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Studies on some physico-chemical factors of Kaptai lake

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Abstract
The present investigation dealt with the climatic and some physico-chemical conditions of the Kaptai lake with respect to their monthly variation. Air temperature was found always higher than water temperature. Vertical variation in temperature (0.8-4.7°C) was observed in all months. The water level fluctuate appreciably throughout the year. Wide seasonal fluctuations were also noted in water transparency. The lake was found to be slightly hard and alkaline pH. Dissolved oxygen (DO) (6.4-9.1 mg/l) and free carbondioxide (4.7-6.0 mg/l) contents showed favourable condition for aquatic lives. DO at different depth showed no wide variation (1.0-2.4 mg/1). Conductivity ranged between 91.9± 7.1 and 106.4 ±5.2 mS/cm.

Key words : Kaptai lake, Water quality

Introduction

The lake Kaptai was created by damming the river Karnafuli in 1961. Occupying an average area of 58300 ha (ARG 1986), it is one of the largest reservoirs in southeast Asia (Fernando 1980). Although the lake was created primarily for hydro-electric power generation, it has also paved the way for substantial contribution to the national economy through freshwater fish production, navigation, irrigation and flood control. To formulate a sound management policy for Kaptai lake fishery, a long term study of various physico-chemical characteristics of lake water is very much needed along with other investigations.

Information on the physico-chemical aspects of the lake is very scanty. The first limnology and primary production of the lake was done by Sandercock (1966), the limnology and primary production of the lake were studied by Chowdhury and Mazumder (1981) and Haldar *et al.* (1992) and the hydrobiology of the lake was studied for one year by the Aquatic Research Group (ARG 1986). Rahman (1988) reported the morphometric details of the reservoir. With a view of evaluating productivity potential and to provide information for sound management policy, the present work was undertaken.

Materials and methods

The present study was conducted from May'90 to April'91. Water samples from three depth i.e. surface, mid and bottom (up to 18m) were taken from five sampling stations (Rangamati, Balukhali, Subalong, Kaptai and Naniarchar) fortnightly using a Kemmerer water sampler between 9 and 10 am. Rainfall and water level data were recorded from the Power Development Board (PDB), Kaptai. Air and water temperatures were measured with a centigrade thermometer. Visibility was determined with a standard Secchidisc. pH-value was determined colorimetrically by means of Lovibond comparator. Conductivity meter (HANNA HI-8033, England) was used to measure specific conductance. Dissolved oxygen was estimated by the azide modification of the Winkler method (APHA 1981). Free carbondioxide content was determined by phenolphthalein indicator method (Welch 1948). Total alkalinity was estimated by using phenolphthalein and methyl orange indicator method (Welch 1948). Total hardness was determined by EDTA titrimetric method (APHA, 1981). HACH test kit (Model-FF-1A, USA) was used to measure ammonium nitrogen and chloride ion only.

Results and discussion

Impoundment waters have their own peculiarities as biotopes. The various physico-chemical properties of impoundments vary widely at different times of the day and in different seasons. A proper understanding of these characteristics, therefore, calls for intensive investigation of such water bodies in different parts of the globe. The average values (three depths of all stations) of different climatological, physico-chemical factors recorded during the study period is furnished in Table 1 and Figure 1 (water temperature and dissolved oxygen only) and discussed under the following heads.

Table 1. Monthly fluctuations of climatological and physico-chemical factors of the Kaptai Lake

