Bangladesh J. Zool. **41**(2): 257-264, 2013

SOME LIMNOLOGICAL CHARACTERISTICS OF DHAKA-NARAYANGONJ-DEMRA DAM CANAL, BANGLADESH

A.H.M. Shafiullah Habib*, M. Mahbub Alam, Suraiya Mahjabeen[1] and M. Niamul Naser[1]

Department of Zoology, Jagannath University, Dhaka, Bangladesh

Abstract: Some limnological parameters of water of Dhaka-Narayongonj-Demra (DND) dam canal were studied for one year period from May 2010 to April 2011. Sampling points were selected on the basis of human activities around the dam. The maximum water temperature was recorded in May 2010 (31.5 ± 0.2041°C) and minimum in December 2010 (18.3 ± 0.1925°C). Water transparency was highest in February 2011(38.1 ± 3.48 cm) and lowest in May 2010 (24.56 ± 2.722 cm). The maximum concentration of dissolved oxygen (DO) was found in winter month December 2010 (6.83 ± 0.4735 mg/l) and the minimum in summer month May 2010 (4.00 ± 0.2378 mg/l). The BOD was highest in August (34 ± 0.122 mg/l) and lowest in January (15 ± 0.274 mg/l). The highest amount of free carbon dioxide (free CO_2) was recorded as 29.67 ± 4.4514 mg/l in January 2011 and the lowest 3.81 ± 0.8972 mg/l in August 2010. Maximum amount of hardness was found in December 2010 (271.20 ± 94.6597 mg/l) and minimum in September 2010 (196.20 ± 66.3963 mg/l) with a year round average of 229.51 ± 7.82 mg/l. pH was found fair (average 7.15 ± 0.08) during the study period. Maximum pH value 7.66 ± 0.14420 was recorded in the month of August while the minimum 6.74 ± 0.0574 in the month of May 2010. Although some water quality parameters of DND canal were found to be suitable for aquaculture but it was organically polluted. Further investigation on the heavy metal pollution is necessary before using the water and crops produced from DND canal for anthropological use.

Key words: DND dam, water quality, pollution, aquaculture

INTRODUCTION

Dhaka-Narayanganj-Demra (DND) dam canal was created in early sixties for irrigation of 6,070 ha enclosed area and also to control the enclosed area from flooding water of Buriganga and Shitalakshya River (Banglapedia, 2006). However, due to the expansion of Dhaka city and urbanization the agriculture practice in the area have been constricted and the created irrigation canal is used for domestic water source, fish culture as well as some part for waste disposal. The water quality of the canal was not documented; in spite of half of the inhabitants of developing countries in particular area do not have access to

---

*Corresponding author:ahmshabib@gmail.com, [1]Department of Zoology, Faculty of Biological Sciences, University of Dhaka, Dhaka-1000, Bangladesh.

safe drinking water and 73% have no sanitation (Mason, 2002). The prospect of good aquaculture practices (GAP) is also an emerging issue. The sources of water pollution may vary depending upon the involvement of human activities on the water system including dumping of domestic wastes, sewage, agricultural and industrial effluents into water bodies (Collocott and Dabson, 1974). Similar nature of canal water usage been seen in urbanization process as a result of expansion of housing and urban facilities has introduced many synthetic materials into the environment. Aquatic biota is sensitive to pH (Bhatia, 2006) and the physico-chemical factors are related to the productivity of water bodies (Boyd, 1982). Although physicochemical characteristics of some inland freshwater bodies of Bangladesh (Patra and Azadi, 1987,and Kabir and Naser, 2011) India (Sreenivasan, 1974, and Singh and Das, 2003) and Pakistan (Mirza *el al.,* 2013) are available but no information is available on the physicochemical condition of water of DND dam canal system. This study was conducted to assess some important water quality features of DND dam canal of Bangladesh.

MATERIAL AND METHODS

Dhaka-Narayangonj-Demra (DND) dam located between the cities of Dhaka and Narayanganj and bounded by the Buriganga and the Shitalakshya rivers. The heights of the DND dam varied from 7.47 m to 7.62 m. Six sampling areas were selected for the present investigation to represent the DND canal as a whole. The first location was in Dhaka district and rest fives were under Narayanganj district (Plate-1).The sampling points were Saddam Market (S1), East Mijmiji (S2), Panchaboti (S3), Dapa (S4), Pagla (S5) and WASA Gate (S6).

