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Water Quality Monitoring of Unhas Lake Water

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ABSTRACT

The Hasanuddin University has two lakes / site that form a reservoir ecosystem network of water potential as a buffer zone soil water conservation both inside the campus and the region around the Unhas campus. Therefore, Unhas Lake water resources must be protected in order to get clear and healthy water for humans and other living things and should be monitored for water quality regularly and continuously. The research method is observational method with a descriptive study design. The water samples were taken from Unhas Lake which is divided into five sampling points determined by purposive sampling method. Based on physical parameters test results of five sampling points obtained, Unhas Lake Water temperatures were quite stable, ranged between 27,2°C-28,2°C. TDS test results obtained that TDS levels of Unhas Lake Water ranged from 129 mg/l-140 mg/l and were under water quality standard for Class 1 that requires TDS level maximum 1000 mg/l. Meanwhile, TSS test results that meet class I quality standard was station 2, 3, 4, ranged between 10 mg/l-26 mg/l, while stations (points) that did not meet the quality standard for Class 1 were station 1 and 5 i. e 60 mg/l and 90 mg/l, while the maximum permissible level was 50 mg/l. Based on chemical parameters test results, quality of Unhas Lake Water did not meet the quality standard criteria for Class 1 listed in Government Regulation Number 82 Year 2001 for parameters ammonia, BOD_5, COD, DO, and nitrite. Meanwhile, the chemical parameters for class 1 quality standard that meet are iron, fluoride, nitrate, and sulfate. Based on microbiological parameters test results of five sampling points showed that *Fecal coliform* bacteria level at stations (points) 1, 2, 3, 4, and 5 were 295 MPN/100 ml, 4352 MPN/100 ml, 17329 MPN/100 ml, 142 MPN/100 ml, and 30 MPN/100 ml, *Fecal coliform* bacteria with the highest number was at station (point) 3 and the lowest was at station (point) 5. The number of total coliform bacteria at stations 1, 2, 3, 4, and 5 were 24196 MPN/100 ml, > 24196 MPN/100 ml, > 24196 MPN/100 ml, 10462 MPN/100 ml, and 10462 MPN/100 ml, total coliform bacteria with the highest number were at station (point) 2 and 3 and the lowest were at station (point) 4 and 5.

Keywords: monitoring, water quality, Unhas Lake
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1. INTRODUCTION

Water is an essential natural resource that is needed to meet the livelihood of many people. Therefore, water resource must be protected so that it can be fully utilized by all living things. Water use must be done judiciously taking into aspects of saving, preservation, and control of pollutants both organic and inorganic pollutants.

Generally, the lake always receives feedback of water from the catchment are around the lake. So, the lake tends to accept the dissolved materials transported along with the incoming water. Therefore, the concentration of

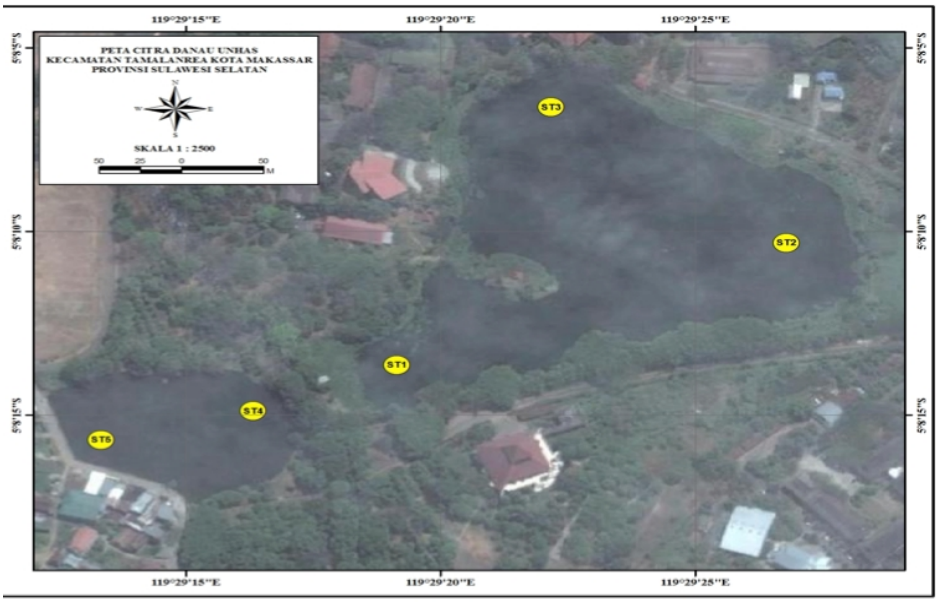

Figure 1. Location of Research and Water Sampling.

substances contained in the lake is the resultant of substances derived from the flow of incoming water. Pollution entering to water bodies can be divided into pollution due to nature and pollution due to human activities.

