J. Environ. Sci. & Natural Resources, **6(1): 345 - 348, 2013** ISSN 1999-7361

Status of Heavy Metal Contaminations of Lake Water of Dhaka Metropolitan City

M. A. A. Mokaddes, B. S. Nahar[1] and M.A. Baten

Department of Environmental Science, [1]Center for Environmental Studies
Bangladesh Agricultural University, Mymensingh

Abstract

A study was conducted to evaluate level of water pollution and its influence on heavy metal contaminations of lake water of Dhaka metropolitan city. The water samples were collected from lakes of Dhaka metropolitan city during February to March, 2008. The chemical analysis of water samples included pH, EC, As, Cu, Mn, 'ln. Pb and Cd. Analysis of lake water samples was done at the Central Laboratory of Bangladesh Agricultural University, Mymensingh. The concentrations of heavy metal of lake water were recorded as: in case of pH = 6.95, in case of EC = 22.44 (μscm^{-1}), in case of Cu = 0.018 ppm, in case of Zn = 0.274 ppm, in case of Mn = 0.084 ppm, in case of As = 0.002 ppb, in case of Pb = 0.002 ppm and in case of Cd = 0.044 ppm. The pH value of lakes water range from 5.34 to 7.68, an indication of slightly acidic to alkaline in nature. The average EC value for lakes water ranged from 17.61 to 34.61 μScm^{-1} where EC value varied from 14.24 to 33.48 μScm^{-1} in the lake water.

Kew Words: Heavy metals, Lakes, Dhaka City

Introduction

Lake is smaller than canal or river. In a city lake is thought to be the store house of drain water, though some lakes may be kept free from the connection with drains. Lake water plays an important role to serve as many purposes like irrigation, aquaculture and livestock usage. Water quality is deteriorated day by day due to numerous of biological, physical and chemical variables causing water toxicity. When concentration of any element or compound exceeds the tolerance limit for organisms and other usage treated as pollutants. Bangladesh is one of the most density populated country of the world with population growth rate of 1.48 per annum (BBS, 2005). The people of Bangladesh have easy access to both surface and ground water supply to support their lives. In fact, water stands as a second available resource after human resources (Azad, 2003). Dhaka metropolitan city is expanding rapidly. Dhaka city has one of the highest urban growth rates in the world. Every year population of Dhaka city is increasing due to large job opportunities which are inadequate in rural areas. As a result the development of slums and squatters are continuously increasing which is also a cause of degrading the water environment (World Bank, 2000). A few days back, BBC telecast the lifestyle of polluted Dhaka city under the caption "Dhaka is the worst polluted city in the world" (Zalil, 1997). In Bangladesh, lake water sources are being polluted for many reasons. Drain channeling lakes receives human waste (excreta), municipal solid waste, industrial waste, heavy metals etc. The average sanitation coverage in Bangladesh is around 43% which indicates that rest 57% of the 150 million people lack sanitation facilities (Ali, 2002a). Everyday 20,000 metric tons of faeces deposited in the open places of Dhaka city due to open defecation and hanging latrines pollute the water bodies like river, cannels, drains and ponds etc. (Ali, 2002b). These finally reach to lakes and thus lake water polluting happen. Tannery and other industrial wastes, unplanned sewage system, medical wastes, nuclear and toxic materials mixing with drain water passes to lakes and thus polluting lake waters, threatening people's liver with health hazards related to toxicity (Abadeen, 2002). Important lakes include the Dhanmondi lake, Romna lake, Crescent lake and Sangsad Bhaban lake, Gulshan lake, Bonani lake, Rampura lake, Sutrapur, Tongi and Airport lake of Dhaka metropolitan city. Pollution and contamination of the lakes water have impacts on the aquatic resources.

In the study area the surface water are used for irrigation (for home, kitchen gardening and field crop irrigation), drinking and domestic uses, air-conditioning, beverage, confectionary, laundering, dyeing, ice factory, cold storage, brick field and other industries. In view of the above mentioned multidirectional usage, a study have been conducted to assess the water quality from different non-point sources of Dhanmondi lake, Romna lake, Crescent lake and Sangsad Bhaban lake, Gulshan lake, Bonani lake, Rampura lake, Sutrapur, Tongi and Airport lake of Dhaka metropolitan city.

The present study was conducted with the following objective:

To determine the heavy metals present in the water of lakes of Dhaka metropolitan city.

