*Original Article*

# DETERMINATION OF WATER QUALITY PARAMETERS AND IDENTIFY POLLUTION SOURCES OF UTTARA LAKE AND GULSHAN LAKE IN DHAKA CITY OF BANGLADESH

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## ABSTRACT

Lakes are traditionally under-valued resources to human society but good water qualities in lakes are essential for maintaining recreation and fisheries and for the provision of municipal drinking water. This study was conducted to investigate the present water conditions and pollution sources of two selected lakes in Dhaka city, which are Uttara Lake and Gulshan Lake. For exploring the problems and the reason of pollution of these lakes, the surrounding environment of the lakes had been thoroughly surveyed where physical and chemical water quality parameters at some selected points had been tested. A questionnaire survey of a total of 200 people was made to find out the major reasons for lake water pollution from $2^{nd}$ January 2022 to $15^{th}$ January 2022. Physical and Chemical Parameters of water such as pH, Conductivity, DO, Iron, Temperature, Color, Alkalinity, $CO_2$, Salinity, Turbidity, $BOD_5$ were analyzed at different three locations of each lake. Finally, the mean value of such respective parameters was compared with the water quality standards as set by the Bangladesh Standards for Drinking Water (ECR 97), WHO Guideline Values (1993), and Bangladesh Standards for Fisheries (EQS, 1997) to find out the present water quality of these selected two lakes.

**KEYWORDS:** Uttara Lake, Gulshan Lake, Water Quality, Pollution Sources, Drinking Water.

## INTRODUCTION

"On earth, 97.2% is ocean water; 2.15% is glaciers and other ice; 0.61% is groundwater; 0.009% is freshwater lakes; 0.008% is inland seas; 0.005% is soil moisture; 0.001% water is in the atmosphere and 0.0001% is in rivers. Surface water is far easier to reach, so this becomes the most common source of potable water. About 321 billion gallons per day of surface water are used by humans. About 77 billion gallons of groundwater are used each day. Problems also exist in the contamination of the water supplies. This further limits the amount of water available for human consumption. Water is found in many different forms and many different places. While the amounts of water that exist seem to be plentiful, the availability of the water for human consumption is limited."[5] Water is vital for all known forms of life in our earth. "It is the lifeline that bathes us, feeds us, and also covers 71% of the Earth's surface. On Earth, only 1% of the Earth's water is freshwater."[6]

Dhaka is located in the geographic center of Bangladesh and it is the capital of this country. In this city, the lake is thought to be the storehouse of drain water, though some lakes may be kept free from the connection with drains. Lake water plays an important role to serve many purposes like irrigation, aquaculture, and livestock usage.

Water is considered polluted when chemicals, pathogens, or contaminants are detected and water pollution in Dhaka is mainly caused due to industrial processes that produce toxic waste, growth of algae, and littering on the land. Surface water pollution is very common in Dhaka due to human activities. The water quality of the lake in this city is deteriorating day by day due to numerous biological, physical, and chemical variables which are causing water toxicity. When the concentration of any element or compound exceeds the tolerance limit for organisms that element is treated as pollutants. Lakes provide a multitude of uses and are rime regions for human settlement and uses include drinking and municipal water supply; industrial water supply; commercial and recreational fisheries; body contact recreation, boating, and other aesthetic recreational uses. In addition, the lake is used for agricultural irrigation, canalization, and waste disposal.

Fish is an inexpensive source of protein in many regions of our planet and the water is the physical support in which they carry out their various life functions. Water quality is determined by carious physic-chemical and biological factors and all living organisms have tolerable limits of water quality parameters. So, good water quality is very essential for the survival and growth of fish. As we know fish is an important protein-rich food resource and

there has been a sharp increase in demand for fish products due to increasing population pressure in this century. For meeting the demand of the food supply, water quality management in lakes to cultivate fish; is an important step that is required to be taken up.