Today, the ecological major issues is the decline in water quality caused by the pollutants from human activities, such as household waste, sedimentation, industry, fertilizer, and pesticide. An increasing number of high populations around the lake can disrupt the balance of the aquatic environment. This will contribute to the rate of addition of nutrients and other organic waste that goes into the water body. The amount of nutrients that enter the water body water is usually greater than nutrient utilization by aquatic biota, and there will be an excessive enrichment (eutrophication).

University of Hasanuddin (Unhas) has two lakes with huge potential as a buffer zone soil water conservation, and good for Unhas environment. The existence of Unhas Lake is multifunctional, for example ecological function, economics, educational, social, cultural, and religious, as a recreation, as a place of research, the maintenance of several types of fish, and as a source of raw water. Unhas Lake Water utilization as a source of clean water has been planned, but not yet done due to the lack of further research that examined the water quality of Unhas Lake itself.

The quality of water entering the Unhas Lake is strongly influenced by the inlet water quality. Based on this description, it is necessary

Table 1. Water Quality Criteria Based Class. Source: Appendix of Government Regulation of RI Number 82 Year 2001

Parameter	Unit	Class			
		I	II	III	IV
Physical					
Temperature	°C	Deviation 3	Deviation 3	Deviation 3	Deviation 3
TDS	mg/l	1000	1000	1000	2000
TSS	mg/l	50	50	400	400

to analyze the physical, chemical, and microbiological parameters quality of Unhas Lake Water. The purpose of this study was to obtain data on the physical, chemical, and microbiological parameters quality of Unhas Lake Water, then the test results obtained were compared with water quality criteria based on the classes listed in the Government Regulation RI Number 82 Year 2001 on Water Quality Management and Water Pollution Control.

2. RESEARCH METHODOLOGY

Water sampling was conducted at Unhas Lake on Thursday, August 28th, 2014 at 06.00 am with five sampling stations (points) as representative.

Location coordinates of Unhas Lake water sampling are as follows.

Station 1: 119° 29' 26,8" 5°8'13,8"
Station 2: 119°29'26,8" 5°8'10,2"
Station 3: 119°29'22" 5°8'6,7"
Station 4: 119°29'16,8" 5°8'15"
Station 5: 119°29'13,2" 5°8'15,7"

The type of research is field survey conducted by taking five water samples and were tested at Health Laboratory Center Makassar to check the physical, chemical, and microbiological parameters. Location of the study and water sampling is shown in figure 1.

Chemical parameters quality analysis of Unhas Lake is done with reference to the water quality criteria based on the classes listed in the Government Regulation Number 82 Year 2001 on Water Quality Management and Water Pollution Control which can be seen in Table 2 below.

Table 2. Water Quality Criteria Based Class

Parameter	Unit	Class			
		I	II	III	IV
Anorganic Chemical					
pH	-	6-9	6-9	6-9	5-9
BOD	mg/l	2	3	6	12
COD	mg/l	10	25	50	100
DO	mg/l	6	4	3	0
NO_3 as N	mg/l	10	10	20	20
NH_3-N	mg/l	0,5	(-)	(-)	(-)
Copper	mg/l	0,02	0,02	0,02	0,2
Iron	mg/l	0,3	(-)	(-)	(-)
Fluoride	mg/l	0,5	1,5	1,5	(-)
Nitrite as N	mg/l	0,06	0,06	0,06	(-)
Sulfate	mg/l	400	(-)	(-)	(-)

Source: Appendix of Government Regulation RI Number 82 Year 2001

Analysis of microbiological parameters quality of Unhas Lake is done with reference to the water quality criteria based on the classes listed in the Government Regulation of RI Number 82 Year 2001 on Water Quality Management and Water Pollution Control which can be seen in Table 3 below.

Table 3. Water Quality Criteria Based Class

Parameter	Satuan	Kelas			
		I	II	III	IV
Microbiology					
Fecal Coliform	MPN/100 ml	100	1000	2000	2000
Total Coliform	MPN/100 ml	1000	5000	10000	10000

Source: Appendix Government Regulation Number 82 Year 2001

3. RESULTS AND DISCUSSIONS

A. Physical Parameters Analysis

Temperature is an important factor in the metabolic processes in aquatic organisms.