Materials and Methods

Dhaka Metropolitan City, the study area lies within the north central region of Bangladesh. The area is enclosed by the Tongi khal on the north, the DND embarkment on the south, the Meghna river, Shitalkshiya river, Balu river on the east and the Turag and Buriganga river on the west. Water samples were collected from ten lakes during February to March 2008. The water samples were collected in 100 ml plastic bottles. These bottles were cleaned with dilute HCl (1:1) and then washed with tap water and distilled water as well. Before sampling bottles were rinsed again 3 to 4 times with water to be sampled. After collection the bottles containing samples were sealed immediately to avoid exposure to air. The samples were taken from the midstream and few centimeters below th3e surface. To provide necessary information for each sample such as data collection, location, source of water, depth etc. were recorded in a note book and each sample collected in a plastic bottle, was labeled separately with unique identification number. After collecting, all samples were filtered with Whiteman No. 1 filter paper to remove unwanted solid and suspended materials before analysis. Then transferred 90 ml of water sample into another 100 ml bottle which contained 10 ml 2M HCl solution. HCl solution was protected water samples from any fungal and other pathogenic attack. After collection all the water samples were carried to the "Central Laboratory" of Bangladesh Agricultural University, Mymensingh for chemical analysis.

Heavy metals viz. Cu, Zn, Mn, Pd, Cd and As were determined with the help of atomic absorption spectrophotometer (AAS, UNICAM 969) following the method of Clesceri *et al*. (1989). The wavelengths of Cu, Mn, Zn, As, Pb and Cd were 324.8nm, 213.9 nm, 193.7nm, 217.0nm, and 228.8 nm, respectively.

Statistical Analysis of the data generated out of chemical analysis of water samples were done with help of Laptop following standard procedure (analysis of variance) as described by Gomez and Gomez (1984).

Results

All the lakes water samples contained lower average of copper which varied from 0.0055 ppm to 0.115 ppm with the mean value, standard deviation (SD) and co-efficient of variation (CV) were 0.018, 0.022 and 122.82%, respectively (Table 1). The higher Cu (0.115 ppm) content recorded in Tongi lake (S_{41}) and lower (0.0055 ppm) from Dhanmondi lake (S_{22}). Eighteen (18) samples (82%) showed the above mean value and the rest 4 sample (18%) were found to be below than the mean value (0.018 ppm).

The average values of Cu for Tongi lake, Dhanmondi lake, Bonani lake and Samsad lake were 0.115 ppm, 0.0211 ppm, 0.0181 ppm and 0.0194 ppm, respectively (Table 2).

The Zn concentration in lake water samples were from 0.0003 to 1.2801 ppm, with the average value, standard deviation (SD) and co- efficient variation (CV) were 0.274 ppm, o.433 and 157.83%, respectively. The highest and lowest amount of Zn were detected in Sutrapur lake (S_{39}) and Dhanmondi lake (S_{20}), respectively (Table 1).

The Average concentration of Zn in Dhanmondi, Ramna, Crescent, Samsad, Gulshan, Bonani, Rampura, Sutrapur, and Airport lades water (Zn) varied from 0.0404 ppm. 0.0379 ppm, 0.0189 ppm,0.238 ppm, 0.0163 ppm, 0.0178 ppm, 0.625 ppm, 0.6983 ppm and 1.2801 ppm respectively (Table 2).

The collected water samples from lakes contained manganese (Mn) fluctuated 0.0469 to 0.1085 ppm. The average value, standard deviation (SD) and co-efficient of variance (CV) obtained was 0.084 ppm, 0.017 and 20.86%, respectively. About 10 samples (52%) were found above the mean and 9 samples (48%) below the mean value (0.084 ppm) (Table 1).

The average values of Mn in the Dhanmondi, Ramna, Crescent, Samsad, Gulshan, Bonani, Rampura, Sutrapur, Airport and Tongi lake were 0.0528 ppm, 0.0700 ppm, 0.0798 ppm, 0.0893 ppm, 0.0904 ppm, 0.0896 ppm, 0.0916 ppm, 0.1020 ppm, 0.1085 ppm and 0.0987 ppm respectively (Table 2). On the other band arsenic (As) content in lake water recorded were 0.001 ppb to 0.003 ppb with an average of 0.002 ppb. The standard deviation (SD) and co-efficient of variation (CV) were 0.006 and 192.95%, respectively (Table 1).

The average concentration of As was ppb for the Meghna, Shitalakshiya, and Turag river where 0.0007 and 0.001 ppb for Buriganga and Balu river, respectively (Table 8). All the lakes contained same concentration of (0.002 ppb) of As except Ramna lake (0.001 ppb) (Table 2).

Lead (Pb) status of four lakes varied from 0.0004 to 0.0027 ppm and the mean value, standard deviation (SD) and co-efficient of variation (CV) 0.002 ppm, 0.003 and 156.24%, respectively (Table 1).

Table 01. Studies on heavy **metal concentration of Cu, Zn, Mn, Pd, Cd and As of different lakes in Dhaka metropolitan city** March-April 2008.