Sampling was done once in a month, at the last week of May 2010 to April 2011. According to Bangladesh Bureau of Statistics (BBS), there are three seasons in Bangladesh and their divisions are March to May as summer, June to September as rainy season and December to February as winter. But in the present study we divided the year into four seasons and were approximately May to July as summer, August to October as rainy season, November to January as winter, and February to April as spring. Water samples were taken from 25 cm depth from the surface with brown bottle with tightly covered cap. The samples were immediately wrapped in black bag and taken into the laboratory for further examination. Water temperature, pH and transparency were measured instantly in the field and recorded at the time of sampling. Temperature was recorded with a centigrade thermometer. Transparency of water was measured by a 20 cm diameter Secchi disk. Dissolved oxygen (DO) was estimated following Winkler’s method (APHA 1985) The free carbon dioxide (free CO_2) was measured by titration using N/44 NaOH and Phenolphthalein indicator (Hargis, 1988). The biological oxygen demand (BOD) was determined from dark bottle incubated sample at 5th day (APHA 1985). Hardness was measured using HANNA Hardness Test Kit. pH was determined by a pH meter (HANNA pHS-25) after calibrated by buffer solution of pH 7.0 and 9.2.

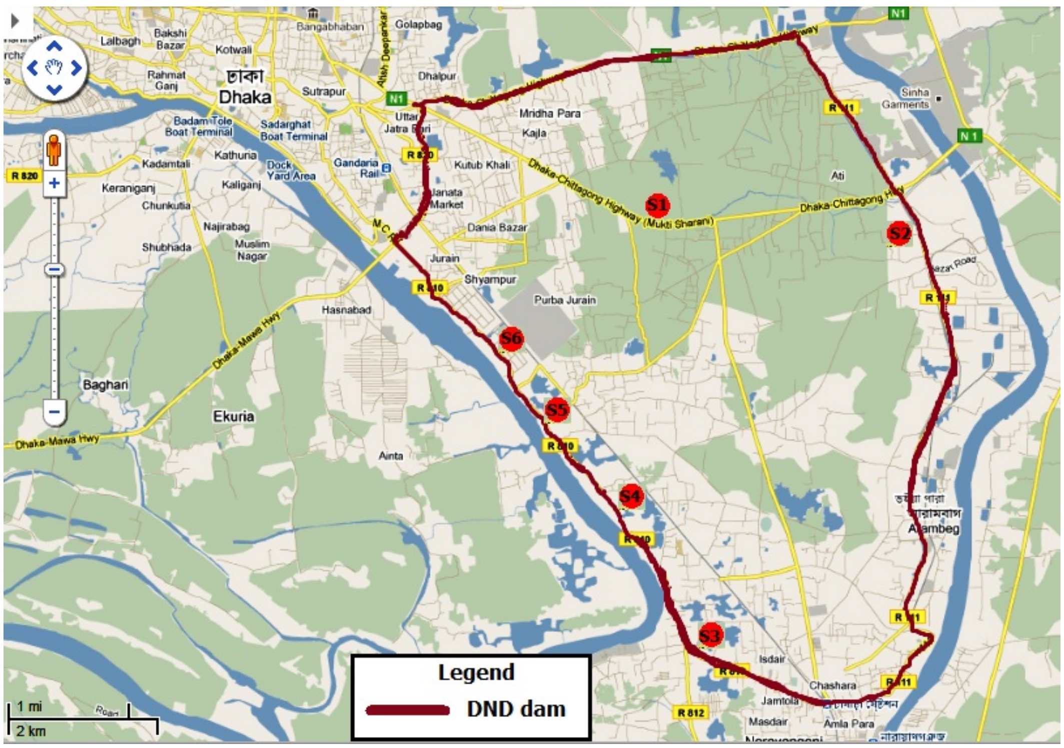

Plate 1.The location of the six study sites: Saddam Market (S1), East Mijmiji (S2), Panchaboti (S3), Dapa (S4), Pagla (S5) and WASA Gate (S6)

Statistical analysis was performed with the Microsoft Excel 2010 software for determination of standard deviation (SD) and standard error.

