Ionic constituents of water of sundarban mangrove forest of Bangladesh

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Abstract: A study was conducted in the Department of Agricultural Chemistry, Patuakhali Science and Technology University to assess the ionic level of water in the selected areas of the Sundarbans Mangrove Forest of Bangladesh. Water samples were collected from Burigoalini and Kadomtola ranges under Satkhira district of the Sundarbans during July to December 2014. The water samples were analyzed for P, K, S, Ca, Mg, Cu, Mn, Zn, Fe and B. The pH and EC values of water were also analyzed. The highest EC value of water was found in Kalagasia canal and the lowest was in Chunkuri River. River waters of Burigoalini area were detected as slightly acidic to alkaline. All the river waters in this area found very strongly saline level (EC>16.0 dSm^{-1}). The concentrations of S, K, Cu, Mn, Zn, Fe and B were found higher and P, Ca and Mg were lower at higher EC levels. The concentrations of S, K, Cu and B in most of the rivers exceeded the permissible level for aquaculture. The river waters of Kadomtola area were detected as slightly acidic to neutral and very strongly saline. The variations in pH and EC were not so pronounced in different rivers of this area. The concentration of P and Fe was found very poor in all the rivers and K, Ca, Cu and Mn were found lower and Mg, Zn, Fe and B found higher at increased EC levels.
Key words: Ionic constituents, pH, EC, Mangrove forest.

Introduction

The sundarban forest one of the largest mangrove forest in the world located in the southwest of Bangladesh. The Sundarbans of Bangladesh is very rich in biodiversity and provides economic, social and ecological benefits to the country. The mangrove ecosystem provides living support to nearly 10,00,000 coastal people through fishing, collecting honey, wax and timber hunting etc. It has also a buffer function, protecting the densely settled agricultural areas at the north from the full force of cyclones and other disasters. The ecosystem of the forest which is full of awe. Negative natural and anthropogenic impacts and overexploitation of natural resources have caused severe damage to the ecosystem (Carpenter *et al.,* 1998). The ecosystem of this forest largely depend on the availability of adequate fresh water (Muhibbullah *et al*., 2005). There are about 165 industries in the upstream Khulna district which is one of the major causes of water pollution which affects the ecosystem also (Wahid *et al*., 2007). Nutrients in water play an important role in lives of aquatic organisms including fish. The quality of water is identified in terms of its physical, chemical and biological parameters (Sargaonkar and Deshpande, 2003). Mangroves act as perennial source for the Eh, pH, salinity, total alkalinity, dissolved O_2, NO_2, PO_4, SiO_2 and NH_4^+ (Bava, 1998). Increasing amount of saline water could result in a negative effect on crop yield. Development of salinity ,sodicity and toxicity not only reduce crop productivity and crop quality but also limit the choice of crops. Suspended solids carry down attached nutrients and agricultural chemicals causing water pollution in the downstream (Sthiannopkao *et al.,* 2006). Mangrove forests are efficient barriers to heavy metal transport and may be considered in management plans of industrial pollution in tropical coastal areas (Silva *et al*., 1990).

The future of the sunderbans will largely depend upon the management of fresh water where the over use of pesticide, excess use of fertilizer and industrialization polluted the water bodies of the forests. Over population and poverty forced people towards crop intensification, use of HYV and dependency on chemical fertilizer. The present study was carried out for the evaluation of ionic constituents of mineral elements of water in sunderban mangrove.

Materials and Methods

Water sample were collected during July 2014 to December 2014 from the Sundarbans west forest division under Satkhira district. It is well known that water sampling in any site is not possible due to unavailability of transport facilities and life safety and security in the jungle. The entire samples were collected from different suitable locations at Satkhira region of the Sundarbans to achieve the target of getting representative samples.The samples were brought to the laboratory, processed and reserved accordingly.

Water sampling locations under Burigoalini Station were Kholpetua river at Kalagasia, Kalagasia canal, Katheshwar khal, Katheshwar canal (inside), Kholpetua river at Katheshwar, Kholpetua river (middle point), Borokeya khali river, Chhotokeyakhali river, Chunkuri river

Water sampling locations under Kadomtola Station were Kalindi river at Koikhali, Koikhali river, Panchmukha river at Koikhali, Madari river, Mirgang riverat Tangrakhali camp, Malancho river at Kadamtola, Ichamoti river at Kadomtola, Malancho river at Munsigonj, Mirgang riverat mirgang camp.