Factor / Month	Air temp. (°C)	pH	Free Carbon-dioxide (mg/l)	Total hardness (mg/l)	Total alkalinity (mg/l)	Conduc-tivity µS/cm	Chloride (mg/l)	Ammonium nitrogen (mg/l)	Water level (MSL)	Secchi-depth (m)	Total rainfal l (mm)
Jun/90	28.0±1.0*	8.1±0.1	4.7±0.3	51.3±0	60.5±3.2	-	16.7±1.9	0.4±0	77.4	1.6±0.4	398**
Jul	31.9±0.7	8.0±0.2	5.3±0.3	51.3±0	60.1±2.4	-	14.0±7.7	0.4±0	83.6	1.8±0.1	659
Aug	33.3±1.0	8.4±0.2	5.9±0.1	49.9±4.0	54.7±4.7	-	18.0±4.0	0.4±0	93.9	1.6±0.7	174
Sep	32.1±0.7	8.2±0.1	6.0±0.2	47.6±4.4	51.9±4.3	-	13.3±1.9	0.4±0	98.5	2.1±0.5	193
Oct	30.0±1.5	7.9±0.5	6.0±0.3	51.3±0	55.7±3.0	93.1±6.4	14.9±7.5	0.4±0	103.0	2.7±0.3	128
Nov	30.2±2.2	7.7±0.4	5.8±0.3	56.4±4.7	55.1±3.6	91.9±7.1	11.7±3.8	0.4±0	103.8	3.0±0.3	091
Dec	27.6±0.9	7.7±0.2	6.0±0.2	54.7±7.6	54.1±2.8	100.1±3.4	14.5±7.5	0.4±0	101.8	3.0±0.4	047

Jan/91	27.6±2.4	7.7±0.2	6.0±0	65.0±4.7	54.6±2.5	105.5±2.7	13.7±7.8	0.4±0	94.3	3.4±0.4	000
Feb	25.0±1.6	7.6±0.1	6.0±0	56.4±4.6	53.9±0.7	106.4±5.2	13.3±5.2	0.4±0	95.5	3.1±0.2	010
Mar	30.6±1.8	8.0±0.2	5.5±0.3	54.7±7.6	47.6±11.6	103.1±3.6	13.5±2.0	0.4±0	89.5	2.8±0.4	013
Apr	32.0±1.9	7.9±0.1	5.6±0.2	53.0±3.8	53.7±0.7	101.6±1.6	12.7±3.6	0.4±0	83.6	1.8±0.2	174
May	33.8±0.7	7.5±0.0	5.1±0.1	52.0±1.2	56.0±2.2	102.0±2.2	15.2±7.4	0.4±0	87.4	1.5±0.3	478

* *Values represent monthly average ± S.D. for all stations for three depths (surface, mid and bottom).*
** *Values represent monthly total (one station).*

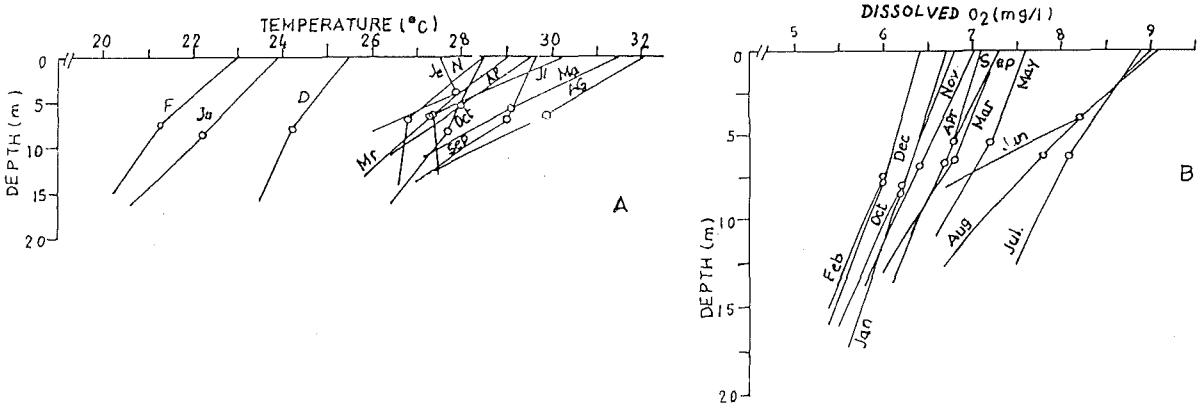

Fig. 1. Water temperature (A) and dissolved oxygen (B) contents at three depths (surface, mid and bottom regions) of Kaptai lake.