RESULTS AND DISCUSSION

Water temperature: One of the most outstanding and biologically significant phenomenon of water bodies is the temperature characteristic. In the present study monthly and seasonal variations were observed. Maximum average temperature of water in six sites (31.5 ± 0.2041 °C) was observed in May 2010 and minimum average temperature (18.3 °C ± 0.1925) in December 2010. Maximum seasonal mean water temperature 30.48 ± 0.4251 °C, was observed in summer and minimum seasonal mean water temperature 21.23 ± 1.1316 °C, was observed in winter. Primary productivity is one of the most important sources of energy input in aquatic ecosystem which is directly related to the water temperature (Verma and Mohanty, 1994).

Transparency: Maximum average (of six sites) transparency was 38.1 cm in February 2011 and minimum was 24.64 cm in May 2010. Maximum seasonal mean transparency of of six sites (34.11 cm) was observed in winter and minimum seasonal mean transparency (27.102 cm) was observed in summer (Table-1). Minimum Secchi depth (high turbidity) occurred in the summer months was evidently due to heavy precipitation, monsoon floods and wind turbulence. Tandon and Singh (1972) found penetration of light was maximum in April and minimum in June in Nangal Lake. The importance of rain as a factor in interpreting results from the horizontal black disc is unclear but might be related to a differential impact of rain on inherence versus apparent optical properties (Steel and Neuhauser, 1999). Chandler (1940) and Sreenivasan (1974) considered dense population of planktonic organisms to be an important contributing factor for low transparency or high turbidity.

pH: In the present study the pH values showed variations in different months round the year. The average pH values of the six sampling sites ranged from 6.74 ± 0.057 in May 2010 to 7.66 ± 0.144 in August 2010 (Table-1). Maximum pH value in August may be attributed to overflow of flood water for three months in the dam area and also for lowest amount of free CO_2 in water in August which agrees with the findings of Karmakar *et al.* (2011). But these variations were neither known to be of any great significance nor showed any correlation with other physicochemical factors except with dissolved oxygen (DO). The seasonal fluctuations of pH values were conspicuous and showed decreasing tendency from October 2010 to April 2011. During March 2011 and April 2011 the pH value was more or less neutral. On the other hand, pH values showed an increasing tendency of acidic character of water from May 2010. Maximum seasonal mean pH value 7.40 ± 0.1872, was observed in rainy season and minimum seasonal mean pH value, 6.98 ± 0.1156, was observed in summer. Cone (1988) worked at the Drew University campus in New Jersey on two ponds and found that pH fluctuated on regular basis. The cause behind this was to the competing effects of photosynthesis and respiration. Kumar and Dua (2009) worked on water quality of river Ravi at Madhopur, India and found high fluctuation of pH value in different months of the study period.

Dissolved oxygen (DO): Maximum seasonal mean concentration of dissolved oxygen (5.82 ± 0.2378 mg/l) was observed in winter and minimum seasonal mean concentration of dissolved oxygen (4.36 ± 0.264 mg/l), was observed in summer. Concentration of dissolved oxygen (DO) increased gradually from May

2010 to December 2010 when it attained its maximum average value of 6.83 ± 0.4735 mg/l and then decreased till April 2011 when it attained its nearly minimum average value of 4.57 ± 0.1663 mg/l (Table-1). The lowest average value of dissolved oxygen, 4.0 ± 0.237 mg/l, was observed in May 2010. Dissolved oxygen concentration of water increased in colder months. Both the maxima were found in winter months (December 2010 and January 2011) and supporting the findings of previous workers like Welch (1952), Reid (1961) and Ferrari (1976). In the present investigation maximum (6.83 ± 0.4735) DO was found in December 2010. The results of dissolved oxygen concentration are also in fair agreement with the findings of George and Fernando (1969), Kumar and Dua (2009), who also recorded maximum dissolved oxygen in winter months.