In this study, the assessment on the recent water quality of Uttara Lake and Gulshan Lake had been done to identify its vulnerable condition and the physio-chemical condition of these lake waters. To characterize the degree of pollution water quality assessment had been done. A strong survey had been done to identify the major reasons behind water pollution. An environmental impact study had also been done to identify and assess the environmental impacts.

## OBJECTIVE OF THE RESEARCH

The specific objectives of this study are

- To observe the water quality parameters of these selected lakes by laboratory test.
- To identify the major sources of pollution of lake water.
- To compare the laboratory test results of water quality parameters with "Bangladesh Standards for Drinking Water (ECR 97)" [3] and "WHO Guideline Values, 1993" [7] for finding out the quality of drinking water of these two lakes.
- To compare the laboratory test results of water quality parameters with "Bangladesh Standards for Fisheries (EQS, 1997)" [4] for finding out the water condition for fish farming in these two lakes.

## MATERIALS AND METHODS

This experiment was conducted to observe different physiochemical properties of water of Uttara Lake and Gulshan Lake and to compare the values with the standard level of water quality parameters to know the suitability for fisheries and other aquatic flora and fauna.

## Sampling Sites

The water samples were collected from different three points of Uttara Lake and Gulshan Lake. These different three sites were chosen because these sites are heavily polluted by different kinds of waste discharge from the tannery industry, commercial sectors, and households.

**Table 1: Names of Sampling Sites.**

| Lake Name | Sample Collection Zone Names |
|---|---|
| **Uttara Lake** | **Sample-01:** Road-2B, Sector-05, Uttara Model Town, Dhaka. |
| | **Sample-02:** Uttara Sector 07 Bridge, Sector-07, Uttara Model Town, Dhaka. |
| | **Sample-03:** Road-10B, Sector-11, Uttara Model Town, Dhaka. |
| **Gulshan Lake:** | **Sample-01:** Road-128, Gulshan-01, Dhaka. |
| | **Sample-02:** Road-93, Madani Avenue, Gulshan, Dhaka. |
| | **Sample-03:** Road-84, Gulshan-02, Dhaka. |

**Sample Analysis**

Different methods and/or instruments were used for the determination of different physiochemical properties of water samples. The methods and/or instruments are given in the table below.

**Table 2: Methods and/or Instruments Used for the Analysis of Different Parameters.**

| No. | Parameters | Methods/Instruments (APHA)[2] |
|---|---|---|
| 01. | pH | pH meter |
| 02. | Conductivity | Conductivity meter |
| 03 | Turbidity | Titrimetric method |
| 04. | Dissolve Oxygen (DO) | Titrimetric method |
| 05. | Iron (Fe) | Titrimetric method |
| 06. | Temperature | Thermometer |
| 07. | Alkalinity | Titrimetric method |
| 08. | Color | Spectrophotometer |
| 09. | Biochemical Oxygen Demand (BOD) | Titrimetric method |
| 10. | Salinity | Salinity meter |
| 11. | $CO_2$ | Titrimetric method |

*N.B. American Public Health Association (APHA).*

**Questionnaire Survey**

A questionnaire survey is a very common and popular method to collect data in a research project and it is a systematic method of gathering information from a targeted population [1]. In this research, a questionnaire survey was conducted amongst 100 people per Lake of Uttara Lake and Gulshan Lake to find out a possible source of pollution. Every people faced total 09 (nine) questions which are shows in the table 3 and table 4.

