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Hydro-Chemistry of Kulsi River, a tributary of the Brahmaputra, NE India

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ABSTRACT

This work was, mainly, intended to assess the temporal and spatial distribution of certain physico-chemical parameters of Kulsi River which harbour a small population of Gangetic dolphin. Overall water quality studied during August 2009 to July 2011 was found within the permissible limit for biological components and therefore, the river health can be said as satisfactory for freshwater biota including Gangetic dolphin.

Key words: River water, status, biological component

INTRODUCTION

Streams and rivers are under various changes due to anthropogenic activities in their catchment areas [1] which ultimately alter the structure and function of stream or riverine biota [2]. The biological response and sensitivity of different organism to physical and chemical changes in aquatic ecosystem can be used as an indicator for the assessment of habitat quality [3].

The Kulsi River is located in the Kamrup district of Assam, India. The river originates from Meghalaya (25 38' N 91 38' E) where it is known as Khri river. After travelling about 12 km from its origin, the river enters Kamrup district of Assam at Ukiang (25 38' N 91 38' E) and is known as the Kulsi from this point. The river finally discharges into the Brahmaputra at Nagarbera. The river is about 76 km in length from Kulsi town to the Brahmaputra confluence [4].The present investigation highlighted certain physico-chemical properties of water which will make a major contribution for long-term conservation of the Kulsi river, a habitat of endangered Gangetic dolphin ,*Platanista gangetica* (Roxb.).

MATERIALS AND METHODS

Demarcation of study sites:
For the convenience of study the entire dolphin sighted stretch of the river was divided into 3 sampling sites as Dumukh (I), Kukurmara (II) and Jiakur (III).The study area is about 2 km stretch of the river, approximately one km distance from one station to the next station.

Water environment:

Following physico-chemical properties of water of the river have been carried out for two consecutive years (August 2009 to July 2011) on a seasonal basis. Four seasons viz., pre-monsoon (Mar-May), monsoon (Jun-Aug), post-monsoon (Sept-Nov) and winter (Dec-Feb) were considered for the present study. Methods adopted for estimating the following 10 abiotic parameters were as follows:-

Air and water temperature were recorded by using mercury thermometer graduated up to 110^{o}C.The current flow and mean depth of the selected sites of the river were recorded according to the method described by [5]. Conductivity and pH value of water were recorded with the help of digital pen type conductivity and pH meter respectively. Dissolved Oxygen (DO_2) was estimated as per Winkler's modified method [6], FCO2 of the wetland water was recorded by Titration method using phenolphthalein as indicator [7],while total alkalinity according to[6].

RESULTS

Water-physico-chemical parameters during pre-monsoon, monsoon, post monsoon and winter seasons in different four stations depicted in the Tables 1-4 (range mean ± SD).

Table 1: Seasonal variations in physico-chemical parameters of R. Kulsi at Dumukh
(Range and mean SD values in parentheses)

Parameters	Pre-monsoon	Monsoon	Post- Monsoon	Winter
Air Temp (^{0}C)	24.6 –28.5 (26.55±2.27)	32.0 -35.4 (33.7±2.14)	27.6 – 29.2 (28.4±1.49)	20.2 – 22.5 (21.35±1.74)
Water Temp (^{o}C)	16.4 – 23.2 (19.8±0.47)	27.5 – 28.0 (27.75±0.29)	22.5 – 25.6 (24.05±1.69)	18.0 – 20.8 (19.4±1.78)
Depth (m)	1.32 – 1.65 (1.49±0.28)	3.36 – 4.20 (3.78±0.51)	1.40 – 1.60 (1.5±0.27)	1.26 – 1.50 (1.38±0.19)
Transparency (cm)	17.5 – 19.0 (18.25±0.78)	17.0 – 18.0 (17.5±052)	18.0 – 20.5 (19.25±1.89)	18.0 – 20.8 (19.4±2.61)
Velocity (m/s)	1.4– 1.5 (1.45±0.48)	2.8 – 3.2 (3.08±0.56)	2.6 – 2.8 (2.7±0.24)	2.0 – 2.2 (2.1±1.3)
pH	6.50 – 6.80 (6.65±0.27)	7.20 – 7.50 (7.35±1.89)	6.60 – 6.80 (6.7±2.07)	6.40 – 6.60 (6.5±1.93)
Conductivity (µS)	60.0 – 65.0 (62.5±2.44)	76.0 – 86.0 (81±5.67)	72.0 – 78.0 (75±4.09)	58.0 – 60.0 (59±1.84)
D. O. (mg/l)	7.2 – 7.4 (7.3 ±0.91)	6.8 – 7.2 (7.01±0.69)	6.6 – 6.9 (6.75±1.27)	7.3 – 7.6 (7.45±2.02)
Free CO_2 (mg/l)	1.42 – 1.64 (1.53±1.45)	1.80 – 2.40 (2.1±3.09)	1.26 – 1.62 (1.44±2.57)	1.08 – 1.32 (1.2±1.76)
Total Alkalinity (mg/l)	56.0 – 60.6 (58.3±2.76)	86.2-116.8 (101.5 ± 11.87)	66.0 – 78.6 (72.3±5.91)	48.0 – 52.6 (50.3±2.18)

