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RESEARCH ARTICLE

ASSESSMENT OF INLAND WATER QUALITY PARAMETERS OF DHAKA CITY, BANGLADESH

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ARTICLE DETAILS

ABSTRACT

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Physicochemical parameters are the important indicators for determining the quality of water. This study was conducted to examine the water quality of two important water bodies located in Dhaka city namely Ramna Lake and Shahidullah Hall Pond of Dhaka University. It analyzed pH, DO, EC, TDS, BOD, HCO₃⁻, Alkalinity and salinity as well concentration of heavy metals i.e., Iron, Lead, Nickel, Silver, Mercury, Chromium, Manganese and Zinc. It is found that the pH of four samples ranged from 6.53 to 6.72 whereas DO varied from 4.18 to 5.03 mg/l, EC 1.79 μS/cm to 2.34 μS/cm, TDS 85.7 to 111.7 ppm and BOD 1.32 to 2.43 mg/l, respectively. Along with physicochemical parameters, the hardness found ranging from 52.13 mg/l to 60.76 mg/l, Alkalinity 92.35 to 96.45, HCO₃⁻ 79.06 to 110.23 while CO₃²⁻ not detected of these water bodies. Moreover, this study found the presence of heavy metals in these water bodies such as Lead varied from 1.8 to 3.5 μg/l, Nickel 4.5 to 6.9 μg/l, Mercury 0.001 to 1.6 μg/l, Chromium 2.0 to 2.2 μg/l and Manganese 0.03 to 0.8 μg/l respectively in which some were exceeding the Bangladesh Standard. Thus, this study is portraying the pollution problem of these water bodies and suggesting the necessity of proper management action as early as possible.

KEYWORDS

Water Quality, Environment, Parameter, Bangladesh

1. INTRODUCTION

The quality of water is vital concern for mankind, since it is directly linked with human welfare. At present, the menace of water borne diseases and epidemics still loom large on the horizons of developing countries in which polluted water is considered as mainly responsible for such public health concerns. The world is experiencing a steady decline in water quality and its availability [1]. About 75 percent of the world's rural population and 20 percent of its urban population have no ready access to safe water. The unstoppable rise in demand for water to grow food, supply industries and sustain urban and rural population has led to a growing scarcity of freshwater in many parts of the world [2]. There are only about 5.6 out of 1400 million cubic kilometers of total water volume is available as surface fresh water in rivers, lakes and swamps even though unevenly distributed. In the developing countries, water and sanitation are mostly poor which cause various diseases due to the insufficient treatment of industrial effluent and domestic sewage [3].

Bangladesh is a riverine country with many trans-boundary rivers which carry heavy loads of sediments and other debris including domestic wastes, agrochemical and industrial wastes [4]. Thus making the water body silting with organic and inorganic pollutants which affect the environment. So, pollution has become a serious problem all over the world and is getting aggravated in developing countries like Bangladesh [5].

In Bangladesh the rate of urbanization is very high and the growth of urban population is higher than national growth. In 1961, the urban population was 2.6 million which was only 4.8 percent of the total

population which reached to 28.60 million i.e., 23.10 percent in 2001. Dhaka, the capital city of Bangladesh experienced in the rapid population growth and accounted for about 37.40 percent of the total urban population in 2001. The unplanned urbanization and industrialization is alarming for decreasing natural environment where water sector or hydrological system is more vulnerable [6, 7]. The pollution from industrial and urban waste effluents and from agrochemicals in some water bodies and rivers has reached alarming levels [8].

There are only 10-15% water bodies in Dhaka city in which Gulshan Lake, Ramna, Dhanmondi Lake and Shahidullah Pond are most prominent [9]. These lakes are one of the most probable water sources which can meet the demand of water scarcity throughout the Dhaka city during the dry season [10]. However, the water bodies of Dhaka city have been deteriorating day by day due to numerous biological, physical and chemical interventions by human that leading to water toxicity [11]. Water are mainly polluting by wastes from households, toxic chemicals from industries with the surface and supplied water as well as hanging latrines [12, 13]. These types of pollution are not only adversely affecting human health but also animals, fish, and birds [3]. Bangladesh is the fourth ranking in the inland fisheries production but due to poor management of lake and ponds it leads to fish mortality and spread out the contiguous disease [14,15]. A number of studies have been done on the water quality of Dhaka city. For example, found very high microbial contamination and physicochemical characteristics in Gulshan, Banani and Uttara lake of Dhaka city [3].