**Questionnaire Survey report of Uttara Lake**

**Table 3: Questionnaires Survey Report of General People on Uttara Lake.**

| UTTARA LAKE | | | |
|---|---|---|---|
| **Questions** | **Total survey on 100 no's of people** | | |
| 1) Are you satisfied with the present situation of the water of this Lake? | Yes | No | |
| | 75% | 25% | |
| 2) Do you find any smell or taste problems in the water of this Lake? | Yes | No | |
| | 40% | 60% | |
| 3) In the summer season do you notice any problem in the water of this Lake? | Yes | No | Sometimes |
| | 10% | 60% | 30% |
| 4) In the rainy season do you notice any problem in the water of this Lake? | Yes | No | Sometimes |
| | 0% | 90% | 10% |
| 5) What are the sources of water of this lake? | Mainly rainwater and sewage water. | | |
| 6) Are you using Lake Water for any purpose? If yes, which purpose? | No | | |
| 7) Have you faced any health-related problems? | No | | |
| 8) Have any suggestions for improving the Water condition of this Lake? | i. Government should aware of improving the water condition of this lake. <br> ii. Moreover, NGOs should come forward with active participation and $CaCO_3$ could be used. | | |
| 9) What do you think about the major sources of Pollution in this Lake? | i. Human unawareness <br> ii. Falling of Tree leaves <br> iii. Connected Sewage lines | | |

**Report Discussion of Uttara Lake**

The majority of people (about 75 percent) are satisfied with the present situation of water of Uttara Lake. 40 percent of people find smell or taste problems in the water of this lake. Almost 30 percent of people sometimes notice the problem in the summer season of this lake and almost 10 percent of people sometimes notice the problem in the rainy season of this lake. Mainly rainwater and sewage water are the sources of water of this lake. No one uses lake water for any purpose.

**Questionnaire survey report of gulshan lake**

**Table 4: Questionnaires Survey Report of General People on Gulshan Lake.**

| GULSHAN LAKE | | | |
|---|---|---|---|
| **Questions** | **Total survey on 100 no's of people** | | |
| 1) Are you satisfied with the present situation of the water of this Lake? | Yes | No | |
| | 0% | 100% | |
| 2) Do you find any smell or taste problems in the water of this Lake? | Yes | No | |
| | 100% | 0% | |
| 3) In the summer season do you notice any problem in the water of this Lake? | Yes | No | Sometimes |
| | 90% | 0% | 10% |
| 4) In the rainy season do you notice any problem in the water of this Lake? | Yes | No | Sometimes |
| | 70% | 0% | 30% |
| 5) What are the sources of water of this lake? | i. Rain Water<br>ii. DOHS sewage water<br>iii. Sewage water<br>iv. Used water of Korail Slum | | |
| 6) Are you using Lake Water for any purpose? If yes, which purpose? | No | | |
| 7) Have you faced any health-related problems? | No | | |
| 8) Have any suggestions for improving the Water condition of this Lake? | i. Removing Korail Slum<br>ii. Government should come forward<br>iii. Awareness of local people especially the people of Korail Slum<br>iv. Developing a proper management system<br>v. Removing Korail slum situated nearby Gulshan lake | | |
| 9) What do you think about the major sources of Pollution in this Lake? | i. Human sanitation of Korail slum<br>ii. Solid and liquid waste of Korail slum<br>iii. Connected sewage lines<br>iv. Nearby Korail slum<br>v. This lake is developed in a block water system | | |

**Report Discussion of Gulshan Lake**

From our survey, it is found that almost 100 people are not satisfied with the present condition of water of Gulshan Lake. Even 100 people find smell or taste problems in the water of Gulshan Lake. In the summer season, almost 90 percent of people notice the problem in the water of this lake. Almost 70 percent of people notice the problem in the water of this lake in the rainy season.

**Water Test Result of Uttara Lake**

**Table 5: Laboratory Test Result of Uttara Lake's Water.**

| UTTARA LAKE | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No. | Water Quality Parameters | Unit | Sample-01 | Sample-02 | Sample-03 | Average (Mean) Value |
| 1. | pH | - | 8.50 | 8.50 | 8.50 | **8.50** |
| 2. | Conductivity | *mS* | 409 | 409 | 442 | **420** |
| 3. | DO | *mg/l* | 5.5 | 5.56 | 5.56 | **5.54** |
| 4. | Iron | *mg/l* | 0.3 | 0.3 | 0.3 | **0.3** |
| 5. | Temperature | *∘C* | 21 | 21 | 21 | **21** |
| 6. | Color | *(Pt-Co)* | 32 | 29 | 32 | **31** |
| 7. | Alkalinity | *mg/l* | 155 | 155 | 167 | **159** |
| 8. | $CO_2$ | *mg/l* | 15 | 15 | 15 | **15** |
| 9. | Salinity | *ppt* | 0.2 | 0.2 | 0.1 | **0.17** |
| 10. | Turbidity | *JTU* | 18 | 18 | 15 | **17** |
| 11. | $BOD_5$ | *mg/l* | 20 | 20 | 26 | **22** |

