′13.66266″), Bakkhali (N 21^0 27′ 10.27″ E 91°58′10.19208″) of the Cox's Bazar. Sampling design considered the Premonsoon (February - June), Monsoon (July - October) and Postmonsoon (November - January).

Four replicated water samples were collected from each sites using Nansen bottle and placed in ice boxes. Then samples were brought to the laboratory and kept at -4°C to –20°C until further analysis.

Measures

In this studies identification of water quality falling agents and their impact on selected biota were determined by collecting water, sediment and biota quarterly from the selected sampling sites. The suitability of water for different purposes was determined by its nutrient, and the presence of pathogenic microorganism. Analysis of water quality and biological samples were done according to the standard procedures e.g. APHA, 1999 and followed stand of NZECC,2000, US-EPA, 1996, WHO, 2003.

Analysis

Analysis of various parameters were conducted to report on a beach's recreational, aesthetic and ecosystem water quality. In this experiment we analyzed the water micro nutrient and biological parameter to investigate quality of five sites of Cox's Bazar. Different methods were followed to analyze different parameters. For the analysis of microbial contamination several microbial growth media were used. Again, some biochemical tests are used for the conformation about type of microbes. The commonly used biochemical tests are as mentioned below:

Indole test, H2S production test, Citrate utilization test, Urease test, VP test, IMViC test, Oxidase test, sugar fermentation test by using various types of sugars. Selective media were prepared for the isolation of select groups of microorganisms from the marine water samples.

Micro-biological parameters are also known as contaminants. In this experiment water samples were taken from five selected points of the study area. Selective media were prepared for the isolation of select groups of microorganisms from the marine water samples.

Name of some used media are following: MacConkey agar medium Brilliant Green agar medium (BGA) Simmon's agar Salmonella Shigella agar (SS) medium Xylose Lysine Deoxycholate ((XLD) agar Triple Sugar Iron Agar (TSI agar) medium Thiosulfate Citrate Bile salts Sucrose agar medium (TCBS) Brain Heart Infusion agar medium (BHI) Sheep blood agar.

Biochemical test for the specific organism detections was conducted: TSI slant test positive result indicates the presence of salmonella bacteria. Citrate test positive result means the presence of Vibrio Catalase test positive result represents the presence of staphylococcus IMViC test positive result identifies the presence of faecal coliform

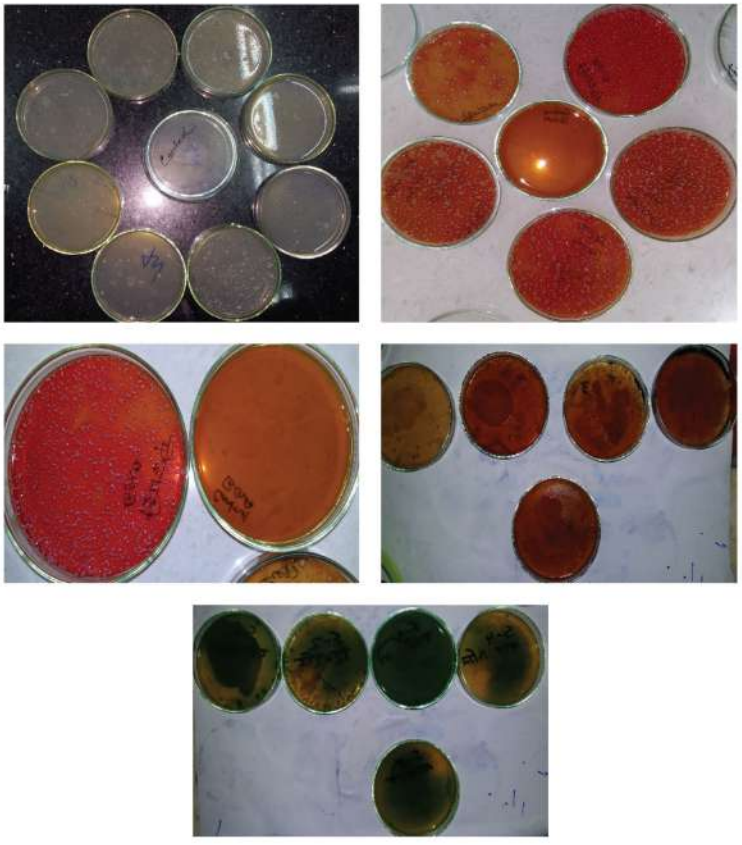
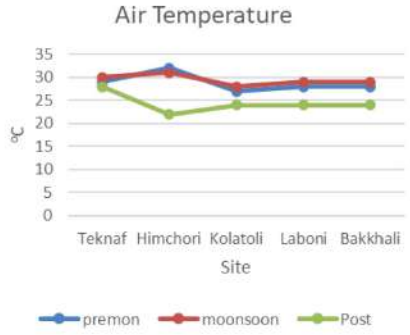


Figure 1. Photographs of microbiological samples at different stage in laboratory.