Sudden changes in temperature or extreme temperatures will disrupt the life of the organism even can cause death. Water temperature may change according to the season, time of measurement, and water depth.

The increasing of temperature leads to increased viscosity, chemical reaction, evaporation, and volatilization. Increased temperature also resulted decreasing of gas solubility in water, for example gas O2, CO2, N2, CH4 [1]. In addition, increasing of temperature also causes an increase in the speed of organism metabolism and respiration of water, and subsequently lead to increased oxygen consumption.

The increasing in temperature causes an increase in oxygen consumption, but on the other hand also caused a decline in dissolved oxygen. Therefore, the condition of aquatic organisms is often not able to meet the dissolved oxygen levels for the purpose of metabolism and respiration processes [2]. The distribution of the value of the temperature parameter test results at five stations (points) on Unhas is presented in figure 2 below.

The results of temperature measurements at five stations (points) on Unhas Lake Water overall did not show great variation, even relatively stable where the lowest temperature was 27,2 ° C at station 5 and the highest temperature was 28,2°C at station 4. Based on the results test above, it can be concluded that the temperature conditions in Unhas Lake Water were still meet water quality standards set by the Class I government in Government Regulation of RI Number 82 Year 2001.

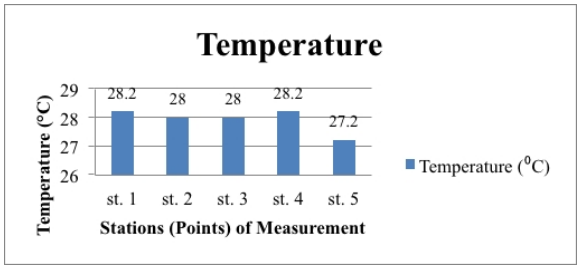

Figure 2. Temperature Test Results of Unhas Lake Water

B. Total Suspended Solid, TSS

Distribution of TSS parameter test results at five stations (points) on Unhas Lake is presented in figure 3 below. Based on Figure 3 above, stations (points) of measurements that meet the water quality standard for class 1 were station (point) 2, 3, and 4. Meanwhile, TSS test results at station (point) 1 and 5 were 60 mg/l and 90 mg l and have exceeded the maximum allowable level of TSS. High level of TSS at station (point) 1 occurred because the station (point) 1 is the outlet 1 of Unhas Lake, resulted in the accumulation and increasing in suspended solids, especially inorganic materials form (clay and sand). Furthermore, TSS level at station (point) 5 contained higher level of TSS than the station (point) 1 because the station (point) 5 is outlet 2 where the water flows towards the outlet 2 also causes organic and inorganic solids carried on and accumulated in station (point) 5. Thus, when compared with Class I water quality standard that requires maximum concentration of total suspended solids 50 mg/l, Unhas Lake Water has exceeded allowable standards.

However, it can still be used for the allocation of water Class 3 and Class 4, which requires maximum total suspended solids concentration of 400 mg/l.

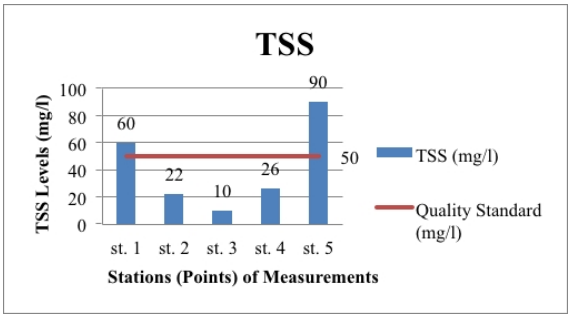

Figure 3. TSS Test Results of Unhas Lake Water

C. Total Dissolved Solid, TDS

TDS is usually caused by material in the form of inorganic ions commonly found in water. The ions commonly found in water consist of: (1) major ions (primary ions): sodium (Na), calcium (Ca), magnesium (Mg), bicarbonate (HCO_3), sulfate (SO_4), and chloride (Cl); (2) secondary ions (secondary ions): iron (Fe), strontium (Sr), potassium (K), carbonate (CO_3), nitrate (NO_3), fluoride (F), boron (B), silica (SiO_2) [2].

Distribution of TDS parameter test results at five stations (points) on Unhas Lake is presented in figure 4 below.

