Asian Journal of Water, Environment and Pollution, Vol. 11, No. 1 (2014), pp. 95–103.

Organic Production of Koromjol, Passur River System of the Sundarbans, Bangladesh

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Received November 20, 2012; revised and accepted October 25, 2013

Abstract: A study on organic production of Koromjol, Passur River System of the Sundarbans was conducted from September 2008 to May 2009. The present study deals with organic production, phytoplankton abundance and nutrients of Koromjol in our sampling station, Koromjol, the values of gross and net primary production were ranged from 18 to 146 and 15 to 86 mgC/m^3/L respectively where maximum were recorded during winter and minimum at rainy season. Supporting biomass and phytoplankton abundance were also given highest values at winter and lowest during rainy season which makes the seasonal variation very significant. Phytoplankton taxa belonging to some major classes, i.e. *Cephaladonia* sp., *Coscinodiscus* sp., *Oscillatoria* sp. and *Melosira* sp. were identified. The ojectives of this study are to determine the organic production, phytoplankton abundance and chlorophyll-*a* with the nutrients of the Passur river.

Key words: Organic production, phytoplankton abundance, chlorophyll, nutrients.

Introduction

Organic production is the production of chemical energy in organic compounds by living organisms. The main source of this energy is sunlight but a minute fraction of organic production is driven by lithotrophic organisms using the chemical energy of inorganic molecules. The organisms responsible for organic production are known as organic producers or autotrophs, and form the base of the food. In terrestrial ecoregions, these are mainly plants, while in aquatic phytoplanktons are primarily responsible. Phytoplanktons are microscopic plants which obtain their energy via photosynthesis.

However, some species of bacteria are also capable of photosynthesis and also fall under this taxonomic category. They are important to the ecosystem because they are part of the primary producing community and assist in recycling elements such as carbon and sulphur which are required elsewhere in the community. The productivity of phytoplankton communities is a function of water quality, substrate and seasonal patterns in temperature and solar illumination. The abundance and composition of the phytoplankton at a given location are governed by the water quality at that point. So observations of their condition generally are useful in evaluating conditions in bodies of water. Changes in primary productivity have been causally linked to the nutrient status of aquatic ecosystems for over a century.

Brandt first proposed that phytoplankton production must be dependent upon the supplies of nitrate-N and phosphate-P to natural waters (Ketchum et al., 1958). However, quantitative tests of Brandt's hypothesis could not be performed until suitable analytical tools for the measurement of primary productivity (the O_2 and 14C methods), and for the measurement of water

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column concentrations of inorganic nutrients, could be developed. as revealed by both the oxygen and radiocarbon techniques. A decade later, Ketchum (1970) confirmed the existence of very strong links between nutrient availability and phytoplankton production by demonstrating a tight relationship between the concentrations of phosphorus and phytoplankton biomass (measured as chlorophyll-*a* (Chla)) in river water samples. Increased nutrient loads have augmented the proliferation and increased distribution of harmful algal blooms in estuaries and coastal waters across the world (Anderson et al., 2002). These blooms harm ecosystems, fishery resources, human health and recreation use through the smothering of benthic habitats and the toxic nature of some species (Carmichael et al., 2001).

One species of concern is the benthic, non-heterocystous, nitrogen fixing cyanobacterium *Lyngbya majuscula* (family Oscillatoriaceae) (Dennison et al., 1999). It appears to be a cosmopolitan species found throughout tropical and subtropical estuarine and coastal waters worldwide (Dennison et al., 1999; Diaz et al., 1990). *L. majuscula* consists of fine, filamentous strands approximately 10–30 cm in length and forms benthic mats growing on the sediment, or loosely attached to substrates such as seagrasses, macroalgae, corals and rocky outcrops in the intertidal zone, to a depth of approximately 30 m (Dennison et al., 1999). Primary productivity measurements should be mandatory in monitoring networks and should be included as a parameter in eutrophication assessments. Rates of primary productivity indeed have been included as a component of many trophic state assessments frameworks for aquatic ecosystems worldwide (Andersen et al., 2006; Rodhe, 1970). However, authors wish to stress in this paper that the units of primary productivity that are chosen for use in future monitoring and restoration efforts will be very important, because not all measures of primary productivity vary monotonically (or even straightforward) with changes in aquatic fertility.