In addition, Ramna Lake situated in the middle of Dhaka City, covering about 72% of the total area of Shahbag region and has been playing a vital role as drainage system of Shahbag and Kakrail areas [16]. It has been polluting due to improper dumping of waste and contaminated water from business firms while Shahidullah hall pond for student activities. The most important sources of pollutants in these water bodies are leftovers from restaurants, gathering for cultural programs, linked with drainage system, garbage and liquid waste disposal etc. At present, there is inadequate information regarding the water quality though it is important that the people have to aware for assuring the good hydrological environment of water body [17]. Hence, the objectives of this study has set to assess the physicochemical parameters, heavy metal concentration and microbial contamination in these water bodies.

2. STUDY AREA

Ramna Lake is a prominent depression within Dhaka metropolitan area. It is situated in the middle of Dhaka City. It also lies within the vicinity of Shahbag areas. The lake is about 8.76 acres and its 72% of the total area exist in Shahbag region and has been playing a vital role in maintaining the only drainage system of Shahbag and Kakrail areas.

Shahidullah Hall Pond is very famous and ideal pond in the Dhaka metropolitan area. It is situated in the heart of Dhaka City. It lies within the locality of Shahbag area. Total area of the pond is about 4 acres.

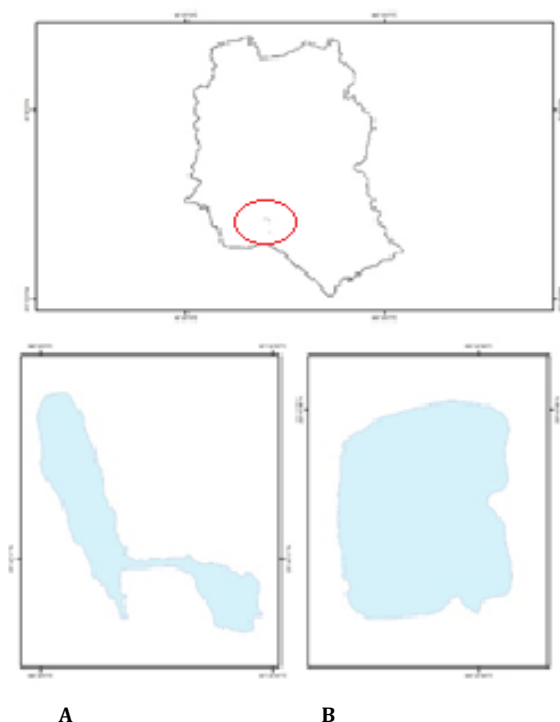


Figure 1: Map of Study Area; (A) Ramna Lake, (B) Shahidullah Hall Pond

3. MATERIALS AND METHODS

There are four water samples from individual sampling points were collected from the Ramna Lake (Figure 1A) and Shahidullah Hall Pond (Figure 1B) during winter seasons and analyzed for physicochemical

parameters, heavy metal and microbial concentration.

3.1 Physicochemical Analysis

The portable instrument and 500 ml beaker were used for the physicochemical parameter analysis. The temperature of the water samples was measured immediately in the field by a mercury thermometer of 0 to 50° C range and with 0.2° C least count [18]. pH was determined by glass electrode using pH meter (Model: Jenway instrument, pH meter 3305). The EC was directly determined in the field by EC meter (Model: HANNA HI-8633) in $\mu\text{S}/\text{cm}$. A rapid determination of Total Dissolved Solids (TDS) of water samples was determined in the field by TDS meter. Dissolved Oxygen (DO) of water samples was determined in the field by DO meter. The hardness or Total Hardness (TH), Calcium plus Magnesium or hardness as CaCO_3 , of the water sample was calculated by adding the milliequivalents of Ca and Mg per liter and multiplying the sum by 50. The total hardness was calculated by the equation as

$$\text{TH} = (\text{Ca}^{++} + \text{Mg}^{++}) \times 50$$

Where, TH is expressed in PPM and the concentration of the constituents is expressed in meq/L.