Water sampling techniques for quality assessment followed were outline by Clesceri *et al.* (1989). The analytical methods are followed for analysis of soil sample is given bellow with their parameters. pH was measured by glass electrode pH meter (Ghosh *et al.*, 1983; Jackson, 1962). Electrical conductivity was determined electrometrically by a conductivity meter (Anderson and Ingram, 1996). Available water phosphorus was determined by Olsen's method (Olsen *et al.*, 1954) calorimetrically using $SnCl_2$ as reductant. Sulphur of water were determined by turbidimetric method with the help of a spectrophotometer (Page *et al*., 1982). Calcium of water were determined by complexometric method of titration using Na_2-EDTA as a complexing agent (Page *et al.*, 1982 and APHA, 2005).

By using the Na_2EDTA in the reaction, magnesium was estimated titrimetrically (Page *et al.*, 1982 and APHA, 2005). Potassium of water samples were determined with the help of flame emission spectrophotometer. Water were analyzed for determination of Zn, Fe, Cu and Mn content directly by atomic absorption spectrophotometer (AAS)

(Model, 170-10, Hitachi) following the procedure suggested by McLaren *et al*. (1984).

Results and Discussion

The pH, EC and ionic constituents of waters at Burigoalini area of the Sundarbans in Satkhira district.

a. The pH and EC values in water: The highest pH was found in the water of the river Kholpetua at Katheshwar and the lowest was in the water of the same river at Kalagasia. The highest EC value was found in Kalagasia canal and the lowest was in Chunkuri River. River waters of this area were detected as slightly acidic to alkaline (Table 1). All the river waters in this area of the Sundarbans contained EC at very strongly saline level (EC>16.0 dSm^{-1}) and this might be due to the evaporation of river water in the sampling period.

b. The status of P and S in water: The concentrations of P and S varied from traces to 0.108 and 30.37 to 115.60 mgL^{-1}. The highest P was detected in Kholpetua River at Kalagasia. The highest S was found in Kholpetua river middle point and the lowest was in Chotokeyakhali River (Table 1). The concentration of S was found higher and P was found poor at higher EC levels. Sulphur concentrations in most of the rivers exceeded the permissible level for aquaculture. The concentration of S was much higher if we consider it as irrigation water (Duncan, 2000).

Table 1. The pH, EC and ionic constituents of mineral elements of water at Burigoalini Station area of the Sundarbans

Sl.	Location	pH	EC (dSm^{-1})	P	K	Ca	Mg	S	Cu	Mn	Zn	Fe	B
								(mgL^{-1})					
1	Kholpetua river (Kalagasia)	6.5	23.1	0.108	180.251	0	0.946	39.66	0.019	0.006	0.057	0	2.2
2	Kalagasia Canal	6.8	24.95	0	182.206	0	0.98	36.16	0.029	0.076	0.046	0	2.43
3	Katheshwar Khal	6.8	24.9	0.016	181.033	0	0.916	114.5	0.026	0.012	0.067	0.004	2.25
4	Katheshwar Canal	6.9	24.85	0	181.42	0	0.974	32.39	0.021	0.007	0.046	0	2.43
5	Kholpetua river (katheshwar)	7.4	24.15	0	181.434	24.8	0.992	46.91	0.022	0.005	0.047	0	2.26
6	Kholpetua river (Middle point)	6.9	24	0	178.296	0	0.947	115.6	0.022	0.003	0.052	0.004	2.54
7	Baro Keya khali river	7	23.85	0.069	177.905	16.94	0.977	45.4	0.019	0.005	0.046	0	2.36
8	Choto Keya khali river	7	23.55	0.014	176.732	32.38	1.014	30.37	0.019	0.008	0.043	0.004	2.38
9	Chunkuri river	7	23	0	175.559	18.99	0.951	39.18	0.023	0.006	0.049	0	2.41
	Range			0.00-0.108	175.559-182.206	0.00-32.38	0.916-1.014	30.37-115.60	0.019-0.029	0.003-0.076	0.043-0.076	0.00-0.004	2.20-2.54
	Mean			0.023	179.4262	10.35	0.966333	55.57444	0.02222	0.0142	0.0503	0.001	2.3622
	SD			0.039	2.366465	12.98	0.029253	34.14241	0.00342	0.0233	0.0075	0.002	0.1077
	CV%			169.2	1.318907	125.5	3.027237	61.43544	15.3887	163.84	14.868	150	4.5583