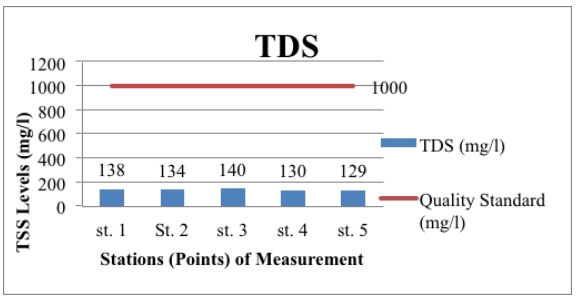

Figure 4. TDS Test Results of Unhas Lake Water

Based on Government Regulation of RI Number 82 Year 2001, the maximum TDS in water quality standards for class 1, 2, 3, and 4 were 1000 mg/l. Based on Figure 4 above, the results of measurements of total dissolved solids (TDS) at five stations (points) as a whole was under 1000 mg /l. Thus, TDS level in Unhas Lake was still below the threshold required quality standard.

Total dissolved solids (TDS) levels obtained from Unhas Lake Water are higher than the total suspended solids (TSS) levels. This illustrates that the solids entering into Unhas Lake are smaller in size (dissolved solids). The solid materials in the Unhas Lake are dominated by solids from organic wastes.

TDS levels in water are strongly influenced by rock weathering, runoff from surrounds, and anthropogenic influences (such as domestic and industrial waste). Dissolved materials in natural waters are not toxic, but if dissolved materials excessive, they can increase turbidity which in turn will inhibit the penetration of sunlight into the water column and eventually affect the photosynthesis process waters.

D. Chemical Parameters Analysis

a) Acidity Degree (pH)

Distribution of pH test results at five stations (points) on Unhas Lake is presented in figure 5 below.

The pH measurement results at five stations (points) on Unhas Lake Water ranged from 6,89 to 7,13 with the highest pH levels were

at station (point) 4 and 5. This is caused by residential water that entered into Unhas Lake. Water contained various chemical compounds that are alkaline such as detergents that can increase pH levels. However, the overall pH levels of Unhas Lake water were still in safe range based on water quality standards for Class 1 that requires pH levels between 6-9.

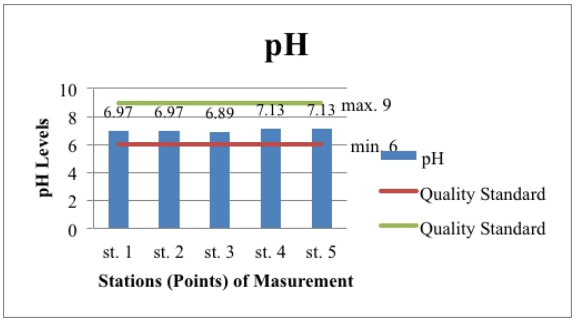

Figure 5. pH Test Results of Unhas Lake Water

b) Biochemical Oxygen Demand (BOD_5)

BOD5 is a parameter that can be used to describe the presence of organic matter in the water. BOD level can describe the amount of biodegradable organic material, which is the amount of dissolved oxygen required by microorganisms to break down or oxidize organic materials to carbon dioxide and water. The high BOD5 level indicates the amount of organic matter that decomposed by using a number of oxygen in the water. Fish and most aquatic life are stifled by a lack of oxygen and unpleasant taste and odors are produced if oxygen level is reduced.

The distribution of BOD5 parameter test results at five stations (points) on Unhas Lake is presented in figure 6 below.

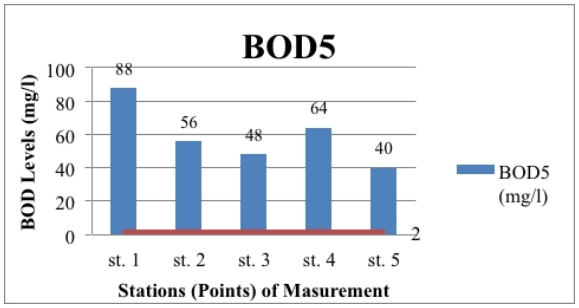

Figure 6. BOD_5 Test Results of Unhas Lake Water

BOD5 measurement results at five stations (points) on Unhas Lake Water ranged from 40 mg/l to 88 mg/l, where the highest level was at station (point) 1 i.e 88 mg/l and the lowest level was station (point) 5 i.e 40 mg/l and the maximum BOD5 level required is 2 mg/l. The high BOD5 level at station (point) 1 is mainly due to outlet 1 where deposition and accumulation of organic waste are at bottom water.