The Sundarbans aquatic habitat is one of the most important natural resources, which has been declared as the world heritage in 1999. It is the largest single continuous productive mangrove forest of the world spreading over the southern part of Bangladesh and West Bengal state of India. A complex network of streams and rivers varying considerably in width and depth intersects the entire area of Sundarbans. The coastal region of the Sundarbans is quite densely populated. The mangroves being adjacent to urban or populated areas are susceptible to pollution by a number of ways. The garbage and solid wastes are transported and dumped in mangrove areas, which are traditionally regarded as wasteland (Saenger et al., 1983). Disposal of waste affects the mangrove regeneration, productivity and waterways closed to mangrove ecosystem. Liquid waste disposal from industries and sewerage also causes toxicity in the mangrove environment. Apart from this, impact of shrimp farming in coastal region and oil spills in coastal water is a matter of great concern affecting the mangrove ecosystems in various ways. The productivity of the Sundarbans water has gone down with water becoming polluted by the toxic effluents discharged from the huge number of shrimp farms in nearby areas, with dumping of domestic and industrial wastes from the Mongla port. The implications of the deteriorating quality of the receiving waters are considerable both in the immediate situation and over the longer time. So, the importance of the study lies in the fact that those fish lives in water and the medium in which it lives must have some effect on the production of phytoplankton. The specific objectives of this study are: (a) to determine the organic production of Koromjol, (b) to measure the biomass and phytoplankton abundance, (c) to determine the concentrations of chlorophyll-*a* and (d) to determine the concentration of major nutrients like total nitrogen, total phosphorous and silicon.

Materials and Method

Location

The Sundarbans, the largest continuous mangrove forest in the world (Chaudhuri and Naithani, 1985) is located at the south of the Tropic of Cancer and the southern extremity of the Ganges River delta i.e., the plain bordering the northern margin of the Bay of Bengal. The Bangladesh Sundarbans lies between the latitudes 21°31′ and 22°30′ N and between the longitude 89° and 90°E. The forest covers an area of about 10,000 m^2 of which 62% falls within the territory of Bangladesh while the remaining areas belong to India. It occupies a land area of 401,600 ha, of which 395,500 ha are covered by forests (Chaffey et al., 1985). Of the total area, approximately 70% are lands and 30% are waters. The distance between the northern and southern boundaries averages about 80 km. The east to west distance within Bangladesh is about 80 km. The Sundarbans is bound by heavily populated agricultural land on the north and east, and by the Indian Sundarbans on the west. The Sundarbans may be classified as tropical moist forests (Holdridge et al., 1964).