Results and Discussion

Physical, chemical, nutrients and micrtobial parameters of coastal water of Cox's Bazar fluctuated significantly during the course of the time period. There parameters and significantly inter related with time and season. This study showed the three seasonal sample results.

Air temperature: Air temperatures varied from 22°C to 32°C at Teknaf, Himchori, Kalatoli, Laboni, Bakkhali sites during the period of investigation. The higher values were recorded during monsoon at all the stations, whereas the lower values were recorded during Postmonsoon at all the stations **(Figure 2)**.



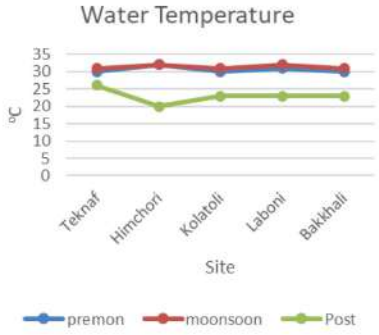


Figure 2. Air temperature (◦C)

Figure 3. water temperature (◦C)

Water temperature: Surface water temperatures ranged between 23°C to 32°C at Teknaf, Himchori, Kalatoli, Laboni, Bakkkhali sites during the period of investigation. The higher water temperatures were recorded during monsoon at all the stations, whereas the lower water temperatures were recorded during Postmonsoon (**Figure 3**).

Hydrogen Ion Concentration (P^H): The P^H values remained more or less static throughout the period of study. Surface water P^H ranged between 7 and 8.1, 6.7 and 8.1, 7.5 and 8.1, 7.5 and 8.1, 7 and 7.7 at Teknaf, Himchori, Kalatoli, Laboni, Bakkkhali respectively. The higher water P^H values were recorded during monsoon at each station and the lower P^H values were recorded during postmonsoon at each stations. The highest values of P^H (8.1) was observed during monsoon at Teknaf, Himchori, Kalatoli, Laboni sites and the lowest value (6.7) was observed during premonsoon at Himchari site. The lower P^H values were recorded during Post Monsoon at Teknaf, Himchori, Kalatoli, Laboni sites (**Figure 4**).

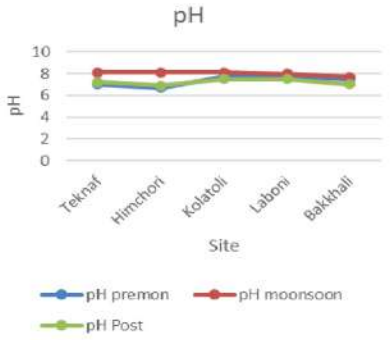


Figure 4. water p^H

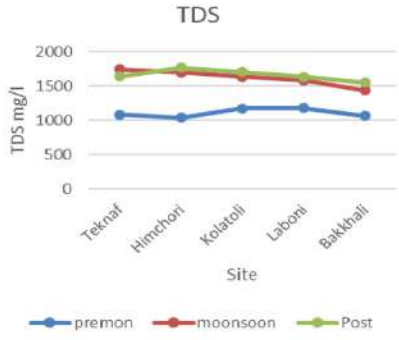


Figure 5. TDS (mg/l)

Total dissolved solids (TDS): Total dissolved solids (TDS) in surface water varied from 1082 to 1740.5 mg/l, 1038 to 1767 mg/l, 1174 to 1705 mg/l, 1177 to 1635 mg/l, 1064 to 1533 mg/l at Teknaf, Himchori, Kalatoli, Laboni, Bakkkhali respectively. The higher TDS values were recorded during postmonsoon most of the sites. The lower TSS values were recorded during premonsoon at all stations in surface water samples. The highest TDS value (1767 mg/l) was observed during postmonsoon at Himchori, whereas the lowest value (1038 mg/l) was observed during premonsoon at Himchori(**Figure 5**).

Nitrite Nitrogen (NO_2-N): Nitrite Nitrogen (NO_2-N) in surface water varied from 0.025 to 0.07 mg/l, 0.03 to 0.075 mg/l, 0.015 to 0.073 mg/l, 0.01 to 0.065 mg/l, 0.03 to 0.105 mg/l at Teknaf, Himchori, Kalatoli, Laboni, Bakkkhali respectively. The higher Nitrite Nitrogen (NO_2-N) values were recorded during monsoon almost at all stations. The lower Nitrite Nitrogen (NO_2-N) values were recorded during post monsoon at all stations in surface water samples (**Figure 6**).

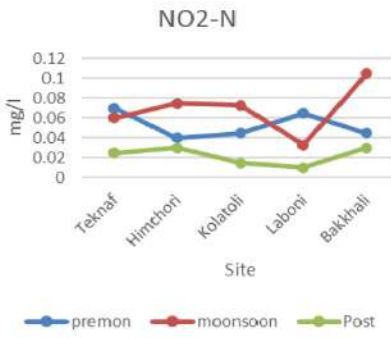


Figure 6. NO_3-N mg/l

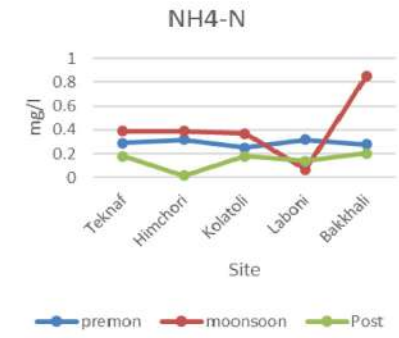


Figure7. NH_4-N mg/l.