3.2 Determination of Heavy Metals

Heavy metals i.e., Lead (Pb), Iron (Fe), Nickel (Ni), Silver (Ag) Cobalt (Co), Mercury (Hg), Chromium (Cr), Manganese (Mn) and Zinc (Zn) content of the water samples were determined by APHA heavy metal determination method, Edition 22 published in 2012. In addition, inductively coupled plasma-optical emission spectroscopy (ICP-OES) and Inductively coupled plasma-mass spectrometry (ICP-MS) have been used for heavy metals.

3.3 Biological Analysis

The Heterotrophic Plate Count (HPC), formerly known as the standard plate count, is a procedure for estimating the number of live heterotrophic bacteria in water and measuring changes during water treatment and distribution or in swimming pools. Colonies may arise from pairs, chains, clusters, or single cells, all of which are included in the term "colony-forming unit" (c.f.u). The final count also depends on interaction among the developing colonies; choose that combination of procedure and medium that produces the greatest number of colonies within the designated incubation time.

4. RESULT AND DISCUSSION

The 4 samples of surface water from Ramna Lake and Shahidullah Hall Pond, Dhaka University (Table 1) showed a pH value ranging from 6.53 to 6.72 which representing a neutral condition as well as within the Bangladesh Standard (6.5-8.5). In addition, the DO value found to be ranging from 4.18 to 5.03 mg/l which also have the resemblance with national standard (i.e., >5 mg/l). Further, the found maximum value of EC was 234 $\mu\text{S}/\text{cm}$ in comparison with minimum 179.7 $\mu\text{S}/\text{cm}$ whereas the standard is 500 $\mu\text{S}/\text{cm}$. Furthermore, Total Dissolved Solids varied from 85.7 to 111.7 ppm which were indicating low organic and inorganic contamination resulting below the national standard (<1000 mg/l). In addition, the BOD value ranged from 1.32 to 2.43 mg/l (Bangladesh Standard <3 mg/l).

Table 1: Result of Physicochemical Parameters

SN	Parameter	DU Pond North	DU Pond South	Ramna lake North	Ramna lake South	BD Standard (EQS)
1.	pH	6.53	6.58	6.72	6.71	6.5.-8.5
2.	DO	4.18 mg/l	5.03 mg/l	4.64 mg/l	4.84 mg/l	< 5 mg/l
3.	EC	234 $\mu\text{S}/\text{cm}$	231 $\mu\text{S}/\text{cm}$	179.7 $\mu\text{S}/\text{cm}$	179.7 $\mu\text{S}/\text{cm}$	500 $\mu\text{S}/\text{cm}$
4.	TDS	111.7 mg/l	110.7 mg/l	85.6 mg/l	85.6 mg/l	1000 mg/l
5.	BOD	1.32 mg/l	1.39 mg/l	1.47 mg/l	2.43 mg/l	3 mg/l or less

Note: Environmental Quality Standard of lake water (used as recreational purposes) [19].

Besides, Total Hardness found a range from 55.01 to 60.76 mg/l along with the Total Bicarbonate from 79.06 to 110.23 mg/l and the alkalinity from 90.35 - 96.45 mg/l respectively (Table 2).

Table 2: Result of Chemical Parameters

SN	Parameter	DU Pond North	DU Pond South	Ramna lake North	Ramna lake South
1.	Hardness	55.01 mg/l	52.133 mg/l	60.76 mg/l	60.40 mg/l
2.	Alkalinity	90.35 mg/l	92.35 mg/l	96.45 mg/l	95.32 mg/l
3.	HCO ₃ ⁻	110.23 mg/l	112.69 mg/l	79.06 mg/l	96.45 mg/l
4.	Carbonate	ND	ND	ND	ND