Sampling Site

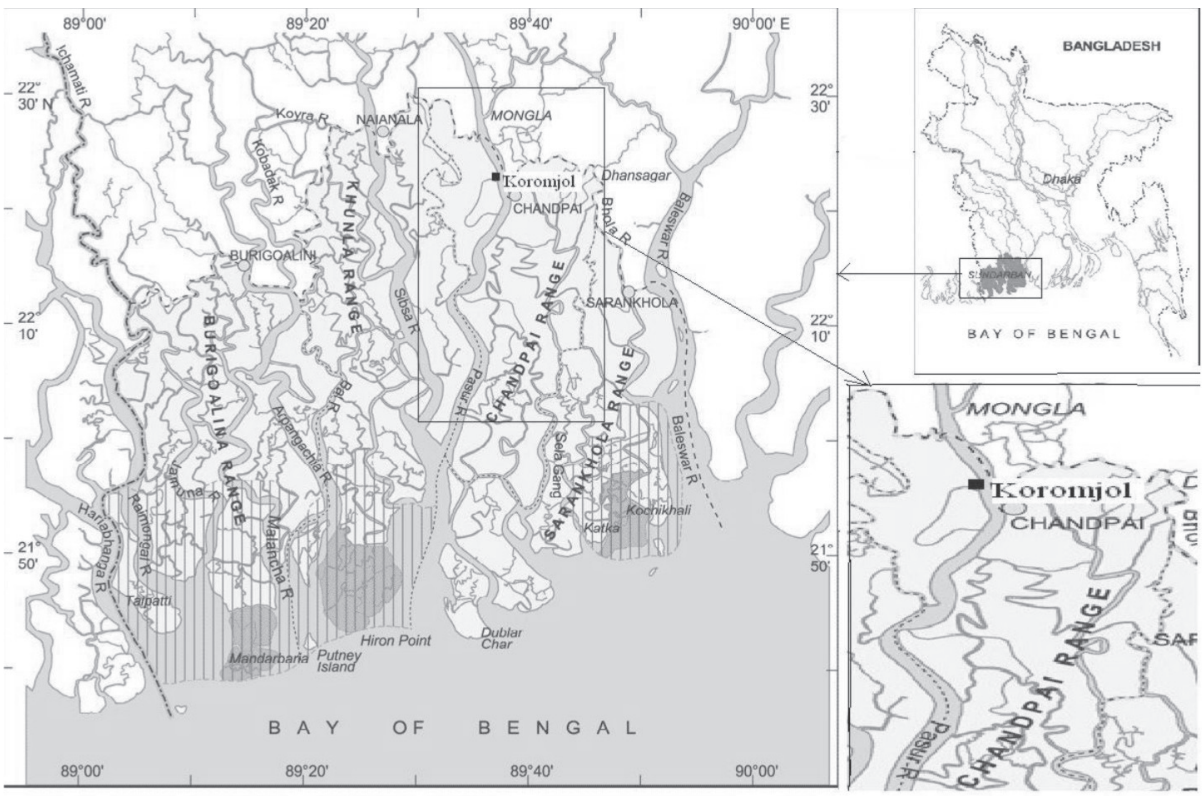
A large number of channels and creeks flow into larger rivers in the Sundarbans. The largest of these rivers are the remains of the Ganges which has shifted eastward and is named the Gorai river. This river, the main tributary of the Ganges, is connected to Passur river and also has an indirect link to the Sibsa river. These two rivers play an influential role in the Sundarbans ecosystems. Passur river is a stream and is located in Khulna, Bangladesh. The latitude and longitude of the Passur river is 21°52′50.23″ and 89°32′47.62″ respectively. The water and phytoplankton samples were collected from the Pussur river at the Sundarbans. The specific location map showing the sampling stations is given in Figure 1.

Sample Collection

Plankton contributions from adjacent lakes, reservoirs and backwater areas, as well as soil organisms carried into the stream by runoff, also can influence data interpretation. The depth from which water is discharged from upstream stratified reservoirs also can affect the nature of the plankton. In lakes, reservoirs and estuaries where plankton populations can vary with depth, samples should be collected from all major depth zones or water masses. The sampling depths will be determined by the water depth at the station, the depth of the thermocline or an isohaline, or other factors (APHA, 1998).

Phytoplankton samples were collected by immersing three 150-ml bottles 5-20 cm beneath the surface. A 150-ml syringe was used to fill the bottles when depths were lower.

Samples were collected from one station at four months intervals. The first sample was collected in rainy season i.e. September 2008, the second was collected in winter season i.e. January 2009 and the another sample was collected in summer season i.e. May 2009. Variables measured in situ were depth, water temperature, electrical conductivity at 25 °C (conductrometer calibrated against a KCl standard), and pH. Two water samples were collected in plastic bottles in order to analyze total nitrogen (TN) and total dissolved solids (TDS). Samples for measuring total phosphorus (TP) were collected in two glass bottles. These were measured in the laboratory according to standard techniques (APHA, 1998).



Part of Sundarban, Locate Study Area

Study Area

Figure 1: The location map showing the sampling stations.

Phytoplanktonic chlorophyll-*a* (Chl a) concentrations were estimated from triple water samples that were collected from the same place where the in situ variables were measured. Water samples were filtered in situ through Whatman GF/F glass microfibre filters (0.7 µm) and then placed in 5 ml of 90% acetone solution for 24 h at 4 °C in the dark for extraction. Chl a was measured with a spectrophotometer and its concentration calculated by Jeffrey and Humphrey (1975) trichromatic method. The primary productivity of phytoplankton was measured in situ by suspending light and dark polyethylene bottles 15 cm below the water surface for a 2-h incubation period at midday.