Ammonium Nitrogen (NH_4-N): Ammonium Nitrogen in surface water varied from 0.18 to 0.389 mg/l, 0.17 to 0.39 mg/l, 0.18 to 0.37 mg/l, 0.07 to 0.32 mg/l, 0.20 to 0.85 mg/l at Teknaf, Himchori, Kalatoli, Laboni, Bakkkhali respectively. The higher NH_4-N values were recorded during monsoon almost at all stations and the lower values were recorded during post monsoon at all stations in surface water samples (**Figure 7**).

Phosphate Phosphorus (PO_4-P): Phosphate Phosphorus (PO_4-P) in surface water varied from 0.015 mg/l to 0.04 mg/l, 0.015 to 0.0.03 mg/l, 0.02 to 0.035 mg/l, 0.01 to 0.04 mg/l, 0.01 to 0.04 mg/l at Teknaf, Himchori, Kalatoli, Laboni, Bakkkhali respectively. The higher Phosphate Phosphorus (PO_4-P) values were recorded during monsoon almost at all stations. The lower Phosphate Phosphorus (PO_4-P) values were recorded during post monsoon at all stations in surface water samples(**Figure 8**).

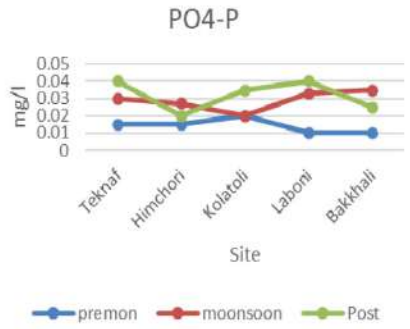


Figure 8. PO_4-P mg/l

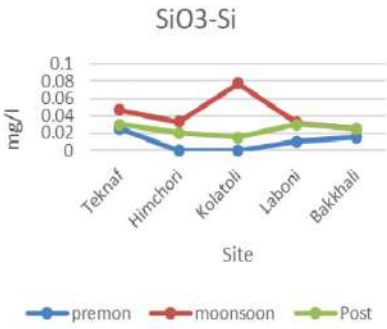


Figure 9. SiO_3-Si mg/l

Silicate Silica (SiO_3-Si) Silicate Silica (SiO_3-Si) in surface water varied from 0.025 to 0.0.048 mg/l, 0.00 to 0.0.033 mg/l, 0.00 to 0.0.078 mg/l, 0.0.01 to 0.0.032 mg/l, 0.015 to 0.025 mg/l at Teknaf, Himchori, Kalatoli, Laboni, Bakkkhali respectively. The higher Silicate Silica (SiO_3-Si) values were recorded during monsoon at all stations. The lower SiO_3-Si values were recorded during pre monsoon at all stations in surface water (**Figure 9**).

TVC TVC in water varied from 165 cfu/ml to 410 cfu/ml, 86 cfu/ml to 764 cfu/ml, 148 cfu/ml to 731 cfu/ml, 175 cfu/ml to 735 cfu/ml, 257 cfu/ml to 336 cfu/ml, at Teknaf, Himchori, Kalatoli, Laboni, Bakkkhali sites respectively. The higher TVC values were recorded during monsoon at all site and the lower TVC values were recorded during Postmonsoon (**Figure 10**).

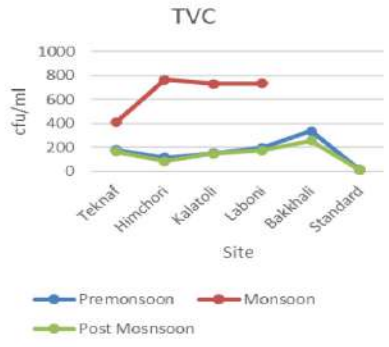


Figure 10. TVC

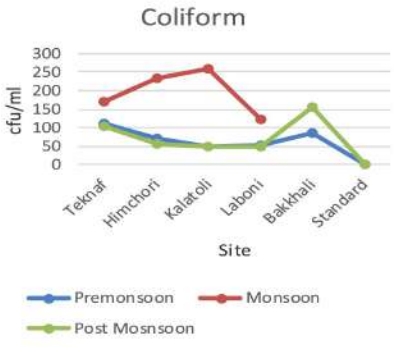


Figure 11. Coliform

Coliform: Coliform in water varied from 105cfu/ml to 169cfu/ml, 36 to 234 cfu/ml, 47cfu/ml to 258cfu/ml, 49cfu/ml to 47cfu/m Teknaf, Himchori, Kalatoli, Laboni, Bakkkhali sites respectively. The higher coliform values were recorded during Monsoon at all the sites. The highest Coliform value (50 /ml) was observed during Monsoon at Kolatoli site, whereas the lowest value (47cfu/ml) was observed during PostMonsoon at Kolatoli site (**Figure 11**).