Sample	Name of lake	Location	Cu (ppm)	Zn (ppm)	Mn (ppm)	As (ppb)	Pb (ppm)	Cd (ppm)
S_{20}	Dhanmondi lake	Road No. 32, Dhanmondi	0.0065	0.0003	0.0502	0.002	0.0004	0.005
S_{21}		Road No. 6/A, Dhanmondi	0.0211	0.0087	0.0469	0.002	0.0013	0.021
S_{22}		Near Banghabondhu museum	0.0055	0.1121	0.0612	0.003	0.0011	0.003
S_{23}	Romna lake	Romna park East Side	0.0078	0.0953	0.0743	0.001	0.0014	0.011
S_{24}		Romna park, West Side	0.0131	0.0089	0.0666	0.001	0.0011	0.009
S_{25}		Romna park, North Side	0.0121	0.0095	0.0691	0.001	0.0013	0.007
S_{26}	Crescent lake	Crescent lake, East Side	0.0111	0.0101	0.0791	0.002	0.0013	0.021
S_{27}		Crescent lake, North Side	0.0079	0.011	0.0759	0.002	0.0005	0.014
S_{28}		Crescent lake, South Side	0.0139	0.0357	0.0845	0.002	0.0009	0.181
S_{29}	Samshad lake	Samshad lake, East Side	0.0147	0.0293	0.0879	0.001	0.0014	0.001
S_{30}		Samshad lake, West Side	0.0194	0.0151	0.0784	0.003	0.0004	0.196
S_{31}		Samsad lake, North Side	0.0162	0.0271	0.1015	0.001	0.0004	0.001
S_{32}	Gulshan lake	Gulshan East side	0.0112	0.0113	0.0932	0.001	0.0006	0.009
S_{33}		Gulshan West side	0.0119	0.0139	0.0888	0.003	0.0014	0.008
S_{34}	Bonani lake	Bonani lake East side	0.0179	0.0249	0.0945	0.002	0.0017	0.001
S_{35}		Bonani lake West side	0.0181	0.0122	0.0839	0.002	0.0005	0.002
S_{36}	Rampura lake	Rampura South side	0.0154	0.9084	0.0877	0.003	0.013	0.001
S_{37}		Rampura North side	0.0169	0.9489	0.0976	0.001	0.0016	0.002
S_{38}	Sutrapur lake	Sutrapur South side	0.0111	0.977	0.1063	0.002	0.0027	0.23
S_{39}		Sutrapur North side	0.0155	0.4929	0.1082	0.001	0.0014	0.0157
S_{40}	Air port lake	Air port lake	0.0129	1.2801	0.1085	0.002	0.0007	0.221
S_{41}	Tongi lake	Tongi Kamarpara Bridge	0.115	0.998	0.0987	0.002	0.0014	0.003
Mean			0.018	0.274	0.084	0.002	0.002	0.044
SD			0.022	0.433	0.017	0.001	0.003	0.079
CV(%)			122.829	157.830	20.863	40.297	156.244	181.568

The maximum Pb average value of (0.0027 ppm) was obtained in Rampura lake (S_{38}) and lowest (0.0004 ppm) from three location Dhanmondi (S_{20}) Samshad lake ($S_{30\text{-}31}$). Out of 22 samples, 1 samples (about 5%) were higher than the mean value and the remaining 21 samples (95%) were less than of mean (0.002ppm) (table 2).The Cd concentration in lake water samples were from 0.001 to 0.221 ppm, with the average value, standard deviation (SD) and co-efficient variance (CV) were 0.044 ppm, 0.079 and 181.568%, respectively. The highest amounts of Cd were detected in sutrapur lake (S_{39}) and Lower amount of Cd were detected in Samshad ($S_{29\&31}$), Bonani, (S_{34}), Rampura (S_{36}) respectively (Table 1).

The Average concentration of Cd in Dhanmondi, Ramna, Crescent, Samsad, Gulshan, Bonani, Rampura, Sutrapur, Airport and Tongi lakes varied from 0.0097 ppm, 0.0090 ppm, 0.072 ppm, 0.0660 ppm, 0.0277 ppm, 0.0102 ppm,0.0044 ppm, 0.0834 ppm, 0.2210 ppm and 0.0030 ppm respectively (Table 2).

