Assessment of Water Quality from Taungthaman Lake in Amarapura Township

Soe Win[1]

Abstract

This study was conducted to evaluate factors regulating surface water quality in an area with agriculture as main use. In this research, the water samples to be analyzed were collected from Taungthaman Lake, Amarapura Township, near Yadanabon University from November, 2020 to October 2021. To evaluate the water quality, its physico-chemical characteristics such as pH, color, electrical conductivity, turbidity, total dissolved solids, total alkalinity, total hardness, sulphate, dissolved oxygen (DO) and biological oxygen demand (BOD) were determined monthly. In addition, its biological characteristics in terms of *Escherichia coli count* (*E.coli*), standard plate count and probable coliform count were also examined throughout the year. The collected water samples of pH, turbidity, electrical conductivity, total dissolved solids, total alkalinity, total hardness and biological oxygen demand (BOD) were gradually increased depending upon the rainfall ranges. The sulphate and dissolved oxygen (DO) were also gradually decreased. It was found that, the water sample was not suitable for drinking purposes or local uses or potable without appropriate treatment and it was found to be suitable for agricultural uses.

Key words: Surface Water, Water Quality, Physico-chemical Characteristics, Biological Characteristics, Agricultural Uses

Introduction

Water covers over more than 71% of the earth's surface. Among these 90% is in the salt ocean, 2% is in the polar ice caps and most of the remainders are beneath of the earth's surface. Water is a finite resource and its availability can be the determining factor as well as reflecting the natural beauty of the environment. Although all water bodies are the most important natural resources, the actual resources for potable water are very limited. The chief resources of fresh water body in the world are rivers, lakes, streams and groundwater (Mather, 1984).

Rain and glacier are the main sources of water. The water gets absorbed into the ground to be tapped as springs or wells, shafts or infiltration galleries are termed as ground water. As water slowly percolates through the ground, the layers, through which it passes, act as a filtering material and have purifying effect on it. Therefore, deep well water is usually clear, colorless and low in bacterial content, although mineral content is generally higher.

Water from rain and glacier flows over the surface to form lakes, ponds, reservoirs, rivers, canals, creeks are termed as surface water. In lake and reservoirs, impurities settle down due to less flow and absence of turbulent conditions. Re-oxygenation from the atmosphere also occurs slowly. Through contamination, nutrients (N, P) enter into lakes causing more algal growth and more microbes' aquatic life. Eutrophication adds to turbidity, organic load and stratification of layers from top to bottom, which cannot be easily reverted within a reasonable time. Hence, care must be taken to limit plant nutrients entering into lakes and to remove weeds and algal growth periodically. Water from lakes will be acceptable for drinking purposes, only if contamination is brought down to the permissible level (Rao, 2003).

In this research, the water sample was collected from three different points of Taungthaman Lake, to analyze the quality of water. Then, the determination of pH,

[1] Professor and Head, Dr., Department of Industrial Chemistry, University of Mandalay

turbidity, electrical conductivity, color, total dissolved solids, total alkalinity, total hardness, sulphate, dissolved oxygen, biological oxygen demand and bacterial count were conducted.

The aim of this research is to study the degree of pollution from various sources in Taungthaman Lake and to determine the water quality of the lake for potable use.

Methodology

Sample Collection

Water samples to be analyzed were collected from November 2020 to October 2021 by using clear, transparent plastic containers each with screwed caps from Taungthaman Lake, Amarapura Township, Mandalay Region. Water samples collection points were marked with Points (A), (B) and (C) as shown in Figure 1.