**Water Test Result of Gulshan Lake**

**Table 5: Laboratory Test Result of Gulshan Lake's Water.**

| GULSHAN LAKE | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No. | Water Quality Parameters | Unit | Sample-01 | Sample-02 | Sample-03 | Average (Mean) Value |
| 1. | pH | - | 8.0 | 8.0 | 8.0 | **8.0** |
| 2. | Conductivity | *mS* | 768 | 801 | 801 | **790** |
| 3. | DO | *mg/l* | 3.50 | 3.50 | 3.50 | **3.50** |
| 4. | Iron | *mg/l* | 0.5 | 0.5 | 0.5 | **0.5** |
| 5. | Temperature | *∘C* | 21 | 21 | 21 | **21** |
| 6. | Color | *(Pt-Co)* | 35 | 35 | 35 | **35** |
| 7. | Alkalinity | *mg/l* | 251 | 257 | 251 | **253** |
| 8. | $CO_2$ | *mg/l* | 24 | 26 | 25 | **25** |
| 9. | Salinity | *ppt* | 0.3 | 0.3 | 0.3 | **0.3** |
| 10. | Turbidity | *JTU* | 20 | 20 | 20 | **20** |
| 11. | $BOD_5$ | *mg/l* | 26 | 28 | 24 | **26** |

**Comparison of Laboratory Test Result of Water with Standard Values**

**Table 6: Comparison of Laboratory Test Results with Standard Values.**

| Sl. No. | Water Quality Parameters | Unit | Bangladesh Standards for Drinking Water (ECR 97) | WHO Guideline Values, 1993 | Water Condition of Selected Lakes | |
|---|---|---|---|---|---|---|
| | | | | | Uttara Lake | Gulshan Lake |
| 1. | pH | - | 6.5-8.5 | 6.5-8.5 | **8.50** | **8.0** |
| 2. | Conductivity | *mS* | - | - | **420** | **790** |
| 3. | DO | *mg/l* | 6.0 | 5.0 | **5.54** | **3.50** |
| 4. | Iron | *mg/l* | 0.3-1.0 | 0.3 | **0.3** | **0.5** |
| 5. | Temperature | *∘C* | 20-30 | - | **21** | **21** |
| 6. | Color | *(Pt-Co)* | 15 | 15 | **31** | **35** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7. | **Alkalinity** | *mg/l* | 200 | 200 | **159** | **253** |
| 8. | **CO$_2$** | *mg/l* | 15 | 15 | **15** | **25** |
| 9. | **Salinity** | *ppt* | 0 | 0 | **0.17** | **0.3** |
| 10. | **Turbidity** | *JTU* | 10 | 5 | **17** | **20** |
| 11. | **BOD$_5$** | *mg/l* | 0.2 | - | **22** | **26** |

*N.B. Bangladesh Standards for Drinking Water (ECR 97). [3]; WHO Guideline Values, 1993[7]*