Climate of the lake region

Though Chittagong Hill Tracts is a hilly region no special weather condition was noticed. Only in winter months, sometimes morning fog and heavy dew were observed and in monsoon, occasionally gasty wind prevails in this area. The mean maximum air temperature (33.8±0.7°C) was recorded in May while minimum (25.0±1.6 °C) was recorded in February. Air temperature in the study area was found always higher than water temperature except in a few cases. A similar relationship between air and water temperature was also reported by Macan (1958), Patra and Azadi in Halda River (1985) and Haldar *et al.* (1992) in Kaptai lake. The annual rainfall in the area was 2365 mm, received mainly from May to July. Winter was usually dry. The rainy period spread over winter and spring months. During summer air temperature varies between 30.6 and 33.8°C. The mean winter temperature was 26.7±0°C. Monthly total rainfall ranged from 10 mm (February) to 659 mm (July) with no rainfall in January. The average rainfall in this area was about 197 mm. The water level is regulated largely by the Power Development Board (PDB), Kaptai maintaining rule curve for Kaptai lake. Variation (93.0 ± 9.0 MSL) in water level in different months of the year was observed. It followed increasing trend from June (77.4 MSL) till November (103.8 MSL) and then decreased gradually with few exceptions (Table 1). The water level was largely dependent on rainfall and the extent of discharge for hydroelectric power generation.

Water transparency and thermal structures

The limit of secchi-disc visibility was found to fluctuate in different months of the year. High visibility was found in winter while low visibility prevailed pre-monsoon and monsoon months. The lowest value of visibility (1.5±0.3 m) was recorded in May and the highest (3.4±0.4 m) in January. The inflow from hill streams carries suspended matter and silt, which causes a sharp rise in turbidity. Chowdhury and Mazumder (1981), ARG (1986) and Haldar *et al.* (1992) also reported the occurrence of high turbidity in the same lake during the monsoon period.

One of the most outstanding and biologically significant phenomena of lakes is the temperature characteristics of water and seasonal variations of the same. Temperature showed marked fluctuations in different months of the year (Fig. 1 A). The surface water temperature of the reservoir ranged between 23.0 (February) and 32.1°C (August) while mid-water temperature fluctuated from 21.3 (February) to 29.9°C (August). Vertical variation in temperature was observed in all months. It has been found that the variation in temperature from surface to mid-water was 0.6-2.8°C except in June when mid-water temperature was above by 0.4°C only. Bottom water temperature ranged from 20.5 (February) to 27.9°C (March). Variation in temperature from mid-water to bottom water ranged between 0.2 and 2.5°C except in July when bottom water temperature was above by 0.1°C only. A wide difference of 0.8-4.7°C was noted between surface and bottom temperatures (Fig. 1 A), indicating some tendency towards thermal stratification. This can not be stated conclusively because temperature was recorded only at three depths (Surface, mid-water and bottom). However, during two years study period (covering all depth at 1 and 2 m intervals) at Kaptai lake ten temporary epilimnial and one typical thermocline was observed by Azadi (1996). Thermal stratification in lakes is related to the difference between the surface and bottom temperature and the presence or absence of strong winds (Vashist 1968). Accordingly, with a large area, high depth, presence of moderate to strong winds in different months of the year and consequent wave action afforded a suitable condition for possible thermal stratification for Kaptai lake.

Chemical features of the lake waters

Dissolved oxygen at the surface of the reservoir ranged between 6.4 (December) and 9.1 mg/l (June). The higher values occurred during monsoon. Maximum concentration of oxygen in the rainy months may be attributed due to wind action and other surface agitation allowing maximum oxygen from air to go into solution at the surface water. However, Chowdhury and Mazumder (1981) and Haldar *et al.* (1992) reported the maximum concentration of oxygen

in the winter months. Dissolved oxygen at different depths showed no wide variation (1.0-2.4 mg/l) from surface to bottom (Fig. 1B). Dissolved oxygen at the bottom of the reservoir ranged between 5.4 and 7.5 mg/l. Sreenivasan (1970) and Timms (1970) considered dissolved oxygen deficit at the bottom as a characteristic feature of productive lake.