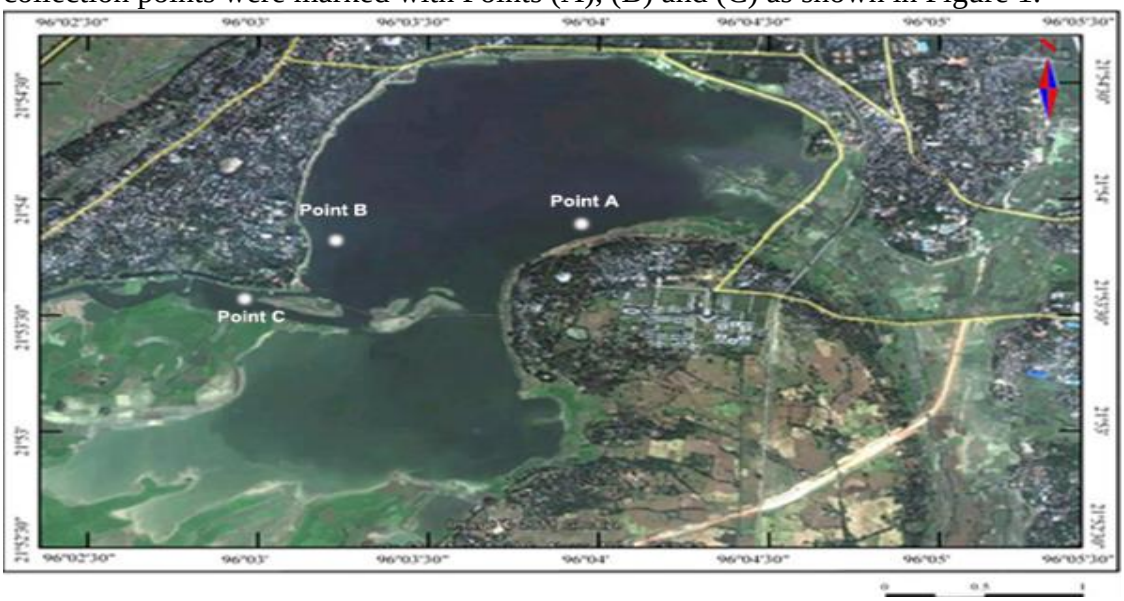

Figure 1. Water samples taken points from Taungthaman Lake

Point (A) - from Longitude 96° 04' 07", Latitude 21° 53' 25"
Point (B) - from Longitude 96° 03' 29", Latitude 21° 53' 48"
Point (C) - from Longitude 96° 02' 56", Latitude 21° 53' 40"

Analysis of Collected Water Samples

The properties such as pH, color, turbidity, electrical conductivity, total dissolved solids, total alkalinity, total hardness, sulphate, dissolved oxygen, biological oxygen demand and bacteria count were determined.

Results and Discussion

The water samples collected for November 2020 to October 2021 from Taungthaman Lake, Amarapura Township, Mandalay Region, marked with Point (A), (B) and (C) as shown in Figure 1.was normally contaminated due to the presence of clay particles, suspended particles, microscopic organisms, decaying vegetation and wastewater flowing from Industrial Zone (1). Preliminary measurements such as pH, color, turbidity, electrical conductivity, total dissolved solids, total alkalinity, total hardness, sulphate, dissolved oxygen, biological oxygen demand and bacteria count were carried out. These results were compared with a relevant standard values.

pH is the measure of hydrogen ion activity in water, which is measured on a log scale. Most biological life in water is restricted to a narrow pH range. pH does not

lead to any severe health effect but beyond the limit of 6.5 to 8.5 can damage the mucous lining of tissues. pH is important in the treatment units like coagulation and chlorination. It was found that the pH values of collected water samples were within the acceptable range of standard value and also gradually increased from July to October 2021 depending upon the falling in rainfall ranges as shown in Tables 1, 2 and 3.

Color is caused by the presence of colloidal substances and aquatic growth in water. It is also caused by substances in solution and the dyes derived from the decomposition of vegetation. The measured color of the collected water samples were greater than the standard value, as shown in Tables 1, 2 and 3.

Turbidity is a particularly important parameter of drinking water quality. Clay, silt, tiny fragments of organic matter and microscopic organisms are some of the substances that cause turbidity. They occur in water naturally or because of human activities and pollution. The measured turbidity values of the water samples collected from November 2020 to October 2021 for Point (A), (B) and (C) were higher than the literature value as shown in Tables 1, 2 and 3.

The electrical conductivity (EC) is the capacity of water to conduct current and is caused by the presence salts, acids and bases, called electrolytes, capable of producing cations and anions. The major ions present in water causing EC are chlorides, sulphates, carbonates, bicarbonates, nitrates, calcium, magnesium, sodium and potassium. The measured value of electrical conductivity from November 2020 to January 2021 for Point (A), (B) and (C) were within the acceptable limit as shown in Tables 1, 2 and 3.