Table 2: Seasonal variations in physico-chemical parameters of R. Kulsi at Kukurmara
(Range and mean SD values in parentheses)

Parameters	Pre-monsoon	Monsoon	Post- Monsoon	Winter
Air Temp (^{0}C)	23.8 – 28.5 (26.15±3.33)	32.0 – 35.0 (33.5±1.67)	28.0 – 29.5 (28.75±0.67)	20.0 – 22.5 (21.25±1.33)
Water Temp (^{o}C)	16.6 – 23.4 (20±3.67)	28.0 – 28.2 (28.1±0.33)	22.5 – 25.0 (23.75±1.67)	18.2 – 20.6 (19.4±0.67)
Depth (m)	1.30 – 2.80 (2.05±1.33)	3.20 – 4.00 (3.6±0.67)	1.60 – 2.60 (2.1±0.67)	1.05 – 1.80 (1.43±0.51)
Transparency (cm)	17.0 – 18.0 (17.5±0.54)	16.0 – 17.5 (16.75±0.67)	18.0 – 18.5 (18.25±0.33)	18.4 – 18.6 (18.5±0.11)
Velocity (m/s)	1.2 – 1.45 (1.33±0.19)	2.6 – 3.0 (2.8±0.27)	2.7 – 2.8 (2.75±0.14)	1.8 – 1.95 (1.88±0.06)
pH	6.6 – 6.8 (6.7±0.33)	7.2 – 7.4 (7.3±0.2)	6.6 – 7.0 (6.8±0.92)	6.4 – 6.6 (6.5±0.33)
Conductivity (µS)	62.0 – 66.0 (64±2.0)	78.0 – 84.0 (81±3.0)	70.0 – 78.0 (74±4.0)	62.0 – 64.0 (63±2.0)
D. O. (mg/l)	6.80 – 7.20 (7.0±0.33)	7.02 – 7.22 (7.12±0.07)	7.00 – 7.40 (7.2±0.26)	7.36 – 7.60 (7.48±0.27)
Free CO_2 (mg/l)	1.42 – 1.80 (1.61±2.12)	1.64 – 2.80 (2.22±0.77)	1.66 – 1.80 (1.73±0.67)	1.22 – 1.40 (1.31±0.89)
Total Alkalinity(mg/l)	58.00 -62.0 (60.7±3.7)	84.5–120.0 (102.25±17.67)	76.4 -78.62 (77.51±1.79)	52.4-60.20 (56.3±4.33)

***Dumukh* (Sampling site I)**: In Dumukh the mean value of air temp is found to be lower in winter (21.35±1.74 ^{0}C) and higher being in monsoon (33.7±2.14^{0}C) whereas water temperature was found between 19.4±1.78 (winter) and

27.75±0.29 ^{0}C (monsoon). Depth was ranged from 1.38±0.19 (winter) to 3.78±0.51m (monsoon); transparency values varied from 17.5±0.52 cm (monsoon) to 20.4±0.67cm (winter); current velocity also varied from 1.45±0.48 m/s (pre-monsoon) to 3.08±0.56 m/s (monsoon); highest value of pH was observed during monsoon (7.35±1.89) and that of lowest value during winter (6.5±1.93); mean conductivity values ranged from 59+1.84 µS to 81±5.67 during winter and monsoon respectively; average dissolved oxygen (DO) ranged from 6.75±1.27mg/l) to 7.45±2.02 mg/l) during post-monsoon and winter respectively; minimum value of FCO_2 was observed in winter (1.2±1.76 mg/l) and that of maximum in monsoon (2.1±3.09 mg/l) and highest value of total alkalinity recorded in monsoon (101.5±11.87 mg/l) and lowest value recorded during winter (50.3±2.18 mg/l).