Table 1. Monthly variation of physico-chemical parameters of water of DND dam area during May 2010 to April 2011

Month	Tempera -ture (°C ± SE)	Transpa- rency (cm ± SE)	pH (± SE)	DO (mg/l ± SE)	BOD (mg/l± SE)	Free CO_2 (mg/l ± SE)	Hardness (mg/l ± SE)
May'10	31.50 ± 0.204	24.561 ± 2.722	6.74 ± 0.057	4.00 ± 0.238	32± 0.261	16.31 ± 2.475	243.00 ± 78.924
Jun'10	30.50 ± 0.192	29.21 ± 3.096	6.97 ± 0.083	4.52 ± 0.105	31± 0.113	14.28 ± 2.894	222.00± 74.602
Jul'10	29.70 ± 0.192	27.432 ± 2.705	7.23 ± 0.084	4.56 ± 0.166	33± 0.121	4.14 ± 0.704	204.20 ± 65.962
Aug'10	29.20 ± 0.280	26.67 ± 2.592	7.66 ± 0.144	4.20 ± 0.254	34± 0.122	3.81± 0.897	202.20 ± 66.298
Sept'10	29.33± 0.192	29.21 ± 2.052	6.94 ± 0.097	4.76 ± 0.276	30± 0.232	09.34 ± 2.281	196.20 ± 66.396
Oct'10	27.50 ± 0.391	31.242 ± 3.261	7.59 ± 0.234	4.92 ± 0.286	31± 0.245	26.96 ± 5.200	217.50 ± 67.523
Nov'10	22.80 ± 0.152	33.782 ± 3.430	7.33 ± 0.216	4.87 ± 0.207	30± 0.132	27.98 ± 4.567	237.50 ± 80.422
Dec'10	18.30 ± 0.192	34.29 ± 2.299	7.21 ± 0.129	6.83 ± 0.473	18± 0.236	29.62 ± 8.961	271.20 ± 94.660
Jan'11	22.60 ± 0.183	34.29 ± 2.735	7.10 ± 0.059	5.75 ± 0.155	15± 0.274	29.67 ± 4.451	268.80 ± 94.153
Feb'11	26.2 0± 0.096	38.1 ± 3.490	7.10 ± 0.063	4.80 ± 0.283	29± 0.312	27.98 ± 1.342	265.00 ± 94.450
Mar'11	28.25 ± 0.204	35.56 ± 4.900	7.05 ± 0.054	4.64 ± 0.434	30± 0.299	27.83 ± 5.989	219.00 ± 79.231
Apr'11	29.25 ± 0.204	27.432 ± 2.498	6.85 ± 0.049	4.57 ± 0.483	31± 0.316	20.57 ± 1.074	207.50 ± 72.730

Biological Oxygen Demand (BOD): The most concerned water quality variables in aquaculture is BOD or biochemical oxygen demand (Boyd, 1990). Like other parameters, BOD values also showed seasonality. The average BOD value of six sample sites ranged from 34 ± 0.122 mg/l in August 2010 to 15±0.274 mg/l in January 2011. The BOD values were negatively related to DO.

BOD was maximum in rainy season (August 2010) when DO was minimum and transparency was low. Again BOD was minimum in winter (January 2011 to December 2011) when DO was maximum and transparency was maximum. But most of the time during the study period BOD values were above 20 mg/l. which is not suitable for aquaculture. In winter season the BOD values were less than 20 mg/l and showed its suitability for aquaculture. Though BOD is not used for aquaculture but the values of BOD for water of DND helps to estimate pollutants in effluents (Boyd, 1990).

Free Carbon dioxide (Free CO_2): Most of the sites showed free CO_2 concentrations higher than 10.00 mg/l. Average annual free CO_2 at six different sites ranged between 3.81 ± 0.897 and 29.67 ± 8.961 mg/l. Maximum average (of six sites) concentration of free carbon dioxide (free CO_2), 29.67 ± 8.961 mg/l, was observed in January 2011 and minimum, 3.81 ± 0.897 mg/l, was observed in August 2010 (Table-1). Seasonally maximum mean concentration of free carbon dioxide, 29.09 ± 4.221 mg/l, was observed in winter and minimum seasonal mean concentration of free carbon dioxide, 11.58 ± 2.751 mg/l, was in summer. Maximum concentration of free carbon dioxide found in January 2011 may be attributed to a large amount of garbage and sewage fall into the dam area.