Note: ND- Not Detected

Meanwhile, this study found the presence of heavy metal in these water bodies. The detected concentration of Iron (Fe) varied from 0.1 to 0.6µg/l which is within the Bangladesh Standard (0.3 - 1.0 µg/l). As well, the Lead (Pb) concentration ranged from 1.8 to 3.5 µg/l which has exceeded the Bangladesh Standard (0.05 µg/l). Further, the concentration of Nickel (Ni) found from 4.5 to 6.9 µg/l, Mercury (Hg) from 0.001 to 0.6µg/l, Chromium (Cr) from 2.0 to 2.2µg/l and Manganese (Mn) from 0.03 to 0.8 ppm

respectively which all are found as exceeding the national standard (Table 3). Only the concentration of Zinc (Zn) found to be within the level of Bangladesh Standard. Which is more than Bangladesh Standard (0.1ppm). The result from four samples of Shahidullah Hall Pond & Ramna Lake showed the concentration of Iron is range from 0.005 ppm to 0.009 ppm which is within the country standard (5ppm).

Table 3: Result of Heavy metals

Parameter	DU Pond North (Sample 1) mg/l	DU Pond South (Sample 2) mg/l	Ramna lake North (Sample 3) mg/l	Ramna lake South (Sample 4) mg/l	BD Standard (ECR-1997) mg/l
Fe	.05	0.6	0.1	0.15	0.3-1.0
Pb	3.4	3.5	1.8	2.6	0.05
Ni	6.9	6.9	6.1	4.5	0.1
Ag	ND	ND	ND	ND	0.02
Hg	1.6	1.4	0.001	0.001	0.001
Cr	2.2	2.2	2.2	2	0.05
Mn	.03	0.3	0.8	0.8	0.1
Zn	0.005	0.005	0.008	0.009	5

Total Coliform: The microbial analysis of the samples found that total coliforms ranging from 90 to 240 along with numerous numbers of Dysentery, Typhoid and Paratyphoid bacilli bacteria. Moreover, there are

7 to 20 colonies of fecal coliform was found in the per 100 ml water sample (Table 4).

Table 4: Results of Coliform Test

Parameter	Sample 1 (DU Pond)	Sample 2 (DU Pond)	Sample 3 (Ramna Lake)	Sample 4 (Ramna Lake)	BD Standard (ECR-1997)
Fecal Coliform (FC)	7	20	13	10	0/100 ml.
Total Coliform (TC)	90	240	150	120	0/100 ml.

5. CONCLUSION AND RECOMMENDATIONS

The water ecosystems in the Dhaka city has been playing an important role for natural balance in the environment. These resources are intrinsically linked with the socio-economic and environmental aspects of this city. Although this study found the physiochemical parameters are within the permissible level of Bangladesh Standard except DO. A number of heavy metal such as Lead, Nickel, Mercury, Chromium and Manganese were found to be more than Bangladesh Standard for drinking as well as coliform are denoting the pollution. Therefore, Dhaka South and North City Corporations need to exercise regular monitoring system to stop solids and liquid waste dumped into these ecosystems. Sewerage lines should not link with the lake and municipal sewerage treatment system should be established. The Department of Environment (DoE) should have proper monitoring and management system to manage the lake

environment. As well, it is important to establish the sufficient dustbin to throw polythene, nut shell, tea cup, and packets of paper, food waste, water bottles and other residues. The indigenous low-cost solid waste treatment plants, sufficient public toilet along with public awareness could reduce the pollution problems of these ecosystems. The overall study states that the quality of water was not good enough to maintain public health and required proper management for the balance of ecosystem by ensuring greatest water quality. This study needs further investigation in wet season to compare the pollution with dry season.