Table 1. The Physical Characteristics of Water Sample for Point (A) from Taungthaman Lake

Characteristics	Months (2020-2021)							*Literature value
	Nov:	Jan:	Mar:	May	July	Sept:	Oct:	
pH	7.5	7.4	7.6	7.5	7.4	7.7	8.1	6.5-8.5
Color	>50	>50	>50	>50	>50	>50	>50	5
Turbidity, NTU	43.2	46.7	48.5	49,7	50.2	73.4	198.1	5
Conductivity, µS/cm	432	447	396	342	280	340	510	800

*WHO (1960)

Table 2. The Physical Characteristics of Water Sample for Point (B) from Taungthaman Lake

Characteristics	Months (2020-2021)							*Literature value
	Nov:	Jan:	Mar:	May	July	Sept:	Oct:	
pH	7.4	7.3	7.5	7.5	7.5	7.7	7.9	6.5-8.5
Color	>50	>50	>50	>50	>50	>50	>50	5
Turbidity, NTU	40.4	42.3	44.7	46.5	48.4	90.5	169.3	5
Conductivity, µS/cm	430	442	381	339	300	340	460	800

*WHO (1960)

Table 3. The Physical Characteristics of Water Sample for Point (C) from Taungthaman Lake

Characteristics	Months (2020-2021)							*Literature value
	Nov:	Jan:	Mar:	May	July	Sept:	Oct:	
pH	7.4	7.3	7.5	7.5	7.5	7.7	7.9	6.5-8.5
Color	>50	>50	>50	>50	>50	>50	>50	5
Turbidity, NTU	40.1	40.2	40.3	40.3	40.4	102	184	5
Conductivity, µS/cm	423	434	378	321	290	330	460	800

*****WHO (1960)

Water being a good solvent, dissolves a number of salts, chlorides, sulphates, bicarbonates of sodium, magnesium, calcium and potassium, etc. But all dissolved substances are not undesirable. About 500 mg/l is good for domestic uses, but excess concentration are harmful in many ways. Total dissolved solids affect the electrical conductivity of water. Tables 4, 5 and 6 were pointed out that the value of total dissolved solids of the collected water samples were lower than the standard values.

The alkalinity of water is usually caused by the presence of carbonates, bicarbonates, sulphate and chloride of calcium and magnesium. Alkalinity is important determination to the water treatment because the action of coagulants used to clarify water and require sufficient alkalinity to ensure a proper reaction for filtration. The measured value of collected water samples from July to October 2021 were within the standard literature value as shown in Tables 4, 5 and 6. But the value of collected water sample from November 2020 to May 2021 were higher than the literature value as shown in Tables 4, 5 and 6.

The total hardness is the main characteristic of the water quality. The ions, especially Ca^{2+} and Mg^{2+} impart hardness to water. Hardness is the property of water which hampers the lather formation with soap. The salts of bicarbonate and carbonate produce temporary hardness, since they can be precipitated simply boiling, in contrast to the salts with chloride and sulphate produce permanent hardness. Hence from the correlation analysis it signifies that the studied water samples are hardwater of both types temporary and permanent. From Table 4, 5 and 6, it was obvious that the measured total hardness values of the collected water samples were indicated relatively higher values than reference standard. But the value of the collected water samples on July and September 2021 for Point (A), (B) and (C) were within the standard value.

Sulphate is one of the main indicators of water quality. Sulphate is occurred due to aerobic oxidation of organic matter in the sulphur cycle. Sulphate forms salts with a variety of elements including barium, calcium, magnesium, potassium and sodium. Magnesium, potassium and sodium sulphate salts are all soluble in water. Sulphate in potable water causes a laxative effect and leads to scale formation in boiler. It was rather obvious from Tables 4, 5 and 6 showed that the measured value of water samples were within the acceptable limit of literature standard.

Dissolved oxygen is generally considered to be one of the most important parameters of water quality in streams, rivers and lakes. A minimum of 4-5 mg/L is essential for fish and aquatic life. Surface water will have more dissolved oxygen due

to greater surface area in contact with atmosphere. The higher the concentration of dissolved oxygen, the better the water quality. It was found that the measured value of water samples from Point (A), (B) and (C) were greater than the acceptable values as shown in Tables 4, 5 and 6.

The biological oxygen demand (BOD) test provides a measure of the biodegradable organic materials in water. The more the organic materials in the water, the higher the BOD value and then the DO level will decrease as the organic matter are decomposed by the microorganisms. The biological oxygen demand of water samples (Point A, B, C) were higher than the acceptable limit as shown in Tables 4, 5 and 6.