Hardness: Water hardness is important for fish culture (Boyd, 1982). Calcium and Magnesium contributes to hardness of freshwater. Hard water has high concentrations of mineral contents typically of Ca^{2+} and Mg^{2+} ions (Wikipedia, 2009). In water bodies Calcium acts as nutrient and then complexing with toxicants to form insoluble precipitates (Miller and Litsky 1976). In the present investigation maximum average hardness was recorded in December (271.2 ± 94.660 mg/l) and minimum average was in September (196.2 ± 66.396 mg/l) (Table-1). Hardness of water at Pagla was always at the highest value. The highest value (789 ± 258.956 mg/l) of hardness at Pagla was observed in December 2010, and the lowest (559 ± 188.734 mg/l) in September 2010. Both the values are far away from the standard concentration of hardness. Maximum seasonal mean hardness of water, 258.90 ± 8.769 mg/l, was observed in winter and minimum seasonal mean hardness of water, 205.20 ± 5.099 mg/l, was observed in rainy season. The results of hardness showed similarities with those of Kumar and Dua (2009) in Indian River waters. Hardness values between 100 mg/l to 250 mg/l matches the Calcium concentration of fish blood, thus suitable for fishes (William and Durborow,1992). But DND waters hardness was high (196.20 ± 66.3963 mg/l to 271.20 ± 94.6597 mg/l). Higher hardness was due to the presence of limestone in the soil of DND canal system.

The DO values for DND dam canal were within the permissible limits according to Boyd and Tucker (1992), and the values of hardness and pH were also within the permissible limits. But free CO_2 values were very much higher than the permissible limits of Boyd (1990). In a general note, DND dam canal is not good for fishing, aquaculture and also not suitable for human use. It is considered to be polluted water and pollution occurred mostly by releasing of huge amount of human-produced garbage, litters, trash, debris, metallic and industrial wastes.

Water parameters like pH, DO, BOD, hardness of DND canal system is suitable for aquaculture. Optimum DO values for fisheries ranged from 4 to 6 mg/l (Boyd 1990), below which most cultivable aquatic organisms could not survive or have good growth. In other word, dissolved oxygen concentration is in safe level in all the locations of DND canal system. But the Secchi disc transparency is always less than 40 cm or 15.74 inch, there is either too much plankton or turbid water due to human activities or organic led water. Halda river water was turbid round the year and transparency varied between 13.62 cm to 28.58 cm (Patra and Azadi 1987). Culture fishes may suffocate during the night when oxygen is not produced by photosynthesis and also when much oxygen is consumed by the respiration of plankton or bacteria. The high BOD values indicate organic pollutants in effluents which is undesirable for aquaculture. Since some water parameters in DND canal were found to be suitable for fish culture but it was evident that DND is organically polluted. Further investigation on the heavy metal pollution is necessary before using the aquatic system of DND canal water for animal and human food production.

Acknowledgements: This work is the MSc research of the second author. Part of this research was supported by National Institutes of Health (NIH) Grant No. RO1A1039129, under collaborative agreements between the Johns Hopkins Bloomberg School of Public Health and the International Centre for Diarrheal Disease Research, Bangladesh (ICDDR,B) and University of Dhaka. The Department of Zoology, University of Dhaka has provided technical laboratory support.

LITERATURE CITED

APHA, 1985. *Standard Methods for the Examination of Water and Waste Water.* (15th Edition) American Public Health Association, New York.

BANGLAPEDIA, 2006. *National Encyclopedia of Bangladesh*, Asiatic Society of Bangladesh.

BHATIA, S.C. 2006. *Environmental Chemistry.* CBS Publishers, New Delhi, 88-89.

BOYD, C.E. 1982. *Water quality Management for Pond Fish Culture.* Elsevier Scientific Pub. Co., UK, 318p.

BOYD, C.E. 1990. *Water Quality in Ponds for Aquaculture. Ala. Agr.Exp.Sta.* Auburn University. 462p.

BOYD, C.E. and TUCKER, C.S. 1992. *Water Quality and Pond Soil Analyses for Aquaculture.* Auburn University. AL. 183.