Decomposition process increases and causes dissolved oxygen content decreases. In addition, according to Canter and Hill [3] an increase of BOD5 level is an indication of decreasing dissolved oxygen in the water due to the activity of decomposing organisms. The same thing happened at station (point) 4 which BOD level reached 64 mg/l because station (point) 4 is an inlet 2 of Unhas Lake which receives water flow from station (point) 1 and causes the organic waste that settles and accommodates process, so that the BOD_5 level increased.

c) Chemical Oxygen Demand (COD)

The distribution of COD parameter test results at five stations (points) on Unhas Lake is presented in figure 7 below.

Other parameter, which can be used as an estimate organic waste pollution is COD. The COD level describes the total oxygen required to oxidize organic matter chemically, both which can be degraded biologically (biodegradable) and non-biodegradable.

COD measurement results at five stations (points) on Unhas Lake range from 100 mg/l to 220 mg/l. The highest level is at station (point) 1 i. e 220 mg/l. The high level of COD at station (point) 1 is mainly due to the outlet 1 of Unhas Lake that build deposition and accumulation of organic waste in the bottom water, decomposition process increases and causes dissolved oxygen content decreases. COD level that obtained in the study is much larger (approximately 2,5 times greater) than BOD level. According to Metcalf and Eddy [4], difference in BOD_5 and COD level usually occurred in polluted water. There are decomposable matters present in the water that can't stabilize by biochemical action, but by chemical action.

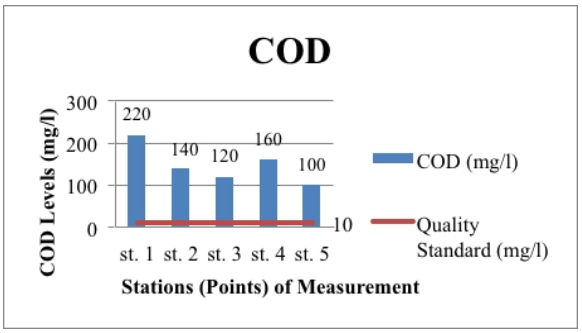

Figure 7. COD Test Results of Unhas Lake Water

d) Dissolved Oxygen (DO)

Oxygen is one of the dissolved gases in natural water with varying levels, which are influenced by temperature, salinity, water turbulence, and atmosphere pressure. Besides necessary for the survival of organisms in water, oxygen is also required in the process of decomposition of organic compounds into inorganic compounds. Sources of dissolved oxygen are mainly derived from the diffusion of oxygen contained in the atmosphere. Diffusion of oxygen into the water is going directly on the stagnant conditions or the water mass upheaval due to waves or wind.

Distribution of DO parameter test results at five stations (points) on Unhas Lake is presented in figure 8 below.

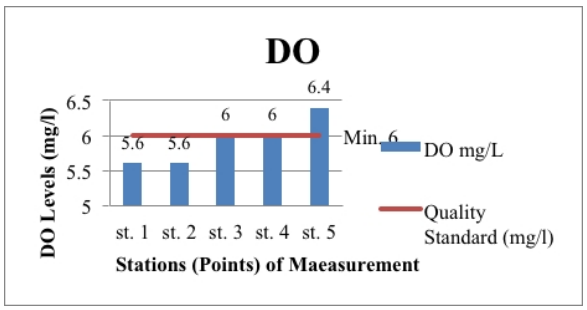

Figure 8. DO Test Results of Unhas Lake Water

DO measurement results at five stations (points) on Unhas Lake Water ranged from 5,6 mg/l to 6,4 mg/l. Based on figure 5 above, the lowest DO test results were at station (point) 1 and 2 i.e 5,6 mg/l, while the highest DO test result was at station 5 i.e 6,4 mg/l. The minimum DO level for Class 1 quality standard is 6 mg/l. Low levels of DO at station (point) 1 and 2 due to the high consumption of oxygen at the station (point) because of the increasing and accumulation of organic and inorganic wastes which derive from human activities around the lake and from activities in the water body itself.

e) Ammonia as N (NH_3-N)

Distribution of ammonia test results at five stations (points) on Unhas Lake is presented in figure 9 below.