**Discussion of Laboratory Test Results Of Water With Standard Values Of Drinking Water**

**Discussion for Uttara Lake**

The pH condition of Uttara Lake is 8.50 whereas Bangladesh Standards for Drinking Water (ECR 97) is 6.5-8.5 and WHO Guideline Values, 1993 is 6.5-8.5, so the pH condition of Uttara Lake is in the acceptance range. The amount of Conductivity of Uttara Lake's water is 420 mS. DO of Uttara Lake is 5.54 mg/l whereas Bangladesh Standards for Drinking Water (ECR 97) is 6.0 mg/l and WHO Guideline Values, 1993 is 5.0mg/l, so DO of Uttara Lake is not in acceptance range according to the Bangladesh Standards for Drinking Water (ECR 97). The amount of Iron in Uttara Lake's water is 0.3 mg/l whereas Bangladesh Standards for Drinking Water (ECR 97) is 0.3-1.0 mg/l and WHO Guideline Values, 1993 is 0.3 mg/l, so the Iron condition of Uttara Lake is in an acceptable range. The temperature of water of Uttara Lake is 21◦C whereas Bangladesh Standards for Drinking Water (ECR 97) is 20-30◦C, so the temperature of water of Uttara Lake is in the acceptance range. The color of water of Uttara Lake is 31 (Pt-Co) whereas WHO Guideline Values, 1993 and Bangladesh Standards for Drinking Water (ECR 97) are 15 (Pt-Co), so the color of the water of Uttara Lake is not in the acceptance range. The Amount of Alkalinity of the water of Uttara Lake is 159 whereas WHO Guideline Values, 1993 and Bangladesh Standards for Drinking Water (ECR 97) is 200 mg/l. The amount of CO$_2$ in the water of Uttara Lake is 15 mg/l whereas WHO Guideline Values, 1993 and Bangladesh Standards for Drinking Water (ECR 97) is 15 mg/l. The Amount of Salinity of the water of Uttara Lake is 0.17 ppt (*ppt= parts per thousand*). The Turbidity of water of Uttara Lake is 17 JTU (*JTU= Jackson Turbidity Units*) whereas Bangladesh Standards for Drinking Water (ECR 97) is 10 JTU and WHO Guideline Values, 1993 is 5 JTU, so Turbidity of water of Uttara Lake is not in the acceptance range. The Amount of BOD$_5$ of the water of Uttara Lake is 22 mg/l whereas Bangladesh Standards for Drinking Water (ECR 97) is 0.2 mg/l, so the amount of BOD$_5$ of the water of Uttara Lake is not in the acceptance range.

**Discussion for Gulshan Lake**

The pH condition of Gulshan Lake is 8.0 whereas Bangladesh Standards for Drinking Water (ECR 97) is 6.5-8.5 and WHO Guideline Values, 1993 is 6.5-8.5, so the pH condition of Gulshan Lake is in an acceptable range. The amount of Conductivity of Gulshan Lake's water is 790 mS. DO of Gulshan Lake is 3.50 mg/l whereas Bangladesh Standards for Drinking Water (ECR 97) is 6.0 mg/l and WHO Guideline Values, 1993 is 5.0mg/l, so DO of Gulshan Lake is not in the acceptance range. The amount of Iron in Gulshan Lake's water is 0.5 mg/l whereas Bangladesh Standards for Drinking Water (ECR 97) is 0.3-1.0 mg/l and WHO Guideline Values, 1993 is 0.3 mg/l, so the Iron condition of Gulshan Lake is not in the acceptance range. The temperature of the water of Gulshan Lake is 21∘C whereas Bangladesh Standards for Drinking Water (ECR 97) is 20-30∘C, so the temperature of water of Gulshan Lake is in the acceptance range. The color of the water of Gulshan Lake is 35 (Pt-Co) whereas WHO Guideline Values, 1993 and Bangladesh Standards for Drinking Water (ECR 97) is 15 (Pt-Co), so the color of the water of Gulshan Lake is not in the acceptance range. The Amount of Alkalinity of the water of Gulshan Lake is 253 whereas WHO Guideline Values, 1993 and Bangladesh Standards for Drinking Water (ECR 97) is 200 mg/l. The amount of $CO_2$ in the water of Gulshan Lake is 25 mg/l whereas WHO Guideline Values, 1993 and Bangladesh Standards for Drinking Water (ECR 97) is 15 mg/l. The Amount of Salinity of the water of Gulshan Lake is 0.3 ppt. Turbidity of water of Gulshan Lake is 20 JTU whereas Bangladesh Standards for Drinking Water (ECR 97) is 10 JTU and WHO Guideline Values, 1993 is 5 JTU, so Turbidity of water of Gulshan Lake is not in the acceptance range. The Amount of $BOD_5$ of the water of Gulshan Lake is 26 mg/l whereas Bangladesh Standards for Drinking Water (ECR 97) is 0.2 mg/l, so the amount of the $BOD_5$ of the water of Gulshan Lake is not in the acceptance range.