CHANDLER, D.C. 1940. Limnological studies of Western Lake Erye, Plankton and certain physico-chemical data of the Ban Island Region, from September 1930 to November 1939. *Ohio J. Sci.* **40**: 293-336.

COLLOCOTT, T.C. and DABSON, A. 1974. *Chambers Science and Technology Dictionary*, Chambers Edinburgh, 56 p.

CONE, D.C. 1988. The diel pH fluctuations of two freshwater ponds and their physiological effects on the resident population of *Carassius auratus*. *Bios*,Vol. **59 (**1/2): 5-15.

FERRARI, I. 1976. Winter limnology of a mountain lake Iago Santo Parmonse (Italy). *Hydrobiol.* **51**(3): 245-257.

GEORGE, M.G. and FERNANDO, C.H. 1969. Seasonal distribution and vertical migration of planktonic rotifers in two lakes of Eastern Canada. *Verh. Int. Ver. Limnol.* **17**: 817-819.

HARGIS, L.G. 1988. *Analytical Chemistry.* Prentice Hall, New Jersey, 179-181p.

KABIR, A.K.M.N. and NASER, M.N. 2011. Physical and chemical limnology of Chandbill oxbow lake of Meherpur, Bangladesh. *Dhaka Univ. J. Biol. Sci.,* **20**(1): 31- 39.

KARMAKAR, S. HAQUE, S.M.S. HOSSAIN, M.M. and SHAFIQ, M. 2011. Water quality of Kaptai reservoir in Chittagong Hill Tracts of Bangladesh. *Journal of Forestry Research,* **22**(1): 87-92.

KUMAR, A. and DUA, A. 2009. Water Quality Index for Assessment of Water Quality of River Ravi at Madhopur (India). *Global J. of Environ. Sci.* **8**(1): 49-57.

MASON, C. F. 2002. *Biology of Freshwater Pollution* (4th edition). Benjamin Cummings. 400 p.

MILLER, B.M. and LITSKY, W. 1976. *Industrial Microbiology.* McGraw-Hill, New York. 576p.

MIRZA, Z.S., NADEEM, M.S., BEG, M.A. and MALIK, I.U. 2013. Spatial and Temporal Fluctuations in the Physico-Chemical Limnology of Mangla Dam (Pakistan). *Pakistan J. Zool.,* **45**(3): pp. 679-686.

PATRA, R.W.R. and AZADI, M.A. 1987. Ecological studies on the planktonic organisms of the Halda River, *Bangladesh J. Zool.* **15**(2):109-123.

REID, G. K. 1961. *Ecology of Inland waters and Estuaries*. Litton Educational Publishing Inc. 375p.

SINGH, D.N. and DAS, A.K. 2003. Diurnal movement of plankton in a peninsular man-made lake. *Reservoir Division of CIFRI, Rajajinagar, Bangalore-560 010, India, Indian J. Fish.,* 50(1): 107-111.

SREENIVASAN, A. 1974. Limnological features of the tropical impoundment, Bhavanisagor Reservoir, India. *Int. Rev. Ges. Hydrobiol.* **53**: 327-342.

STEEL, E. A. and NEUHAUSER, S. 1999. A Comparison of Methods for Measuring Water Clarity. *J. North Am. Benth. Soc.* North American Benthological Society, Lawrence, KS.

TANDON, K.K. and SINGH, H. 1972. Effect of certain physico-chemical factors on the plankton of the Nangal Lake. *Proc. Ind. Acad. Sci. Sect. B.* **76**(1): 15-25.

VERMA, J.P. and MOHANTY, R.C. 1994. Primary productivity and its correlation with certain selected physico-chemical and bio-community parameters. *Environ. Ecol.* **12**(3): 625-629.

WELCH, P. S. 1952. *Limnology.* McGraw Hill Book Company, London. 538 p.

WIKIPEDIA, 2009. *Hard water*, http://en.wikipedia.org/wiki/Hard_water. The Free Encyclopedia, accessed on 20 April, 2011.

WILLIAM, A.W. and DURBOROW, R.M. 1992. Interactions of pH, carbon dioxide, alkalinity and hardness in fish ponds. *SRAC publication.* No.464.

(Manuscript received on 8 November 2012; revised on 31 November 2013)