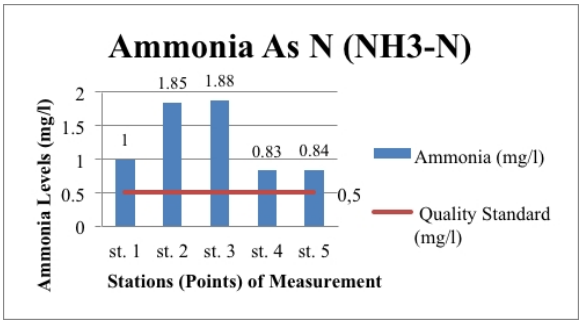

Figure 9. Ammonia Test Results of Unhas Lake Water

Based on the figure 6 above, ammonia levels in Unhas Lake ranged from 0,83 mg/l to 1,88 mg/l with the highest level were at station 2 and 3 reached 1,85 mg/l and 1,88 mg/l. High levels of ammonia at station (point) 2 and 3 were caused by domestic sewage from residential areas located close to the sampling site. In addition, the presence of aquatic biota in the lake also contributed because feses of aquatic biota supplied ammonia and decomposition process of organic matters (plants) and aquatic biota that have died by microbes and fungi.

Free ammonia (unionized) is toxic to aquatic organisms. Ammonia toxicity to aquatic organisms will increase if there is a decrease in dissolved oxygen levels, pH, and temperature [2]. DO test result at station (point) 2 was 5,6 mg/l, while the pH test result at the station was 6,7 with temperature 28°C. With reference to these levels, although DO levels at station (point) 2 are quite low, but the pH level was near to neutral. Thus, ammonia level at station (point) 2 was not toxic. Similarly, although ammonia level at station (point) 3 reached 1,88 mg/l, but it was not toxic because DO level was still quite high i.e 6 mg/l and pH level was 6,89 (close to neutral pH).

f) Nitrate (NO_3^--N)

The distribution of nitrate parameter test results at five stations (points) on Unhas Lake is presented in figure 10 below.

Nitrate test results at five stations (points) on Unhas Lake Water ranged between 0,13 mg/l to 0,84 mg/l. Generally, the nitrate contents in Unhas Lake water were still under water quality standard for class, while nitrate content for raw water maximum is 10 mg/l. However, it should get attention because nitrate level more than 0,2 mg/l can cause water eutrophication [2].

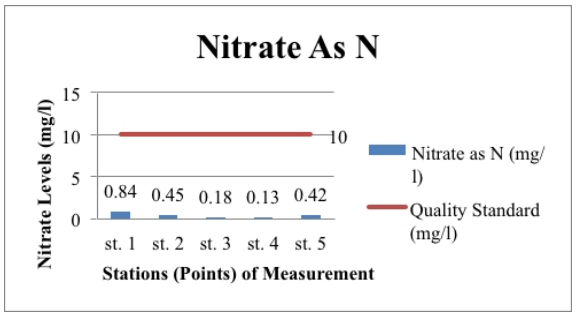

Figure 10. Nitrate Test Results of Unhas Lake Water

g) Nitrite (NO_2^--N)

In natural water, nitrite is usually found in very small amount, less than nitrate, because it is not stable in the presence of oxygen [2]. Nitrite is an intermediate form between ammonia and nitrate (nitrification) and between nitrate and nitrogen gas (denitrification). Nitrite can be a source of industrial waste and domestic waste.

Distribution of nitrite parameter test results at five stations (points) on Unhas Lake is presented in figure 11 below.

Based on figure 11 above, the highest nitrite level was found at station 2 i.e 0,09 mg/l, while the lowest level of nitrite was at station (point) 4 i.e 0,03 mg/l. High level of nitrite in station (point) 2 due to domestic sewage residents living around Unhas Lake. Nitrification is the oxidation of ammonia to nitrite and nitrate which takes place in aerobic conditions with optimum pH 8-9 with optimum temperature 20°C-25°C [2].

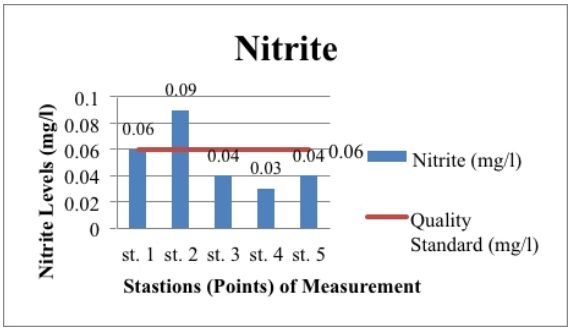

Figure 11. Nitrite Test Results of Unhas Lake Water

h) Iron (Fe)

The iron measurement results at five stations (points) on Unhas Lake are < 0,02 mg/l, < 0,02 mg/l, 0,12 mg/l, < 0,02 mg/l, and 0,02 mg/l. Based on Class 1 water quality standard, the maximum iron content of raw water is 0,3 mg/l. Thus, the level of iron in Unhas Lake Water didn't exceed the water quality standard for Class 1 defined in Government Regulation Number 82 Year 2001.