Table 2. Average heavy metal concentrations of different lakes in Dhaka metropolitan city

Name of lake	Cu (ppm)	Zn (ppm)	Mn (ppm)	As (ppb)	Pd (ppm)	Cd (ppm)
Dhanmondi lake	0.0110	0.0404	0.0528	0.0023	0.0009	0.0097
Romna lake	0.0110	0.0379	0.0700	0.0010	0.0013	0.0090
Crescent lake	0.0110	0.0189	0.0798	0.0020	0.0009	0.0720
Samshad lake	0.0168	0.0238	0.0893	0.0017	0.0007	0.0660
Gulshan lake	0.0133	0.0163	0.0904	0.0019	0.0009	0.0277
Bonani lake	0.0164	0.0178	0.0896	0.0020	0.0010	0.0102
Rampura lake	0.0162	0.6250	0.0916	0.0020	0.0052	0.0044
Sutrapur lake	0.0143	0.6983	0.1020	0.0017	0.0031	0.0834
Air port lake	0.0129	1.2801	0.1085	0.0020	0.0007	0.2210
Tongi lake	0.1150	0.9980	0.0987	0.0020	0.0014	0.0030

Discussion

Surface water samples collected from the Dhaka metropolitan city area were categorized by analyzing chemical constituents. Several components like pH, ECAs, Cu, Mn, Zn, Pb and Cd etc. where considered for the classification of different usage. The pH value of lakes water range from 5.34 to 7.68 indication slightly acidic to alkaline. The average EC value for lakes water ranged from 17.61 to 34.61 µscm ^{1} where EC value varied from 14.24 to 33.48 p.scm"^{1} in the lakes water. Again the EC of surface water also excellent for irrigation in acid loving crops and unsuitable for drinking purpose and home use.

From the experiment, the As concentration of lakes water were same and ranged from 0.001 to 0.002 ppm, which is under the recommended limit of drinking, irrigation and livestock consumption. Arsenic concentration in all surface water samples both rivers and lakes were tested qualitatively but not a single was detected to be polluted with arsenic. The results indicated that all the collected surface water samples contained trace amount so As (<0.05 ppm/mgL^{-1}).

The average value of Cu was 0.018 ppm, where lakes water Cu concentration were 0.0006 to 0.0147 and 0.0255 to 0.0115 ppm, respectively. According to WHO (1972) and U.S. Environmental Protection Agency (1975) the water of study areas were harmful for drinking.

The concentration of Manganese (Mn), lakes water ranged from 0.0144 to 0.6141 and 0.0469 to 0.1085 ppm. The average concentration of Mn in lakes were 0.075 and 4.084 ppm and both of the value were suitable for human and livestock drinking but unsuitable for irrigation. For lakes water average Mn concentration in the study areas was 0.49 ppm which was unsuitable for drinking and irrigation.

Recommendation concentration of Mn for drinking is 0.05 mgL^{-1} (U.S Environmental Protection Agency, 1975) as shown Appendix III. According to the recommendation to the above mentioned agency all the tested water samples were unsuitable for drinking. Lead (Pb) status varied from 0.03 to 1.14 ppm for lakes water, respectively and the average concentration of Pb 0.40 ppm, which exceeded the permissible limit.

The concentration of Zinc (Zn) varied from 0.08 to 3.065 ppm. In case of Zn concentration the samples of surface water was unsuitable for drinking and irrigation water all the samples were lower than the maximum permissible limit. All the components were higher in lake water except pH.

Conclusion

It may be concluded from the study that the lakes of Dhaka metropolitan city contained acceptable amount of As, Zn, Pb, Cd where Mn exceeded the recommended limit for drinking water, public water irrigation water and for aquaculture. In that sense it is hazardous for health, crops and aquaculture. All the water of lakes of Dhaka city can safely be used for specific purpose after proper treatment. Routine research work with wide public awareness, government participation and government regulations can save the water of Dhaka metropolitan city and thus a safe and sound water environment can be made for future generations**.**

References

Abadeen, M. J. 2002. Industrial waster. Give earth a chance. World Environment Day, 5 June 2002. Report Dept. Env., The Government of Bangladesh.

Ali, A. M. 2002a. Public Private Partnership for Controlling Air Pollution: The case of Dhaka Urban Transport Project, Bangladesh.

Ali, M. A. 2002b. Public private priority for water resource management in Bangladesh water. Two billion people are dying for it! World Environment Days 5 June 2003. Dept. Env. The Government of Bangladesh.

Azad, A.K. 2003. Impacts of Farakka barrage on surface water resources in Bangladesh. World Environment Day 5 June 2003. *Report, Dept. Env*., The Government of Bangladesh. Pp. 40-43.

BBS. 2005. Statistical year book of Bangladesh published by Bangladesh Bureau of Statistics.

Clesceri, L.S.; Greenberg, A.E. and Trussel, R.R. 1989. Standard Method for the Examination of Water and Waste Water. 17th edn., American Public Health Asso., Washington D. C. 20005. pp. 1-30, 40-175.

Gomez, K.A. and Gomez, A.A. 1984. Statistical Proceedure for Agricultural Research. 2nd edn. Rice Res. Inst., Book. A Wiley Inter Science Publication, New York. P. 28.

World Bank. 2000. Urban Development Strategy and City Assistance Programme in South Asia, Dhaka, Bangladesh