***Salmonella sp.*:** Salmonella in water varied from 10cfu/ml to 31cfu/ml, 2 to 48 cfu/ml, 35cfu/ml to 104cfu/ml, 0cfu/ml to 16cfu/ml, 26 cfu/ml to 32cfu/ml at Teknaf, Himchori, Kalatoli, Laboni, Bakkkhali sites respectively. The higher Salmonella values were recorded during Monsoon and the lower Salmonella values were recorded during Post Monsoon at all the sites. Salmonella sp. Standard value was 2.7 cfu/ml (**Figure 12**).

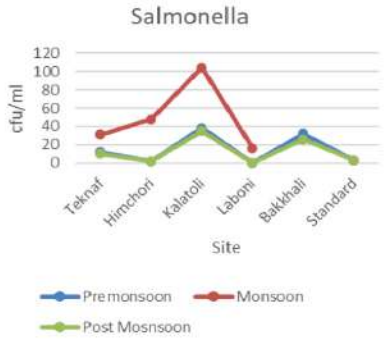


Figure 12. Salmonella

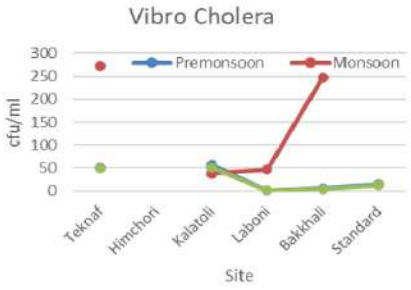


Figure 13. Steptococcus

Vibrio Cholerae: *Vibrio Cholerae* in water varied from 49 cfu/ml to 271 cfu/ml, 38 to 57 cfu/ml, 1 cfu/ml to 47 cfu/ml, 6 cfu/ml to 268 cfu/ml, 14 cfu/ml to 12 cfu/ml at Teknaf, Himchori, Kalatoli, Laboni, Bakkkhali sites respectively. The higher *Vibrio Cholerae* values were recorded during Monsoon and the lower *Vibrio Cholerae* values were recorded during Post Monsoon at all the sites (Figure 13). Salmonella sp. Standard value was 7 cfu/ml.

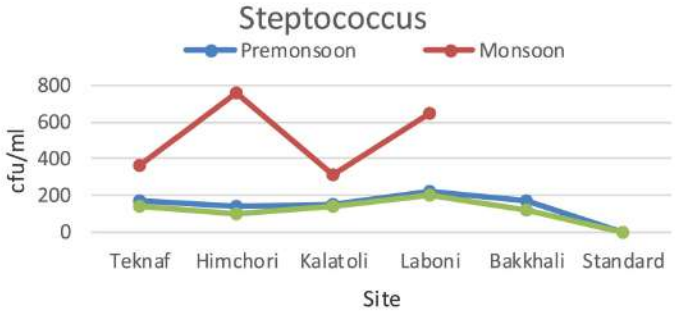


Figure 14. Steptococcus

Steptococcus: Steptococcus in water varied from 145 cfu/ml to 359 cfu/ml, 103 to 761 cfu/ml, 127 cfu/ml to 311 cfu/ml, 196 cfu/ml to 648 cfu/ml, 120 cfu/ml to 166 cfu/ml at Teknaf, Himchori, Kalatoli, Laboni, Bakkkhali sites respectively. The higher Steptococcus values were recorded during Monsoon and the lower Steptococcus values were recorded during Post Monsoon at all the sites Salmonella sp. Standard value was 1 cfu/ml (Figure 14)

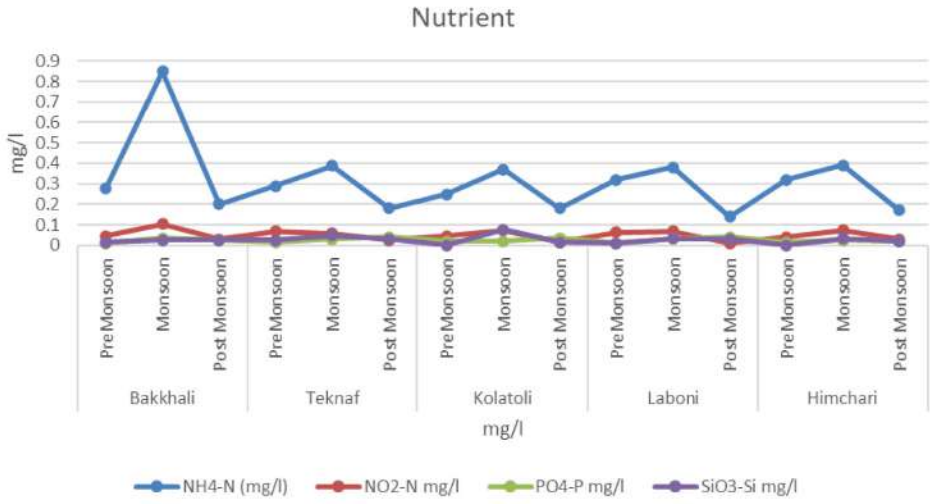


Figure 15. Graphical presentation of microbial parameters in different sites.