Iron level in water that have sufficient aeration (aerobic) is almost never more than 0,3 mg/l [2]. Iron level in natural water ranged from 0,05 mg/l to 0,2 mg/l [6]. Fe^{2+} concentration (dissolved iron) is affected by the decomposition of organic sediment in the bottom of the lake and phosphorus levels in the water. If the decomposition is done by aerobic bacterial decomposition, the dissolved oxygen content must be high and level of dissolved iron will low. When anaerobic bacteria are more in the decomposition, dissolved oxygen level will low and dissolved iron level will high.

i) Copper (Cu)

Copper measurement test results at five stations (points) on Unhas Lake Water were respectively < 0,005 mg/l and maximum level of Copper for Class 1 for raw water standard is 0,02 mg/l. Thus, copper levels in Unhas Lake Water didn't exceed the maximum level of copper for Class 1 raw water quality standard.

Sources of copper (Cu) derived from natural erosion mineral such as rock, dust, and particulate. Copper in air layer enters the water body through the rain, while from non-natural derived from human activities, such as shipbuilding industry, processing wood, and household waste. Copper content in lake water can be increased by increasing the number of settlement around the lake, which could potentially generate household waste. Copper enters into the lake water due to flow of water through corrosive water pipes channel. In natural water, copper level is usually less than 0,02 mg/l and maximum copper content for drinking water is 0,1 mg/l [5].

i) Sulfate

The distribution of sulfate parameter test results at five stations (points) on Unhas Lake is presented in Figure 12 below.

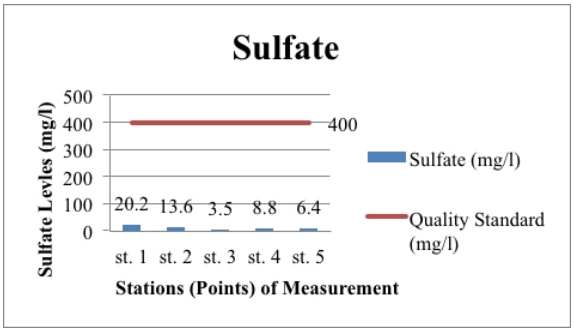

Figure 12. Sulfate Test Results of Unhas Lake Water

The sulfate measurement results at five stations (points) on Unhas Lake Water ranged between 3,5 mg/l to 20,2 mg/l. Meanwhile, sulfate maximum limit for Class 1 raw water is 400 mg/l. Thus, sulfate content in Unhas Lake Water was still relatively low. Sulfate source in Unhas Lake Water only comes from household waste, including the use of detergent. Based on figure 9 above, the highest level of sulfate was at station (point) 1 because station (point) 1 is the outlet 1 of Unhas Lake resulted increasing of organic and inorganic pollutants at the station (point). Sulfate content is high in water if water flows through the rock gypsum or close to the industrial water disposal site [2].

k) Fluoride (F)

The fluoride measurement results at five stations (points) on Unhas Lake Water are less than 0,1 mg/l, while the maximum level of fluoride for Class 1 raw water is 0,5 mg/l. Thus, fluoride level in Unhas Lake Water doesn't exceed the maximum level allowable fluoride level.

The presence of fluoride in water can occur naturally or with a controlled amount. The fluoride presence in Unhas Lake Water is caused by domestic waste around Unhas Lake. Fluoride level in water will increase if the waste flows from the industrial production activities such as steel industry, glass, metal plating, aluminium, and pesticides [2].

E. Microbiological Parameters Analysis

a) Fecal coliform

Coliform bacteria can be used as an indicator of fecal contamination or human and animal waste in the water. This class of bacteria commonly found in humans and animals feces. Therefore, its presence in water is not desired, both in terms of health, aesthetics, cleanliness, and the possibility of dangerous infections. Several types of diseases can be transmitted by coliform bacteria through waterborne, particularly stomach diseases such as typhoid, cholera, and dysentery.

The distribution of fecal coliform test results at five stations (points) on Unhas Lake is presented in Figure 13 below.