**Comparison Between Laboratory Test Report And Standard Values For Fisheries Of Selected Lakes**

**Table 7: Comparison between Laboratory Test Report and Standard Values for Fisheries of Selected Lakes.**

| Sl. No. | Water Quality Parameters | Unit | Bangladesh Standard for Fisheries (EQS,1997)[4] | Laboratory Test Report of Selected Lakes | |
|---------|--------------------------|------|------------------------------------------------|------------------|------------------|
| | | | | Uttara Lake | Gulshan Lake |
| 1. | pH | - | 6.5-8.5 | 8.50 | 8.0 |
| 2. | DO (mg/l) | mg/l | 4.0-6.0 | 5.54 | 3.50 |
| 3. | Temperature(°C) | ∘C | 25 | 21 | 21 |
| 4. | BOD₅ | mg/l | (-) or below 2 | 22 | 26 |

**Discussion of Laboratory Test Results Of Water With Standard Values Of Fisheries**

**Discussion for Uttara Lake**

From this study, it is seen that all the values without $BOD_5$, are in favorable condition for fisheries in Uttara Lake.

**Discussion for Gulshan Lake**

From this study, it is seen that all the values without DO and $BOD_5$, are in favorable condition for fisheries in Gulshan Lake.

**Recommendations**

More intensive sample and analysis, including the sampling of water and more spatial locations, would better describe the Lake water quality. The floral and faunal population (including fish) of these Lakes should be carefully monitored to assess the effect of water quality on the local ecology.

There are many ways to prevent the pollution of Uttara Lake and Gulshan Lake. To prevent the pollution of the Lake various attempts should be taken which are as follows:

- Household effluents should not be connected with the lake.
- RAJUK (Rajdhani Unnayan Kartripakkha– literally the Capital Development Authority of the Government of Bangladesh.) authority can play a vital role in freeing up the lake from the encroachers.
- A public awareness program can be initiated to save the lakes from pollution.
- Should be developed water quality of selected lakes and ecosystems by proper monitoring.
- Should be required to implement original Master Plan of Dhaka city by authority.
- Money can be invested by Government for improving the present water condition of Dhaka City lakes. For doing these, they can take help from different NGOs.

**CONCLUSION**

From the survey throughout the Uttara Lake and Gulshan Lake, it has been found, the present condition of these lakes deteriorating day by day. Unabated discharge of domestic and industrial effluents, sediments from under-construction buildings and liquid sewage through WASA drains have made the lake a dumping ground. Some of the residents blamed the absence of improved sewerage and waste treatment facilities in the Rajuk Plan for this condition.

From the laboratory test results of water, it is seen that the quality of physiochemical parameters of selected lake water is not in a suitable condition. Especially Turbidity and $BOD_5$ are in the worst condition of all the two selected lakes. For identifying the major sources of pollution of lake water, the questionnaire survey result shows that the connected sewage lines and human unawareness are mainly responsible for lake water pollution. For finding out the possible solution for improving the water quality of these two selected lakes, the questionnaire survey result shows that increasing public and government awareness, disconnecting sewage line connections, removing industries situated beside lakes are the possible solutions for improving the water quality of these lakes. Although the water condition of these selected lakes are not in a suitable place for having higher $BOD_5$ and other physiochemical parameters of water, Uttara Lake's water is in the best situation and Gulshan Lake's water is in the worst position for fisheries which has been found from laboratory water test results.

## ACKNOWLEDGEMENT

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