Relation between TVC and Nutrients: Among the three season, the higher level of Total Viable Count (TVC) had shown at all the sites in Monsoon season and lower level of Total Viable Count (TVC) had shown in Pre monsoon and Post monsoon whereas the, standard value of TVC was only 10 cfu/ml. TVC ranged in the studied sites was from 764-86cfu/ml. Islam (2009) observed 746000 (in Post monsoon) to 13000cfu/ml (in monsoon) in St. Martin Island coastal water. In respect of nutrient NH_4-N, NO_2-N, SiO_3-Si were higher in Monsoon but PO_4-P value were lower in Monsoon and higher in Pre monsoon and Postmonsoon.

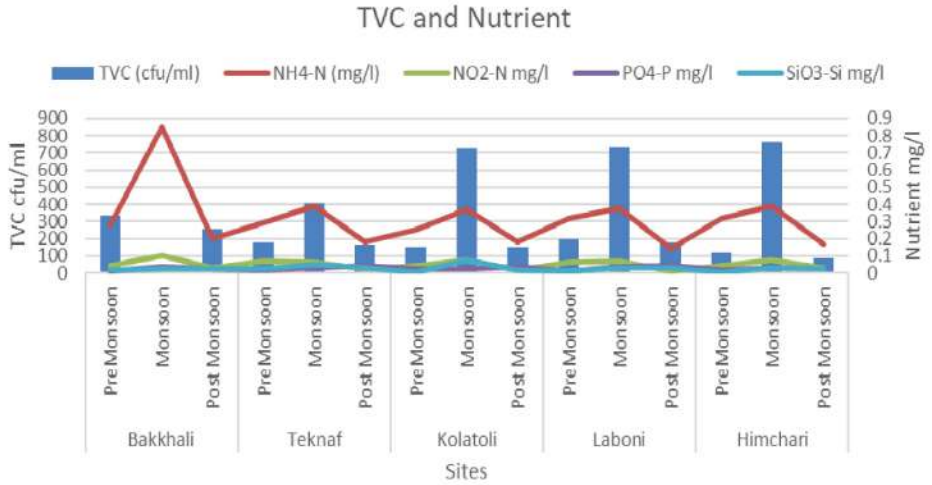


Figure 16. Relation between fecal coliform and nutrients.

Relation between Fecal Coliform and Nutrients: In the study sites, Fecal Coliform level was from 258cfu/ml to 48cfu/ml. It was observed that in Monsoon season, the higher value of Fecal Coliform had shown at all the sites and lower level of Fecal Coliform had shown in Pre monsoon and Post monsoon whereas the, standard value of Fecal Coliform was only 1 cfu/ml. Islam (2009) reported 1(Monsoon) to 0 cfu/ml (in Postmonsoon) in St. Martin Island coastal water. In respect of nutrient NH_4-N, NO_2-N, SiO_3-Si were higher in Monsoon but PO_4-P value were lower in Monsoon and higher in Pre monsoon and Post monsoon.

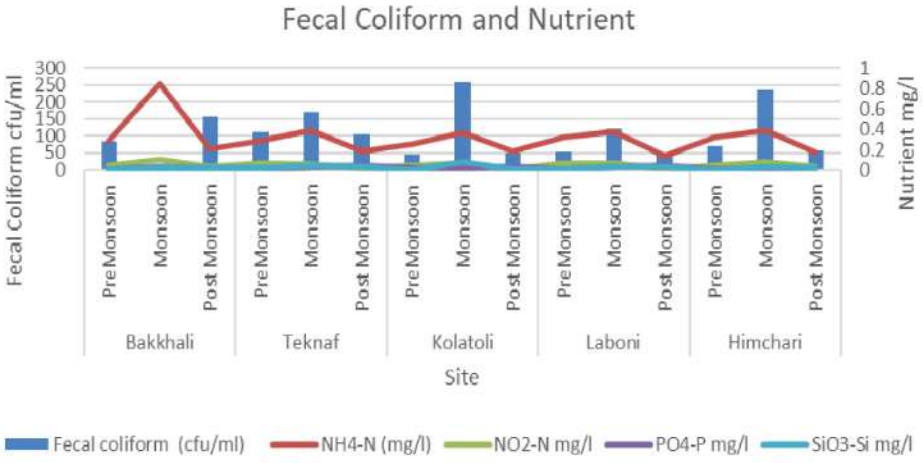


Figure 17. Relation between fecal coliform and nutrients.