Table 4. The Chemical Characteristics of Water Sample for Point (A) from Taungthaman Lake

Characteristics	Months (2020-2021)							*Literature value
	Nov:	Jan:	Mar:	May	July	Sept:	Oct:	
Total dissolved solid, mg/L	200	200	100	100	100	200	400	500
Total alkalinity, mg/L	280	280	290	230	200	190	180	200
Total hardness, mg/L	110	105	105	105	100	100	165	100
Sulphate, ppm	109	115	120	120	120	100	100	200
DO, mg/L	7.5	6.7	6.9	7.2	8.9	8.0	6.5	<5
BOD, mg/L	11.2	11.7	12.4	12.6	12.7	15.8	20.88	<5

*WHO (2015)

Table 5. The Chemical Characteristics of Water Sample for Point (B) from Taungthaman Lake

Characteristics	Months (2020-2021)							*Literature value
	Nov:	Jan:	Mar:	May	July	Sept:	Oct:	
Total dissolved solid, mg/L	200	100	100	100	200	300	400	500
Total alkalinity, mg/L	280	285	290	295	180	165	190	200
Total hardness, mg/L	107	107	107	105	97	89	160	100
Sulphate, ppm	115	119	106	117	109	100	90	200
DO, mg/L	9.3	8.7	8.8	9.5	9.7	8.7	6.8	<5
BOD, mg/L	10.6	10.9	11.32	11.45	11.87	16.86	20.3	<5

*WHO (2015)

Table 6. The Chemical Characteristics of Water Sample for Point (C) from Taungthaman Lake

Characteristics	Months (2020-2021)							*Literature value
	Nov:	Jan:	Mar:	May	July	Sept:	Oct:	
Total dissolved solid, mg/L	100	200	100	100	200	300	400	500
Total alkalinity, mg/L	254	269	280	287	154	169	190	200
Total hardness, mg/L	150	140	146	109	90	96	160	100
Sulphate, ppm	124	120	116	115	103	105	90	200
DO, mg/L	9.7	9.3	8.9	10.8	9.8	9.2	7.2	<5
BOD, mg/L	12.23	12.45	12.53	12.68	12.76	16.9	21.23	<5

*WHO (2015)

Tables 7, 8 and 9 showed that collected water samples from Taungthaman Lake contain high content of coliform and *E.coli* by the contamination of environment. Therefore, the water is unsuitable for potable purposes without appropriate treatment.

Table 7. The Biological Characteristics of Water Sample for Point (A) from Taungthaman Lake

Characteristics	Months (2020-2021)							*Literature value
	Nov:	Jan:	Mar:	May	July	Sept:	Oct:	
Standard plate count	>300	>300	>300	>300	>300	>300	>300	<600
Probable coliform count	5/5	5/5	5/5	5/5	5/5	5/5	5/5	50 Max.
Esherichia count	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	-

*WHO (2015)

Table 8. The Biological Characteristics of Water Sample for Point (B) from Taungthaman Lake

Characteristics	Months (2020-2021)							*Literature value
	Nov:	Jan:	Mar:	May	July	Sept:	Oct:	
Standard plate count	>300	>300	>300	>300	>300	>300	>300	<600
Probable coliform count	5/5	5/5	5/5	5/5	5/5	5/5	5/5	50 Max.
Esherichia count	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	-

*WHO (2015)

Table 9. The Biological Characteristics of Water Sample for Point (C) from Taungthaman Lake

Characteristics	Months (2020-2021)							*Literature value
	Nov:	Jan:	Mar:	May	July	Sept:	Oct:	
Standard plate count	>300	>300	>300	>300	>300	>300	>300	<600
Probable coliform count	5/5	5/5	5/5	5/5	5/5	5/5	5/5	50 Max.
Esherichia count	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	-

*WHO (2015)

According to the physical, chemical and biological analysis of collected water samples, the water quality from Taungthaman Lake was not suitable for drinking purposes or local uses or potable without appropriate treatment. The collected water sample were so found to be suitable for agricultural uses.

Conclusion

The water quality from Taungthaman Lake varies with the rainfall ranges and the tidal river. The collected water samples of pH, turbidity, electrical conductivity, total dissolved solids, total alkalinity, total hardness and biological oxygen demand were gradually increased depending upon the rainfall ranges. The sulphate and dissolved oxygen were also gradually decreased. So, the overall determination of pH, color, turbidity, electrical conductivity, total dissolved solids, total alkalinity, total hardness, sulphate, dissolved oxygen, biological oxygen demand and bacteria count indicates that the overall water quality of three different points from Taunghthaman Lake showed considerable degree of contamination.

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