Sample Preservation and Storage

The most suitable phytoplankton preservative is Lugol's solution, which can be used for most forms including the naked flagellates. Unfortunately, acidic Lugol's solution (or formalin) dissolves the coccoliths of Coccolithophores, which are common in estuarine and marine waters.

Using Lugol's solution: To preserve samples with Lugol's solution, 0.3 mL Lugol's solution to 100 mL sample was added and stored in the dark. For long-term storage 0.7 mL Lugol's solution per 100 mL sample was added and buffered formaldehyde to a minimum of 2.5% final concentration after 1 h.

Preparation of Lugol's solution: Dissolved 20 g potassium iodide (KI) and 10 g iodine crystals in 200 mL distilled water containing 20 mL glacial acetic acid.

Preparation of modified Lugol's solution: Utermohl's modification of Lugol's solution results in a neutral or slightly alkaline solution. Dissolved 10 g KI and 5 g iodine crystals in 20 mL distilled water, and then added 50 mL distilled water in which 5 g anhydrous sodium acetate has been dissolved (APHA, 1998).

Using formalin: To preserve samples with formalin, 40 mL buffered formalin (20 g sodium borate, $Na_2B_2O_4$ + 1 L 37% formaldehyde) was added to 1 L sample immediately after collection. In estuarine and marine collections, pH adjusted to 7.5 with sodium borate for samples containing Coccolithophores (APHA, 1998).

Analysis

Appropriate chemical analysis procedures can be determined via reference to accepted published procedures Standard Methods for the Examination of Water and Wastewater (APHA, 1998).

Determination of Organic Production

Light and dark chamber method: Samples of typical periphyton communities were grown on artificial substrate or collected natural material. Transferred identical portion to both clear and opaque chambers, taking care to use sufficient periphyton to make the ratio of chamber volume to periphyton area equivalent to the ratio of stream volume to periphyton substrate area. Measured current in the stream and match the circulation rate in the clear and opaque chambers to the current. Measured DO concentrations initially in both clear and opaque chambers and after 1 to 3 h to estimate the rate of oxygen increase or decrease. Made concurrent measurements of phytoplankton activity using light and dark bottle technique. Incubated light and dark bottles for the same time interval as the chambers.

Determination of Phytoplankton Abundance

Phytoplankton samples were collected both qualitatively and quantitatively from 16 stations by using simple conical tow-net mesh size 90 µm and Lugol's solution of 0.3 ml per 100 ml samples was used for preservation. Phytoplankton cells were enumerated under a light microscope and identified, while Sedwick-Rafter cell was used for quantitative analysis of phytoplankton.

Determination of Chlorophyll

After collection, the samples were concentrated by centrifugation. The samples were placed in a tissue grinder, covered with 2 to 3 ml 90% aqueous solution and macerated at 500 rpm for 10 min. Transferred sample to a screw-cap centrifuge tube, rinsed with a few ml 90% aqueous acetone and added the extraction slurry. Adjusted total volume to 10 ml with 90% aqueous acetone. Used solvent sparingly and avoided excessive solution of pigments, for dry samples at least 2 h at 4°C. Glass fibre filters of 25 and 47 mm dims have dry displacement volumes of 0.03 and 0.10 ml respectively. Transferred 3 ml clarified sample to a 1-cm cuvette and read optical density at 750 and 665 nm. Acidify extract in the cuvette with 0.1 ml 0.1 N HCl and read optical density at 750 and 665 nm after acidification.

Determination of Total Nitrogen

In a 50 ml sample, 40 ml 1 N KCl solution was added and the content shaken for 30 minutes. The content was filtered with WN-1 filter paper. The aliquate was the extract (sample). 10 mL extract sample was taken for distillation. Added 0.2 g Davarda's alloy and 10 ml 10% NaOH into the sample. NH_3 was collected into 10 ml 4% boric acid mixed indicator solution for 3 minutes up to about 50 ml. Titrated the solution against standard

0.01 N H_2SO_4 (Colour change from green to wine red). A blank was carried during the experiment.

Determination of Total Phosphorus
10 ml sample was taken in a 50 ml test tube and added 10 ml colouring reagent. Finally the volume was made 25 ml with deionized water and thoroughly mixed the content. Spectrophotometer reading (absorbance) was taken at 470 (400 to 490) nm wavelength after 10 minutes. The colour develops rapidly; however, the reading is taken after 10 minutes to assure full strength. This is a permanent colour and reading can be taken even after a week.