Relation between Salmonella and Nutrients: The higher level of Salmonella had shown at all the sites in Monsoon and lower level of Salmonella had shown in Pre monsoon and Post monsoon whereas the, standard value of Salmonella was only 2.7 cfu/ml. Salmonella value ranged from 104 to 0 cfu/ml. Islam (2009) reported 1(Monsoon) to 0 cfu/ml (in Post monsoon) in St. Martin Island coastal water. In respect of nutrient NH_4-N, NO_2-N, SiO_3-Si were higher in Monsoon but PO_4-P value were lower in Monsoon and higher in Pre monsoon and Post monsoon.

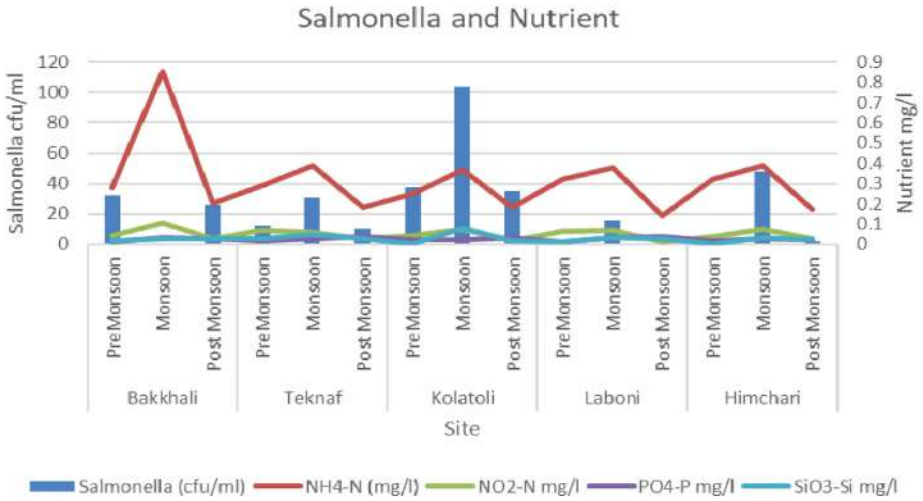


Figure 18. Relation between salmonella and nutrients.

Relation between Vibrio Chlorella and Nutrients: In consideration of season, the higher level of Vibrio Chlorella had shown at most of the sites in Monsoon and lower level of Vibrio Chlorella had shown in Pre monsoon and Post monsoon whereas the, standard value of Vibrio Chlorella was only 51 cfu/ml. Vibrio Chlorella ranged from 271 to 1 cfu/ml. Islam (2009) reported Vibrio Chlorella all the season in St. Martin Island coastal water. In respect of nutrient NH_4-N, NO_2-N, SiO_3-Si were higher in Monsoon but PO_4-P value were lower in Monsoon and higher in Pre monsoon and Post monsoon.

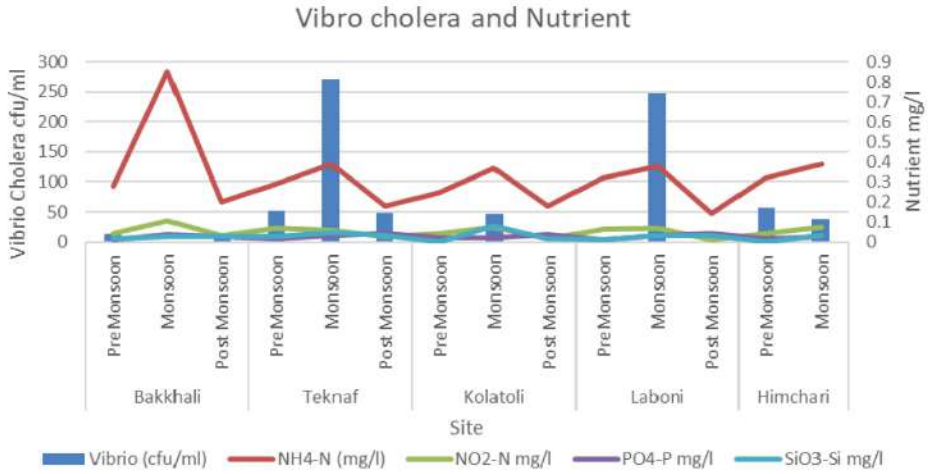


Figure 19: Relation between vibrio chlorella and nutrients.

Relation between Streptococcus and Nutrients: In case of season, the higher level of Streptococcus had shown at all the sites in Monsoon and lower level of Streptococcus had shown in Pre monsoon and Post monsoon whereas the, standard value of Streptococcus was only 1 cfu/ml. In respect of nutrient NH_4-N, NO_2-N, SiO_3-Si were higher in Monsoon but PO_4-P value were lower in Monsoon and higher in Pre monsoon and Post monsoon. According to the Parvizishad et. Al. (2017) high level of nitrite has diverse carcinogenic effect like gastrointestinal tract tumours, Non Hodgkin's lymphoma (NHL) and Urinary tract tumors.