***Kukurmara* (Sampling site II):** The lowest mean value of air temp was recorded during winter (21.25±1.33^{0}C) and that of highest in monsoon (33.5±1.67 ^{0}C) whereas water temperature varied from 19.4±0.67 ^{0}C (winter) to 28.1±0.33 ^{0}C (Monsoon); depth ranged from 1.43±0.51m (winter) to 3.6±0.67m (monsoon); transparency was ranged between 16.75±0.67 cm (monsoon) and 18.5±0.11cm (winter); current velocity also varied from 1.33+0.19 m/s (pre-monsoon) to 2.8+0.27 m/s (monsoon); highest value of pH was observed during monsoon (7.3±0.2) and that of lowest during winter (6.5±0.33); conductivity was recorded between 63+2.0µS and 81+3.0 µS during winter and monsoon respectively; dissolved oxygen (DO_2) also ranged from 7.0±0.33mg/l and 7.48±0.27 mg/l during pre-monsoon and winter respectively; minimum value of FCO_2 was observed in winter (1.31±0.89 mg/l) and that of maximum in monsoon (2.22±0.77 mg/l). The lowest value of total alkalinity recorded in winter (56.3±4.33 mg/l) and that of highest was recorded during monsoon (102.25±17.67).

***Jiakur* (Sampling site III):** Air temp is found to be lowest during winter (20.6±0.58^{0}C) and highest during monsoon (33±1.1^{0}C) whereas water temperature ranged from 19.5±1.26^{0}C (pre-monsoon) to 27.5±0.32^{0}C (Monsoon); depth was ranged from 1.28±0.08 m (winter) to 3.53±0.43 m (monsoon); transparency values found between 17.2±2.07 cm (monsoon) and 20.25±1.78 cm (pre-monsoon); current velocity also varied from 1.17±0.08 m/s (premonsoon) to 2.65±0.19 m/s during post-monsoon; highest value of pH was observed during monsoon (7.08±0.11) and that of lowest value during pre-monsoon (6.73+0.16); conductivity values ranged from 65+2.18µS to 82±4.87µS during pre-monsoon and monsoon respectively; dissolved oxygen (DO) ranged between 7.1±0.15 mg/l and 7.6±0.34/l) during pre-monsoon and winter respectively. Again, the minimum value of FCO_2 was recorded during winter (1.32±0.27 mg/l) and that of maximum during post monsoon (1.66±0.67 mg/l). The lowest value of total alkalinity recorded in pre-monsoon (60.4±4.65 mg/l) and highest value recorded during monsoon (95.6±26.54).

Table 3: Seasonal variations in physico-chemical parameters of R. Kulsi at Jiakur
(Range and mean SD values in parentheses)

Parameters	Pre-monsoon	Monsoon	Post- Monsoon	Winter
Air Temp (^{0}C)	24.2 – 28.4 (26.3 ±1.82)	32.0 – 34.0 (33±1.1)	28.0 – 29.0 (28.5±0.91)	20.2 – 21.0 (20.6±0.58)
Water Temp (^{o}C)	16.5 – 23.6 (20.05±3.87)	27.0 – 28.0 (27.5±0.32)	21.5 – 24.8 (23.15±2.11)	18.0 – 21.0 (19.5±1.26)
Depth (m)	1.24 – 1.45 (1.35±0.18)	3.20 – 3.86 (3.53±0.43)	1.26 – 1.68 (1.47±0.35)	1.20 – 1.36 (1.28±0.08)
Transparency (cm)	18.0 – 22.5 (20.25±1.78)	16.0 – 18.4 (17.2±2.07)	18.6 – 19.0 (18.8±041)	19.5 – 20.0 (19.75±02)
Velocity (m/s)	1.08 – 1.26 (1.17±0.08)	2.2 – 2.85 (2.53±0.3)	2.6 – 2.7 (2.65±0.19)	1.4 – 1.85 (1.63±0.24)
pH	6.60 – 6.90 (6.75±0.17)	6.95 – 7.20 (7.08±0.11)	6.80 – 7.00 (6.9±0.13)	6.60 – 6.85 (6.73±0.16)
Conductivity (µS)	64.0 – 66.0 (65+2.18)	78.0 – 86.0 (82±4.87)	74.0 – 76.0 (75±1.87)	64.0 – 68.0 (66±2.34)
D. O. (mg/l)	7.0 – 7.2 (7.1±0.15)	7.2 – 7.6 (7.4±0.26)	7.2 – 7.8 (7.5±3.44)	7.4 – 7.8 (7.6±0.34)
FCO_2 (mg/l)	1.26 – 1.40 (1.33±0.67)	1.46 – 1.80 (1.63±0.29)	1.60 – 1.72 (1.66±0.67)	1.24 – 1.40 (1.32±0.27)
Total Alkalinity (mg/l)	56.0 – 64.8 (60.4±4.65)	68.8-122.4 (95.6±26.54)	74.2 – 82.2 (78.2±3.76)	68.0 – 74.6 (71.3±4.26)