Determination of Silica
In a 50 ml sample added 1.5 ml of mixed reagent (50 ml ammonium molybdate solution was added with an equal volume of the sulphuric acid reagent under mixing) by the micropipette and mixed well. Then, 10-20 minutes later, 1 ml oxalic acid was also added followed by 1 ml ascorbic acid solution by micropipette and mixed it well. After that, absorbance reading was recorded from spectrophotometer at 810 nm wavelengths after 30-40 minutes against reagent blank as reference.

Results and Discussion

Organic Production
The productivity, the rate at which inorganic carbon is converted to organic carbon, was ranged 15 to 86 mgC $m^{-3}h^{-1}$ as net and 18 to 146 mgC $m^{-3}h^{-1}$ as gross in this study (Table 1). Chlorophyll-bearing organisms (phytoplankton, periphyton, macrophytes) serve as primary producers in the aquatic food chain. Photosynthesis ultimately results in the formation of wide range of organic compounds, release of oxygen, and reduction of carbondioxide in the surrounding water. These values are much more higher than at Jagannath canal of the Sundarbans in West Bengal, India. The values of Jagannath canal varied from 5.81 to 22.16 mgC $m^{-3}h^{-1}$ (Saha et al., 2001). Another study carried out in Mandovi (11.25-45.82 mgC $m^{-3}h^{-1}$) and Zuari estuary of Goa (12.49-48.40 mgC $m^{-3}h^{-1}$) (Dehadrai et al., 1972). Qasim (1979) found 11.78-36.99 mgC $m^{-3}h^{-1}$ in Vellar estuary. Higher photosynthetic production of 19.71-40.83 mgC $m^{-3}h^{-1}$ was also observed by De et al. (1991) in Hugli estuary. Estimates of net primary production by phytoplankton mostly fall within the range 0.05-0.5 gC/m^2/day with values as high as 5 gC/m^2/day in the most productive sea areas. Phytoplankton productivity in mangrove waterways may be quite high. In the coastal lagoons of the Ivory Coast production may be up to 5 gC.m^{-3}.d^{-1} (Pages et al., 1981). Such high production rates occur in lagoons which receive significant quantities of nitrogen and phosphorus from adjacent human population. However, even in systems which do not have high eutrophication rates, phytoplankton primary production can still be substantial. For instance the coastal lagoons of Mexico, daily production can be up to 2.4 g C.m^{-3}.

Phytoplankton productivity appears to be significantly lower in estuarine mangrove areas than in lagoons fringed by mangroves, or in open embayment fringed by mangroves. For instance, in the large delta of the Fly river in Papua New Guinea, Robertson et al. (1992) measured daily production rates ranging from 22 to 693 mgC.m^{-2}, similar to value 10-1068 mgCm^{-3}.d^{-1} (Lee, et al., 1984) measured in Malaysian estuarine mangrove systems. The relative importance of phytoplankton to total mangrove system primary production varies with geomorphology of the study site, the rates of flow of water and consequently the turbidity and rates of delivery of nutrients. The earliest attempts to measure organic production in aquatic ecosystem were indirect, being based on estimates of the total amount of plant materials in the water, i.e. the standing stock. The size of the standing stock depends upon the balance between the rate of production of new plant cells and the rate at which they are lost by animal consumption and by sinking below the photosynthetic zone. To determine production rates from standing stock measurements

Table 1: Seasonal variation of organic production of the Karamjal creek, The Sundarbans Mangrove Forest, south-west of Bangladesh

Season	*Production in mg $O_2L^{-1}h^{-1}$*		*Production mgC $m^{-3}h^{-1}$*	
	Net production	*Gross production*	*Net production*	*Gross production*
Rainy season	0.04	0.05	15	18
Winter season	0.23	0.39	86	146
Summer season	0.11	0.21	41	78
Jagannath canal				5.81 to 22.16

a: Saha et al., 2001

it is therefore necessary to estimate both the rate of change in size of the population and also the rate of loss, the latter being particularly difficult to assess with any certainty.