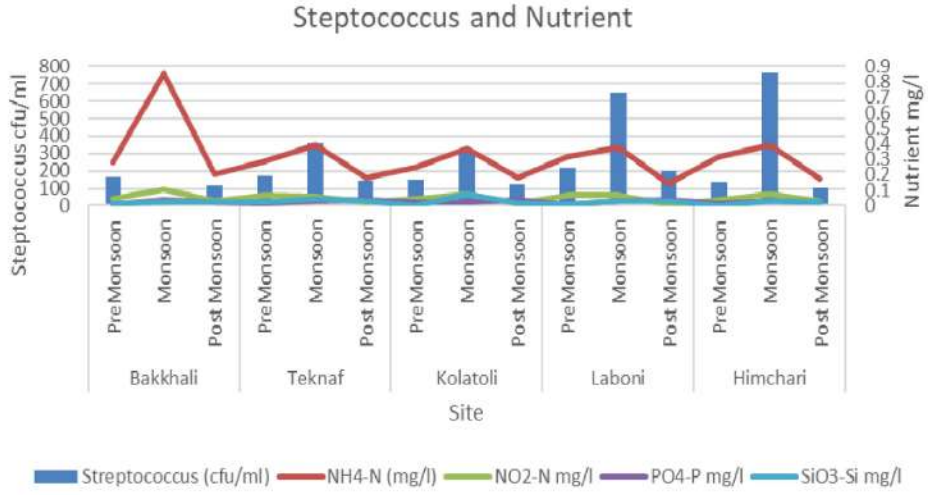


Figure 20: Relation between streptococcus and nutrients.

Conclusion

The research finds microbial load is out of limit for bathing and swimming. Microbial load was related with seasonal nutrient loads. To make a reference for water quality including physical, chemical, microbial water parameters this study will be helpful to future research, public health, safety, ecotourism and sustainable environment. Considering the research experience and results it was recommended that for sustainable tourism, public health issues including bathing experience in this coastal water and disease history it was very important to study in details (Hourly sampling and observation including high tide and low tide).

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References

Ahmed, H.R. (1989). Oceanography of the near shore waters off Chittagong with some notes on productivity. M.Sc. Thesis. IMS, University of Chittagong, Bangladesh. 149 pp.

Ali, S, Saha, S. and Mahmood, N. (1985). Studies on the Physical and Chemical aspects of Maheskhali Channel, Bay of Bengal. Dhaka Univ. Studies. (B) 43-49 pp.

APHA (1999). Standard methods. 20th Edition.

Abhijit Mitra, Avijit Gangopadhyay Anumeha Dube, André C. K. Schmidt and Kakoli Banerjee (2007). Observed changes in water mass properties in the Indian Sundarbans (northwestern Bay of Bengal) during 1980–2007 . Current Science Vol. 97, No. 10, 25 November 2009.

Church MJ. (2008). Resource control of bacterial dynamics in the sea. Microbial Ecology of the Oceans, Second Edition. 335–82 pp.

Devassy,V.P and Bhatachiri, P.N.A. (1981).Distribution of phytoplankton and chlorophyll a around Little Andaman Island .Ind.J.of Mar.Sci.Vol.10. 248-252 pp.

Gilbert JA, Field D, Swift P, Newbold L, Oliver A, Smyth T, et al. (2009). The seasonal structure of microbial communities in the Western English Channel. Environmental microbiology. 11 (12): 3132–9 pp.

Hossain, M.M., Mahmood, N. and Bhouyan, A. M. (1988). Some water quality characteristics of the Karnafully river estuary. Mahasagar. 21(3). 183-188 pp.

Islam, M. Hashibul (2009). Environmental Study of St. Martin's Island of the Bay of Bengal of Bangladesh with emphasis on Physical- Chemical parameters of both water and Sediment. M. Phil Thesis. Institute of Marine Sciences and Fisheries, University of Chittagong, Bangladesh. 226 pp.

Islam, A. K. M. and Aziz, A (1975). Study on the Marine Phytoplankton from the North Eastern Bay of Bengal, Bangladesh. J. Bot. (1-2). 1-32 pp.

Jashimuddin, S.M. (1993). Environmental Impact Assessment of the municipal sewage discharge through Majhirghat canal on the Karnafully river waters, Chittagong. M. Sc. Thesis.IMS, University of Chittagong, Bangladesh. 76pp.

Khan, S.H., Inam, A., Danish, M., Saleen, M., Tabrez, S.M., Ali, S.M., Razzaq, D.A., Amjad, S. and Kidwai, S. (2002). Study of nutrients, Sediment and Carbon fluxes into the Indus delta system, Pakistan. Proceedings (draft) of the workshop on "An assessment of material fluxes to the coastal zone in south Asia and their impacts". 08-11 December 2002, Negombo, Srilanka. 23-35 pp.