Fecal coliform test results bacteria at five stations (points) on Unhas Lake Water ranged from 30 MPN/100 ml - 17329 MPN/100 ml with the highest number was at station 3, ie 17329 MPN/100 ml. Meanwhile, the maximum level of fecal coliform for Class I raw water was 100 MPN/100 ml. This indicated that station (point) 3 congested domestic waste both from the buildings around Unhas Lake and resettlement, especially by human and animal feces. Fecal

coliform bacteria are mainly composed of Escherichia, so it can be used as an indication of fecal contamination of the water by human or animal feces [2]. The number of fecal bacteria in station (point) reach 4352 mg / l. This is caused by domestic waste from the Campus's Mosque and residential around Unhas Lake.

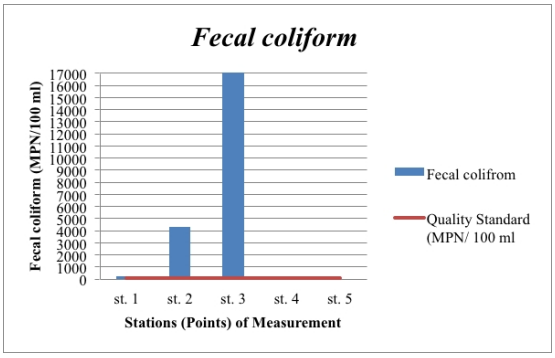

Figure 13. Fecal coliform Test Results of Unhas Lake Water

Thus, fecal coliform bacteria levels has exceeded the threshold of Class 1 water quality standard set by the government [7].

b) Total Coliform

Total coliform bacteria, as well as fecal coliform is an indicator of bacteria in assessing the level of hygiene water body. Total coliform bacteria includes all types of aerobic and facultative anaerobic bacteria, and rod shape bacteria that can ferment lactose and produce gas within 48 hours at a temperature 35°C. Therefore, total coliform bacteria consist of Escherichia, Citrobacter, Klebsiella, and Enterobacter [2].

The analysis results o of coliform bacteria at five stations (points) on Unhas Lake Water were 24196 MPN/100 ml, > 24196 MPN/100 ml, > 24196 MPN/100 ml, 10462 MPN/100 ml, and 10462 MPN/100 ml, while the maximum number of total coliform bacteria in raw water for Class 1 is 1000 MPN/100 ml. The number of total coliform bacteria in the station (point) 1 was high because the station (point) 1 is the outlet 1 of Unhas Lake, This is caused by accumulation of organic and inorganic pollutants that had large potential to increase the number of total coliform bacteria in the station (point). Not much different from station (point) 1, the number of total coliform bacteria in the station (point) 2 was high due to domestic waste originating from the Campus Mosque and residential around the sampling point. At station (point) 3, the number of total coliform bacteria is also high due to domestic waste originated from buildings, including domestic waste settlement residents living around the Unhas Lake.

Based on the above, the number of total coliform bacteria in Unhas Lake water has been above the threshold for Class 1 of water quality standards set by the government [7].

4. CONCLUSION

1. Based on physical parameters test results of five sampling points obtained, Unhas Lake Water temperatures were quite stable, ranged between 27,2°C-28,2°C. TDS test results obtained that TDS levels of Unhas Lake Water ranged from 129 mg/l-140 mg/l and were under water quality standard for Class 1 that requires TDS level maximum 1000 mg/l. Meanwhile, TSS test results that meet class I quality standard was station 2, 3, 4, ranged

between 10 mg/l-26 mg/l, while stations (points) that did not meet the quality standard for Class 1 were station 1 and 5 i.e 60 mg/l and 90 mg/l, while the maximum permissible level was 50 mg/l.

2. Based on the chemical parameters test, quality of Unhas Lake Water did not meet the quality standard criteria for Class 1 listed in Government Regulation Number 82 Year 2001 for parameters ammonia, BOD_5, COD, DO, and nitrite. Meanwhile, the chemical parameters for class 1 quality standard that meet are iron, fluoride, nitrate, and sulfate.
3. Based on microbiological parameters test results of five sampling points showed that Fecal coliform bacteria level at stations (points) 1, 2, 3, 4, and 5 were 295 MPN/100 ml, 4352 MPN/100 ml, 17329 MPN/100 ml, 142 MPN/100 ml, and 30 MPN/100 ml, Fecal coliform bacteria with the highest number was at station (point) 3 and the lowest was at station (point) 5. The number of total coliform bacteria at stations 1, 2, 3, 4, and 5 were 24196 MPN/100 ml, > 24196 MPN/100 ml, > 24196 MPN/100 ml, 10462 MPN/100 ml, and 10462 MPN/100 ml, total coliform bacteria with the highest number were at station (point) 2 and 3 and the lowest were at station (point) 4 and 5.

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