c. The status of K, Ca and Mg in water: The concentrations of K, Ca and Mg varied from 175.56 to 182.21, traces to 32.38 and 0.92 to 1.0 mgL^{-1}, respectively. The highest level of K was found in Kalagasia at 24.95 dSm^{-1} EC level and the lowest was found in Chunkuri River at 23.00 dSm^{-1} EC level. The highest Ca and Mg were observed in Chhotokeyakhali River and the lowest (traces) was in Kholpetua River at Kalagasia, Kalagasia canal, Katheshwar khal, Katheshwar canal and Kholpetua River (middle point). The lowest Mg was found in Katheshwarkhal (Table 1). The concentration of K was found higher and Ca and Mg were lower at increased EC levels. The concentrations of K in all the rivers exceeded the permissible level for aquaculture. As guideline of nutrient concentration of irrigation water the K concentration was very high and it may be threating for plants in this area as the water was more or less used in irrigation of agricultural land and the other value that the Ca concentration was within the normal range while the Mg concentration was much lower in case of irrigation water (Duncan, 2000).

d. The status of Cu, Mn, Zn, Fe and B in water: The highest amount of both Cu and Mn was found in Kalagasia canal at 24.95 dSm^{-1} EC level and the lowest was at Barokeyakhali at 23.85 dSm^{-1} EC level. The lowest level Mn was found in Kholpetua River (middle point). The highest Zn was found in Katheshwarkhal and the lowest was in Chotokeyakhali River. The highest level of Fe was found in both the Katheshwarkhal and Kholpetua River (middle point) and the lowest was at most of the locations. The highest level of B was found in Kholpetua river (middle point) and lowest was present in Kholpetua river at Kalagasia at 24.00 dSm^{-1} EC level (Table 1). The concentrations of Cu, Mn, Zn, Fe and B were found higher at increased EC levels. Similar finding was also reported by Azam *et al.* (2010). Undisturbed sediments currently situated in the riverbanks contaminates with heavy metals such as Zn, Fe, Mn, Cu, Pb into the river system during flooding. This release could be markedly enhanced by increased nutrient levels into the river system. The concentration of Cu, Mn , Zn, Fe, B was within the normal range of irrigation water (Duncan, 2000).

The pH and EC and ionic constituents of waters at Kadomtola range area of the Sundarbans in Satkhira district

a. The pH and EC values in water: The values of pH and EC varied from 6.9 to 7.0 and 23.00 to 23.90 dSm^{-1}. The highest pH and EC both were found in Malancho River and Ichhamoti rivers at Kadomtola and the lowest was in the water of Panchmukhi River at Koikhali, Madari River, Mirgang River at Tangrakhali and Mirgang camp (Table-2). The river waters of this area were slightly acidic to neutral and very strongly saline. The variations both in pH and EC were not so pronounced in different rivers of this area. Water salinity in the Sundarbans RS is highly dependent on the freshwater input coming from the upstream areas and the nature of tide.According to Hoq *et al*. (2006), the pH of Sundarbans river water is slightly alkaline and remains neutral to alkaline (7.4-8.1) throughout the year. Adedokun *et al.* (2008) observed higher pH in the RS of Ibadan Metropolis, Nigeria, during rainy season than during dry season.

b. The status of P and S in water: The concentrations of P and S varied from traces to 0.008 and 20.94 to 90.39 mgL^{-1}. The highest P was detected in Mirgang River at Tangrakhali and the lowest level was detected at most of the rivers. The highest S was found in Mirgang River at Mirgang and the lowest was in Kalindi River at Koikhali

(Table 2). Sulphur concentrations in most of the locations in this area were found at above the acceptable limit for aquaculture (Goel, 2006). Taniguchi (1999) observed that nutrient discharges many agricultural fields have brought a large amount of nutrients such as SO_4^{2-}, Cl^- and Na^+.