Kingsley, I., Renee, M.T., Townsend, S.M., Norris, T.L., Ficht, T.A., Adams, L.G and Baumler, A.J. (2000). Impact of horizontal gene transfer on evolution of Salmonella pathogenesis. In: Virulence Mechanisms of Bacteria Pathogens, 3rd edition.

Laford, K. G. (1958). Seasonal Cycle of the surface Temperature and salinities along the East Coast of India Andhra Univ. Mem. Oceanogr: 2. 12-21 pp.

NZECC, 2000-Australian and New Zealand guideline for fresh and marine water quality (2000).

Palleyi, S, Kar, R N and Panda, C (2011). Influence of Water quality on the biodiversity of phytoplankton in Dhamra River Estuary of Odisha Coast, Bay of Bengal. J. Appl. Sci. Environ. Manage. March, 2011, Vol. 15 (1) 69–74.

Parvizishad, M., Dalvand, A., Mahvi, A. H., and Goodarzi, F (2017). A Review of Adverse Effects and Benefits of Nitrate and Nitrite in Drinking Water and Food on Human Health. Health Scope. 2017August;6(3): e14164.

Radhakrishana, K, Bhuttathiri, P. M. A and Devasy, V. P (1982). Chlorophyll a pheopigment and particulate organic carbon in the Northern and western Bay of Bengal. Indian J. Mar. Sci. Vol. 11, No 4 pp 287-291

Ramanadham, R.T., Rao, N, E and Panigraphy,N.S. (1986). Distribution of Nitrogenous compound in the Western Bay of Bengal. Bull.Mar.Ins.Sci.Ind.Vol.38.125-132 pp.

Sankarnaraynan, V.N. and Reddy, C.V.G (1967), Nutrient of the North western Bay of Bengal, Bull. Nat. Ins. Sci. India. No. 38. 148-163 pp.

SantoshKumar Sarkar, Mahua Saha, Hideshige Takada, Asokkumar Bhattacharya, Pravakar Mishra, Badal Bhattacharya (2007). Water quality management in the lower stretch of the river Ganges, east coast of India: an approach through environmental education. Journal of Cleaner Production, Volume 15, Issue 16, November 2007, Pages 1559-1567

Sarma, N. S and Rao, I. N. (1989). Distribution of chlorophyll-a, organic carbon, nitrogen and Carbohydrate pf Particulate matter of Visakhapatam harbour water, east coast of India. Ind. J. Mar. Sci. Vol. 18. No.1. 24-29 pp.

Satyanarayan, D; Sahu, S.D; and Panigrathy, P. K.(1992). Assessment of eutrophication in the Marine environment of Visakhapatam using nutrient index as a tool. Ind. J. Mar. vol. 21, No 2, pp 155-157

Selvam, v., Azariah, J and Azariah, H (1992). Diurnal variation of physio-chemical properties and primary production in the interconnected marine, mangrove and fresh water biotope of Kakinda coast, Andra Pradesh, India, Hydrobiologia. Vol. 247. 181-186 pp

Shahidullah, M. (1985). Review of exploratory Surveys under taken to assess the Marine fishery resources of Bangladesh and the present status of exploitation. Nat. Symposium Proc.1985. BARC. 129 pp.

Sridhar, R., Thangaradiou, T,. Senthil, S., Kannan, L. (2006). Water quality and phytoplankton characteristics in the Palk Bay, southeast coast of India. India J Environ Biol. 2006 Jul;27(3):561-6.

Shirwaiker, P and Ansari, Z. A. (1987). Impact of marine pollution on living resources–Case studies on the effect of mining activity and organic environment of benthic fauna. National-Science Day, 28 February, 1987. A comparative volume, New Delhi, India. CSIR 087. 96-99 pp.

Sousa, S.N.D., Gupta, R.S., Sanzgiri, S and S. Rajagopal, M.D. (1981a). Studies of nutrients of Maldovi and Zurai River system. Indian. Jar. Mar. Sci. Vol.10. 314-321 pp

Sousa, S.N.D., Gupta, R.S., Sanzgiri, S and S. Rajagopal, M.D. (1981b). Distribution of nutrients in the water of a Bay of Bengal. Indian. J. Mar. Sci. Vol.10. 327-331 pp

Tariq, J. (2017). Destination competitiveness: Attributes affecting tourist decisions- A case study on Cox's Bazar. Journal of Business and Management, 19: 10.

US-EPA, 1996.

Venugopalan, V. K, Vijayalakshmi, G.S and Rajandran, A (1981). Nitrate Phosphate relationship in a tropical estuarine environment. Indian J. Of Mar. Sci. Vol 10, pp 379-381.

Vishnupriya Sowjanya, I. and Raja Sekhar, P.S. 2015. Assessment of Coastal Water Quality through Weighted Arithmetic Water Quality Index around Visakhapatnam, Bay of Bengal, India. Int. J.Rec. Innov. Acad. Res. 1 (1): 11-19.

WHO (2003). Guidelines for Safe Recreational Water Environments, vol. 1, Coastal and Freshwaters. World Health Organization, Geneva, Switzerland.