Chlorophyll

The concentrations of chlorophyll-*a* in the studied area were 2.67, 4.11 and 3.34 µg/L in rainy, winter, and summer season respectively as shown in Table 2. According to Hoq et al. (2006) in the Sundarbans, chlorophyll-*a* value was fluctuating among different months although low chlorophyll-*a* was recorded in premonsoon and monsoon seasons in Koyra, Kholpatua and Madar rivers of Sundarbans. Higher range of chlorophyll-*a* value was obtained during winter months. The highest mean chlorophyll-*a* value recorded was 15.47 µg/L and the lowest was 0.48 µg/L. Very low concentration of chlorophyll-*a* (<0.01 µg/L) was recorded at some sampling sites. The concentration of chlorophyll-*a*, the dominant photosynthetic pigment in phytoplankton, is widely used by biological oceanographers as a proxy for phytoplankton carbon biomass. Because it is operationally difficult to distinguish routinely organic carbon in autotrophic phytoplankton from that in microheterotrophs and detritus, measurement of chlorophyll-*a* remains the best chemical index of the biomass of natural assemblages of autotrophic phytoplankton (Cullen, 1982).

The concentrations of chlorophyll-*a* in mangrove waterways is highly variable (Table 2). For instance, in pristine mangrove systems such as in Missionary Bay in tropical Australia and in the Fly river in New Guinea there is a relatively narrow range of chlorophyll concentrations from 0.15 to 5.07 µg/L. By contrast, in areas close to large human populations, or in regions where large monsoonal rainfall delivers high concentrations of nutrients to enclosed mangroves lagoons, chlorophyll-*a* concentrations may reach 60 µg/L. In an another study, chlorophyll pigments recorded significant seasonal variation ranging from ND to 40.86 µg/L (chlorophyll-*a*), ND to 6.00 µg/L (chlorophyll-*b*) and ND to 13.80 µg/L (chlorophyll-*c*). Both monsoon and post-monsoon seasons recorded higher concentration of pheophytin compared to chlorophyll-*a* and the maximum concentration of chlorophyll was observed during pre-monsoon (Manju et al., 2012).

Phytoplankton Abundance

There have been few studies of phytoplankton species diversity in mangrove habitats, but there is an indication of a relatively low diversity of phytoplankton taxa (Kutner, 1975; Ricard, 1984).

Phytoplankton is globally the most important amongst the primary producers, which form base line of many food webs considered in the aquatic environment. The maximum phytoplankton abundance was recorded in winter season, when the water level was low. The minimum abundance was recorded in rainy season, when the water level was high. The densities of net phytoplankton cells varies over four orders of magnitude within and between different mangrove waterways. For instance, in Guadeloupe, Ricard (1984) recorded densities of net phytoplankton of 2×10^4 to 5×10^8 cells.l^{-1} over an annual cycle. Berner (1951) found paucity of plankton and benthos in the Missouri river and concluded that swift current is perhaps the most important factor, limiting aquatic life in this river. Chakraborty et al. (1959) in a study on the plankton and the physico-chemical conditions of the river Jamuna, observed that current, turbidity and sudden influx of the river water act as controlling factors or even lethal factor as instanced by depletion of plankton. Allen (1920) also stated that water current above a very moderate speed is distinctly detrimental to plankton development. The species which were observed in this study are shown in Table 3.

Table 2: Comparison of chlorophyll-*a* of this study and other studies

Seasons	*Concentration µg/L*	*References*		
		Location	*Habitat*	*Chlorophyll-a (µg/L)*
Rainy	2.67	India[1]	Estuarine mangroves	2.1
Winter	4.11	India[2]	Coastal lagoon	4.36-39.8
Summer	3.34	Malaysia[3]	Estuarine mangroves	0.53-21.20
		Australia[4]	Mangrove creek	1.3
		New Guinea[5]	Estuarine mangroves	0.25-5.07

[1]Pant et al., 1980; [2]Sunderaraj and Krishnamurthy, 1973; [3]Lee et al., 1984; [4]Boto and Bunt, 1981b; [5]Robertson et al., 1992.