The pH of the lake water was found within alkaline range (7.5 ±0 - 8.4±0.2). It exhibited a narrow range of fluctuation during the study period (Table 1). Present findings is in close agreement with Haldar *et al.* (1992) and ARG (1986) but differ significantly with Chowdhury and Mazumder (1981).

Free carbondioxide varied between 4.7 ± 0.3 and 6.0 ± 0.3 mg/l in the lake. Carbondioxide contents never exceeded 6.2 mg/l and was found almost uniform in an annual cycle. Free CO_2 is present even in the surface waters of soft and medium-hard-water reservoirs, but is absent in hard-water lakes (Sreenivasan 1992). Since Kaptai lake is a slightly hard water lake, present observations for CO_2 accept the above mentioned rule.

Total hardness in water is the sum of the concentrations of alkaline earth metal cations. Value of total hardness varied between 47.6 ± 4.4 and 65.0±4.7 mg/l in the reservoir. The highest value was found in January and the lowest value in September (Table 1). ARG (1986) and Haldar *et al.* (1992) reported a wide range of hardness but Chowdhury and Mazumder (1981) reported a narrow range from the same reservoir. Lake water registering hardness as calcium carbonate below 24 mg/l is generally regarded as soft (Clegg 1974). According to Brown *et al.* (1970) a soft water body contains 0-60 mg/l calcium carbonate. Accordingly, the water of the Kaptai lake may be regarded as slightly hard.

The alkalinity or acid combining capacity of impounded waters is generally caused by carbonates and bicarbonates of calcium and magnesium. Combining with dissolved CO_2 these carbonates and bicarbonates form an equilibrium which plays an important role in the productivity of the system. The total alkalinity content in the lake water exhibited a little variation among different months (47.6±11.6 - 60.1±2.4 mg/l) during the course of the present study. It recorded high values from May up to July. In the subsequent months values were more or less similar and declined on March only. Haldar *et al.* (1992) found the highest values in March and April and the lowest value in August. The lake water was found to have an increasing trend value in August. The lake water was found to be an increasing trend of alkalinity value comparing with the findings of the above authors. Jhingran (1989) Observed that alkalinity values of more than 50 mg/l are most productive and those of less than 10 mg/l do not produce large crops. He added that total alkalinity values up to 20 mg/l indicate poor production and values above 40-90 mg/l show high production. Accordingly, Kaptai lake may be regarded as productive lake.

Conductivity was monitored from October to May only during the investigation period. Average range of conductivity of lake water was between 91.9 ± 7.1 and 106.4 ± 5.2 mS/cm. The minimum and maximum being found in November and February respectively. High values of conductivity occurred in winter months (Table 1). Similar phenomenon was also reported by Patra and Azadi (1985) from Halda river, Chittagong.

The mean monthly chloride content in the lake water varied between 11.7 ± 3.8 and 18.0 ± 4.0 mg/l. The maximum chloride content was recorded in August and the minimum in November. Zafar (1964) and Munawar (1970) observed that in fish ponds chlorides increase in summer and decrease in winter depending upon the water level. As per lake is concern the present study partially accept this view.

The nitrogenous compounds in water are derived to an appreciable degree directly or indirectly from the atmosphere, whereas ammonia is the chief decomposition product from plant and animal proteins (Ruttner 1953). Ammonium nitrogen content recorded was not high and occurred the same value in different months (0.4 ± 0 mg/l) (Table 1). Jhingran (1989) reported that dissolved nitrogen concentration of 0.2-0.5 mg/l is favourable for fish life. On the basis of above mentioned conditions water body of Kaptai lake was found to be suitable for fish culture.

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