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REFERENCES

- [1] Ayres, R.S., Westcot, D.W. 1985. Water Quality for Agriculture. FAO Irrigation and Drainage Paper No. 29, Food and Agriculture Organization of the United Nations.
- [2] Nayeem, A.A., Majumder, A.K., Hossain, M.S. 2017. Assessment of Water Quality Parameters in Karnafuli River: A Case Study in Karnafuli Paper Mill Area. *Journal of Water Resources and Pollution Studies*, 2(3).
- [3] Ahmad, T., Uddin, M.E., Alam, M.K., Moniruzzaman, M., Saha, B., Sufian, A., Alam, M.G., Hossain, I. 2018. Evaluation of Microbial and Physicochemical Properties of Three Selected Lakes Water in Dhaka City. *Bangladesh Scholars Academic Journal of Biosciences*, pp. 230–238.
- [4] Rahman, A.K.M., Sattar, M.A., Baten, M.A., Hossain, M.A. 2005. Contamination of River waters Bangladesh. *Journal of Environmental Science*, 11 (2), pp. 319-322.
- [5] Sarker, M.A.K. 2005. Study on the Accumulation and Seasonal Variation of Trace Metals in Water, Sediment and Some Fishes of the Buriganga River, M.Sc. thesis (1998-1999), Department of Zoology, Dhaka University, Dhaka, Bangladesh.
- [6] Akter, M., Sikader, T., Ullah, A.K.M.A. 2014. Water Quality Assessment of an Industrial Zone Polluted Aquatic Body in Dhaka, Bangladesh. *American Journal of Environmental Protection*, 3(5), pp. 232–237.
- [7] Chhatwal, G.R., Mehra, M.C., Staka, M., Katyal, M., Nagahiru, T. 1992. *Encyclopedia of Environmental Agricultural Pollution and its control*, 21, Anmol Publications, New Delhi, pp. 70-254.
- [8] Ahmed, A.U., Reazuddin. 2000. *Industrial Pollution of Water Systems in Bangladesh*. University Press Limited, Dhaka, Bangladesh, pp. 175-178.
- [9] Miah, M.B., Majumder, A.K., Latifa, G.A. 2017. Evaluation of microbial quality of the surface water of Hatirjheel in Dhaka City. *Stamford Journal of Microbiology*, 6(1).
- [10] Islam, M.S., Rehnuma, M., Tithi, S.S., Kabir, M.H., Sarkar, L. 2015. Investigation of Water Quality Parameters from Ramna, Crescent and Hatirjheel Lakes in Dhaka City, ISSN 1999-7361. *Journal of Environmental Science & Natural Resources*, 8(1), pp. 1–5.
- [11] Alam, M.S. 2014. Assessment of Water Quality of Hatirjheel Lake in Dhaka City. *International Journal of Technology Enhancements and Emerging Engineering Research*, pp. 97–100.
- [12] Alam, K. 2003. *Cleanup of the Buriganga River: Integrating the Environment into Decision Making*, PhD Dissertation. Perth, Murdoch University.
- [13] Mokaddes, M.A., Nahar, B.S., Baten, M.A. 2013. Status of Heavy Metal Contaminations of River Water of Dhaka Metropolitan City. *Journal of Environmental Science & Natural Resources*, 5(2), pp. 349–353.
- [14] Halim, M.A., Sharmin, S., Rahman, H.M.H., Rahman, M.S., Islam, M.S. 2018. Assessment of water quality parameters in baor environment, Bangladesh: A review. *International Journal of Fisheries and Aquatic Studies*, 6(2), pp. 259–263.
- [15] Ferdoushi, Z., Chowdhury, R.H., Fatema, K., Islam, A. 2015. A study on limnological aspects of Ramsagar lake in Dinajpur district, *Journal of the Bangladesh Agricultural University*, 13(1), pp. 145–152.
- [16] Trisha, M.M. 2017. Assessment of Physicochemical Parameters of Dhanmondi and Ramna Lakes; BSc Thesis, Department of Environmental Science, Stamford University, Bangladesh.
- [17] Majumder, A.K., Islam, K.M.N., Nite, R.N., Noor, R. 2011. Evaluation of Microbiological Quality of Commercially Available Bottled Water in the City of Dhaka, Bangladesh. *Stamford Journal of Microbiology*, 1(1), ISSN: 2074-5356.
- [18] Gupta, P.K. 2000. *Methods in Environmental Analysis: Water, Soil and Air*. Agro bios, Jodhpur, India. pp. 5-76.
- [19] EQS (Environmental Quality Standard). Bangladesh Gazette, Registered. Department of Environment, Ministry of Environment and Forest, Government of Bangladesh.
- [20] ECR (Environmental Conservation Rules). 1997. Department of Environment, Peoples' republic of Bangladesh.