c. The status of K, Ca and Mg in water: The concentrations of K, Ca and Mg varied from 174.47 to 198.04, 2.00 to 29.43 and 0.92 to 1.01 mgL^{-1}, respectively. The highest level of K was found in Koikhali River at 23.10 dSm^{-1} EC level and the lowest was found in Madari River at 23.50dSm^{-1} EC level. Kalindi River in Koikhali at 23.00 dSm^{-1} EC level and the lowest amount was found in Ichhamoti River at Kadomtola at 23.90 dSm^{-1} EC level. Malancho River at Munsigonj at 23.85 dSm^{-1} EC level and the lowest was found in Pachmukhi River at Koikhali at 23.00 dSm^{-1} EC level (Table 2). The concentration of K and Ca were found lower and Mg was found higher at increased EC levels. The excess amount of K can be a threat for both plant and animal. Globally, wetlands are amongst the most fertile and productive ecosystems and important breeding grounds for fish and game, they regulate water quality, quantity, nutrient cycling, and act as a buffer between terrestrial and aquatic systems (Versfeld and Wassen, 2005).

Table 2. The pH, EC and ionic constituents of mineral elements of water at Kadomtola Station area of the Sundarbans

Sl.	Location	pH	EC (dSm^{-1})	P	K	Ca	Mg	S	Cu	Mn	Zn	Fe	B
							(mgL^{-1})						
1	Kalindi river (Koikhali)	7	23	0	177.905	29.43	0.946	20.94	0.053	0.003	0.049	0	2.37
2	Koikhali river	7	23.1	0	198.034	24.63	0.964	36.04	0.024	0.006	0.045	0	2.47
3	Pachmukha river (Koikhali)	6.9	23	0	177.123	15.39	0.92	33.66	0.022	0.008	0.046	0	2.51
4	Mathari river	6.9	23.5	0	174.469	10.33	0.993	34.22	0.021	0.0033	0.047	0	2.57
5	Morgang river (Tangrakhali Camp)	6.9	23.8	0.008	180.642	12.83	0.976	36.29	0.02	0.003	0.044	0.005	3.08
6	Morgang river (Mirgang Camp)	6.9	23.8	0	183.373	16.45	0.951	90.39	0.026	0.004	0.045	0	3.13
7	Maloncho river (Kadomtola)	7	23.9	0	183.77	4.32	0.991	35.69	0.02	0.003	0.047	0	3.26
8	Ichamoti river Kadomtola)	7	23.9	0	183.778	0	0.979	61.87	0.024	0	0.052	0	3.29
9	Maloncho river (Munsigonj)	7	23.85	0	182.968	26.41	1.005	34.23	0.022	0.004	0.053	0.001	3.31
	Range			0.00-0.01	177.123-198.034	0.00-29.43	0.92-0.97	20.94-90.39	0.02-0.05	0.00-0.008	0.044-0.053	0.00-0.005	2.37-3.31
	Mean			0.000889	182.4513	15.53222	0.969444	42.59222	0.025778	0.003811	0.047556	0.000667	2.887778
	SD			0.002667	6.740609	9.977696	0.026885	20.84219	0.010402	0.002213	0.003167	0.001658	0.39695
	CV%			300	3.694469	64.23869	2.773189	48.93426	40.35125	58.0596	6.658879	248.7469	13.74587

d. The status of Cu, Mn, Zn, Fe and B in water: The concentrations of Cu, Mn, Zn, Fe and B in soil varied from 0.01 to 0.05, traces to 0.01, 0.04 to 0.05, traces to 0.01 and 2.37 to 3.31 mgL^{-1}, respectively . The highest amount Cu and lowest amount of Fe and B were found in Kalindi River at 23.00 dSm^{-1} EC level and the lowest amount of Cu was found in Malancho River at Kadomtola at 23.90 dSm^{-1} EC level. Pachmukha River at Koikhali at 23.00 dSm^{-1} EC level and the lowest was in Ichhamoti River at Kadomtola at 23.90 dSm^{-1} EC level. The highest amount of Zn and B was found in Malancho River at Munsigonjat 23.85 dSm^{-1} EC level and the lowest amount Zn and the highest amount Fe was found in Mirgang River at Tangrakhali at 23.80 dSm^{-1} EC level (Table 2). The concentration of Fe was found is very poor in most of the locations. The concentrations of Zn, Fe and B were found higher but Cu and Mn found lower at increased EC levels. The heavy metal concentration was within the normal level and not up to the pollution level.

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