DISCUSSION

The air and water temperature followed the seasonal pattern of temperature fluctuation. Temperature directly affects the amount of oxygen that can be dissolved in water; the rate of photosynthesis by algae and larger aquatic plants; the metabolic rates of aquatic organisms; and the sensitivity of organisms to toxic wastes, parasites and diseases. The depth and current velocities that have measured in all the sectors of the river showed high in the wet period due to the high water discharge. Reduction in transparency during the monsoon was due to addition of turbid water of the river loaded with substances such as silt, micro-organisms, plant fibers, sawdust, and plankton. That suspended

matters make water cloudy. The rain water brought large amounts of dissolved and undissolved inorganic and organic materials, which made water turbid and cause lower transparency in the rainy months [8]. Plankton and soil particles of eroded riverbank are the most common sources of low transparency. Assessed data on pH of the water of different sites was found in between neutral to alkaline range throughout the period indicates the healthy status of the river. The pH of an aquatic ecosystem is important because it is closely linked to biological productivity. Although, the tolerance of individual species varies, P^H values between 6.5 and 8.5 usually indicate good water quality. Even small changes in pH are harmful to pH sensitive species. Most fish can tolerate P^H values of about 5 to 9. The P^H values outside that range can create problems for reproduction and survival. Amphibians are particularly susceptible to acid waters. Higher P^H value is normally associated with the high photosynthetic activity in water [9]. Alkaline range of water is suitable for the growth of aquatics. Environment Protection Agency of United State's criteria for pH of fresh water aquatic life is 6.5 to 6.9. When compared to these standards, pH observed in Kulsi River water in general was within the safe limits for aquatic biota.

Fluctuation in conductivity was observed seasonally**.** These observations pointed out that EC is a highly variable factor in freshwaters. Taheruzzaman and Kushari [10] observed an increase in EC during monsoon which according to them is due to voluminous runoff carrying diverse types of electrolytes from the nearer as well as distant areas. But according to Sarojini [11] seasonal EC fluctuations are closely related to evaporation and concentration of soluble salts. Since no significant differences in conductivity of all the surface waters among all the studied longitudinal section i.e. different sampling station were observed, it may be concluded that there exist quite good upstream downstream mixing of waters because of uninterrupted longitudinal connectivity in the river.

However, when the alkalinity level is used as a criterion for assessing the nutrient status [12, 13] the water of Kulsi River is moderately nutrient rich. According to their classifications waters are grouped into three different nutrient status groups on the basis of alkalinity: (a) 1 to 15 mgL^{-1} as nutrient poor, (b) 16-60 mgL^{-1} as moderately rich, and (c) more than 60 mgL^{-1} as nutrient rich.

Slight seasonal variation in Dissolve oxygen values with a higher range is signifying the healthy water environment for the aquatic biota. Dissolved oxygen is considered as one of the indispensable factor in an aquatic system. It affects the solubility and the activity of several nutrients and therefore, the productivity of an aquatic ecosystem controlled by DO_2 [14]. Very low light transparency in summer seasons (May- Aug) with a substantial amount of DO_2 in the study area may be due to either contribution of DO_2 by photosynthetic parts of the giant macrophyte as well as other aquatic plants like algae and true hydrophytes to some extent or may be due to constant current flow of the streams. Higher DO_2 mean rate of oxygen replenishment in water is greater than DO_2 consumption and this is healthy for almost all aquatic systems [15]. The value of FCO_2 was recorded, which were inversely proportional to values of DO_2. Lower FCO_2 value during indicates reduction in photosynthesis results in lower oxygen concentration levels and high carbon dioxide levels. The FCO_2 data represents the positive balance between producer and consumer in the system. Although CO_2 is a minor component of air it is abundant in water because of its solubility which is 30 times more than that of oxygen, and the amount of CO_2 in water usually shows an inverse relationship with oxygen [16].Free CO_2 is essential for photosynthesis and its concentration affects the phytoplankton, and its productivity. Excess of it gets dissociated into carbonic acid. The limit of free CO_2 as per acceptable Standards is 10 mgL-1 of surface water. Increase in CO_2 indicates increase in pollution load [17].All these physicochemical properties of water exhibit the healthy status of the river.

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