Table 3: Seasonal variation of phytoplankton population in Karamjol creek, SRF, Bangladesh

Season→	*Rainy*	*Winter*	*Summer*
Species→	Navicula sp.	Oscillatoria sp.	Discoidia sp.
	Cephaladonia sp.	Navicula sp.	Oscillatoria sp.
	Discoidia sp.	Melosira sp.	Coscinodiscus sp.
	Coscinodiscus sp.	Fragillaria sp.	Navicula sp.
	Oscillatoria sp.	Coscinodiscus sp.	Cephaladonia sp.
	Fragillaria sp.	Cephaladonia sp.	Melosira sp.
	Melosira sp.	Discoidia sp.	Fragillaria sp.
Total Counting→	3000-3100 units/L	5800-5900 units/L	3500-3600 units/L

Total Nitrogen

The results obtained for the Passur river water samples from Koromjol sampling sites during three seasons are presented in Table 4. The total nitrogen (TN) values in water samples from Koromjol was obtained relatively low. The highest and lowest levels of TN in Passur river were observed during rainy season and winter season respectively. The major forms of nitrogen in aquatic system are nitrate, nitrite and ammonia. The combined forms of these elements do occur and may well be utilized by some organisms in periods of nitrate starvation. Nitrogen in soluble may be used by those blue-green algae capable of nitrogen fixation.

Based on the catchments characteristics the tributaries or reaches can be classified into four types, including headwater in mountainous areas (type I), agricultural non-point source (NPS) pollution in rural areas (type II), municipal and industrial pollution in urban areas (type III), and combined pollution in main stream (type IV). The mean concentrations of TN were decreases in the sequence: type III > type IV > type II > type I (Jin et al., 2009). The anthropogenic sources which contribute a significant amount of nitrogen in water bodies are sewage treatment plant effluents, agriculture, urban developments, paper plants, industrial effluents, recreation and mining (blasting residuals). Only a limited industrial effluent influences the study area. Some influences occurred for recreation and mining. So, the result we obtained becomes low.

Total Phosphorous

The total phosphorus obtained for the Passur river water samples from Koromjol sampling sites during three seasons are presented in Table 4. During rainy season the concentration of total phosphorus in Koromjol was 0.7 mg/L which was the maximum concentration. The recorded minimum concentration was 0.06 mg/L in winter and finally during summer season the concentration of total phosphorous was 0.135 mg/L. In natural water phosphorous occurs in solution in both inorganic and organic forms; in river orthophosphate appears to be the main source. It is an essential plant nutrient and is often the most limiting nutrient to plant growth in fresh water. Sewage treatment plant effluent, agriculture, urban developments (particularly from detergents), industrial effluents etc. were responsible for growth of phosphorus during rainy season.

Silicon

The concentrations of silicon in water at Koromjol in Sundarbans coastal area ranged from 0.6 to 2.4 mg/L when highest value (2.4 mg/L) was recorded during rainy season and lowest value (0.6mg/L) in winter. The concentrations of silicon in different seasons are presented in Table 4. In a study in Sundarbans, Chaudhuri et al. (2012) showed that silicate concentration was observed to be 24.23 μmol/L in post-monsoon, 14.58 μmol/L in pre-monsoon and 22.47 μmol/L in monsoon. Highest silicate concentration was recorded in October

Table 4: The concentration of total nitrogen (TN), total phosphorus and silicon values in mg/L in water samples during three seasons

Sample station name	*Season*	*Concentration of TN (mg/L)*	*Concentration of TP (mg/L)*	*Concentration of silicon (mg/L)*
Koromjol	Rainy	1.7	0.7	2.4
	Winter	0.8	0.06	0.6
	Summer	1.2	0.135	1.1

(29.58 μmol/L) and lowest in June (11.02 μmol/L). Diatoms require silicate in soluble form for wall silicification. The silicoflagellates are also dependent on silicate for construction of their tubular skeleton and some scale-bearing flagellates. At the time of maximum diatom growth, natural water shows a decline in silicate content. During rainy season the sources of silicon, specially domestic and industrial, are in mobile phase which contribute to increase the concentration of silica in water body. Dissolved silica (DSi) is believed to enter aquatic ecosystems primarily through diffuse sources by weathering. Point sources have generally been considered negligible, DSi inputs from domestic and industrial sources. In addition, particulate amorphous silica (ASi) inputs from terrestrial ecosystems during soil erosion and in vegetation can dissolve and also be a significant source of DSi.

Conclusion

Sundarbans is the largest single continuous productive mangrove forest of the world spreading over the southern part of Bangladesh and West Bengal state of India. It is now facing a number of problems including salinity increase in western part of the forest, siltation, pollution due to man-made activities. Organic production is one of the important events in the aquatic ecosystem processes. Koromjol is first forest station of the Sundarbans situated along the Passur river. Anthropogenic activities are much more prominent than any other station of the forest. This station was selected for the study of organic production in aquatic system. The organic production of the investigated area was moderately good. The influences of major (total nitrogen, total phosphorous and silicon) nutrients were dominant on the overall production and biomass of the Sundarbans aquatic ecosystem.

Since the actions and reactions of both biotic and abiotic factors constitute a complex ecosystem dynamics, their exact environmental role or function cannot be described individually. However, the productivity of phytoplankton communities is a function of water quality, substrate, and seasonal patterns in temperature and solar illumination. So observations of their condition generally are useful in evaluating conditions in bodies of water. Current, turbidity and sudden influx of river water can act as controlling factors or even lethal factor as instanced by the depletion of plankton. As the Sundarbans Reserved Forest area plays an important role in supplying different varieties of fishes for both domestic use and export purposes, ideal condition should be maintained for the optimum growth of phytoplankton. In order to keep the aquatic world of Sundarbans sustainable, it should be protected from unwarranted production, degradation and pollution. There should be both national and bilateral strategy to protect this largest mangrove forest of the world with its biodiversity and productivity. Policy planners of both Bangladesh and India should come forward with immediate and long-term strategies for sustainable development of the area.

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Calendar of Events

4th International Conference on Future Environment and Energy - ICFEE 2014
4th to 5th January 2014
Melbourne, Australia
Website: http://www.icfee.org/
Contact person: Mr. Issac Lee
Organized by: CBEES

3rd International Conference on Climate Change and Humanity - ICCCH 2014
4th to 5th January 2014
Melbourne, Australia
Website: http://www.iccch.org/
Contact person: Ms. Lydia Liu
Organized by: CBEES

1st Journal Conference on Environmental Science and Development (JCESD 2014 1st)
24th to 25th January 2014
Macau, China
Website: http://www.ijesd.org/jcesd/1st/
Contact person: IJESD Committees
Organized by: CBEES

5th International Conference on Environmental Science and Development – ICESD 2014
19th to 20th February 2014
Singapore
Website: http://www.icesd.org/
Contact person: Mr. Issac Lee
Organized by: CBEES

3rd International Conference on Clean and Green Energy - ICCGE 2014
19th to 20th February 2014
Singapore
Website: http://www.iccge.org/
Contact person: Ms. Sophia Du
Organized by: CBEES

Two-day National Conference on Sustainable Water Resources Management
21st to 22nd February 2014
Vizianagaram, Andhra Pradesh, India
Website: http://www.swarm14.webs.com
Contact person: Mr Ch.V Ravi Sankar
Organized by: MVGR College of Engineering and AICTE, India

International Conference on Renewable Energy (ICRE 2014)
21st to 23rd February 2014
Pune, India
Website: http://www.saise.org/icre2014
Contact person: Mr. Zeke Zhou
Organized by: SAISE

International Conference on Environmental Engineering (ICEE 2014)
21st to 23rd February 2014
Pune, India
Website: http://www.saise.org/icee2014
Contact person: Ms. Teresa Zhang
Organized by: SAISE

4th International Conference on Environment and Industrial Innovation (ICEII 2014)
12th to 13th March 2014
Penang, Malaysia
Website: http://www.iceii.org/
Contact person: Ms. Eve Li
Organized by: CBEES

International Conference on Biological, Civil and Environmental Engineering (BCEE -2014)
17th to 18th March 2014
Dubai, United Arab Emirates
Website: http://www.iicbe.org/2014/03/17/39
Contact person: Conference Secretary – BCEE - 2014
Organized by: International Institute of Chemical, Biological & Environmental Engineering