Study on Physical and Chemical Parameters of Lake Limboto for the Development of Aquaculture

[2]Merti Djakaria, [1,2]Hasim, [2]Faizal Kasim

[1]hasim@ung.ac.id
[2]Department of Aquatic Resources Management, Faculty of Fishery and Marine Sciences
Universitas Negeri Gorontalo

Abstract

This study aims to determine the physical and chemical parameters for the development of aquaculture in Limboto Lake, Gorontalo Regency. Data collection was carried out from March to December 2016. This study used a quantitative descriptive method. Data collection was carried out three times at each station, namely, Station I (Central Point), Station II (Eastern), Station III (North), Station IV (West) and Station V (South). Measurement of physical and chemical parameters refers to water quality standards according to PP Law no. 82 of 2001 concerning water quality management and water pollution control. While determining the status of water quality using the Pollution Index Method according to the Minister of Environment Decree 115/2003. The results showed that the physico-chemical parameters in Lake Limboto that still support the development of aquaculture are temperature, pH, total dissolved solid (TDS), total suspension solid (TSS), dissolved oxygen (DO) and nitrate while the parameters that do not support the development of aquaculture fishery, namely brightness, depth, chemical oxygen demand (COD) and biochemical oxygen demand (BOD). Based on the determination of the overall water quality status of Limboto Lake, including waters with lightly polluted conditions with an average value of 2.28-4.71 mg/l.

Keywords: physical parameters; chemical parameters; Limboto Lake

Introduction

A lake is a freshwater ecosystem resource that has the potential to be developed, as a conservation area, fisheries, and tourism. Several facts show that the lake has the potential to be used for various purposes to meet human needs. One of the things that happens a lot is the development of fisheries using floating nets and cages techniques. On the one hand this activity can improve the economy of the surrounding community from the results of fish culture and sales, but on the other hand this activity if not controlled can cause a decrease in lake water qualities due to feed residue, or also accumulation of fish waste (Aisyah & Subeh, 2012).

Lake Limboto, which is a swamp-type lake, has ecological and economic functions for the people living around the lake. The lake acts as a reservoir for river water that empties into the lake so that it affects the hydrological system and supports biodiversity. In addition, the lake also functions as a capture fisheries and aquaculture area so that it becomes a source of community income (Mulis, 2012).

Lake Limboto is seen by local government as a center for development of freshwater fisheries. But on the other hand, the condition of the lake is getting worse as indicated by the shallower waters and the narrower the area. The depth of the lake in 1930 was 30 meters with an area of 8000 Ha, while in 2007 the depth was 2.5 meters with an area of 3000 Ha (Akuba & Biki, 2007 in Hasim et al, 2012). The development of aquaculture business is one solution to overcome the decline in catches. The development of this business will be able to guarantee the supply of fish throughout the year and this will have a positive impact on the lives of fishermen in the future.

Characteristics of physical and chemical parameters in waters are strongly influenced by several factors, one of which is environmental

pollution caused by various activities around the waters and from the cultivation business itself. From the cultivation business, for example, the feed given is not consumed properly by the fish. The rest of the feed that is not eaten will settle to the bottom of the water and then a decomposition process occurs by microorganisms.

Seeing the importance of the role of water quality, it is necessary to conduct research on and chemical parameters for the development of aquaculture to see the feasibility of a waters to be used as cultivation areas (Maniagasi, 2013).

Research Methods

This research was conducted from April to December 2016 in Limboto Lake, Gorontalo Regency.

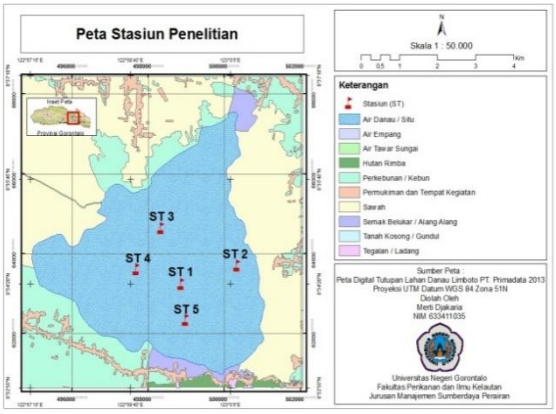

Figure 1. Stations of the research in the Limboto Lake (Source: PT. Primadata, 2013).

Tools and materials used in this study include GPS, writing instruments, secchi disk, conductivity meter, litmus paper, plastic bottle, meter, camera, tissue, aquades, and label paper.

The research method uses is survey. For the water sampling point, there are five stations that are taken purposively: Station I (midpoint), Station II (eastern part), Station III (north part), Station IV (west) and Station V (south). Measurement and sampling in the field were repeated three times at each station, and were carried out in two parameters, namely physical and chemical parameters in situ, namely temperature, pH, brightness, depth, total dissolved solid (TDS) and laboratory analysis, namely dissolved oxygen. (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspension Solid (TSS) and nitrate.

Analysis of water qualities by referring to water quality standards according to PP Law no. 82 of 2001 concerning water quality management and water pollution control. Determination of water quality status using the Pollution Index (IP) method according to KepMenLH 115/2003 (Islaeni, 2015).

Results and Discussion

Physical and Chemical Parameters

Water quality analysis is carried out to determine the suitability of water for a particular designation by comparing it with water quality standards according to water class based on its designation, then the results of observations of physical parameters (temperature, TSS, and TDS) and chemical (pH, DO, COD, BOD, and nitrate) at each observation station in this study, then compared with the water quality standard according to Government Regulation No. 82 of 2001 (class III). The results can be seen in Table 1.

Table 1. Physical and chemical parameters in Lake Limboto

No	Parameter / Kualitas Air	Satuan	Baku Mutu	Stasiun				
				I	II	III	IV	V
1	Suhu	(˚C)	3	27,6	27,43	27,73	25,5	8,4
2	Kecerahan	(cm)	–	11,33	8,33	5,33	10,33	8,67
3	Kedalaman	(m)	–	1,44	1,77	1,47	1,55	1,65
4	Total Disolved Solid (TDS)	(mg/)	1000	10,44	4,03	4,67	43,53	85,31
5	Total Suspension Solid (TSS)	(mg/)	400	154,33	259,67	305,33	140,3	152,67
6	pH	(-)	6–9	6	6	6	6	6
7	Chemical Oxygen Demand (COD)	(mg/)	50	83,67	134	160	77,5	84
8	Biochemical Oxygen Demand (BOD)	(mg/)	6	38,33	63,83	75	35,83	38,83
9	Oksigen Terlarut (DO)	(mg/)	3	8,01	7,97	7,98	8,05	7,97
10	Nitrat	(mg/)	20	1	1	1	1	1
	Titik		N	00˚34' 19.8"	00˚34' 35.0"	00˚34' 29.8"	00˚34' 31.1"	00˚33' 53.2"
			E	122˚59' 23.5"	122˚59' 40.8"	122˚59' 27.1"	122˚59' 10.2"	122˚59' 22.6"

The water temperature is 25.50-28.40^{o}C, and the average temperature for the five stations is 27.33 ˚C. This is below the water quality standard according to PP No. 82 of 2001 (class III). The low temperature at Station IV is thought to have no human activity, while the high temperature at station V is caused by the ongoing floating net cage (KJA) activity. The organic waste generated from aquaculture activities can cause a decrease in water quality. The high and low temperatures in a waters are largely determined by several factors, including the altitude of an area, high rainfall, and the intensity of sunlight that penetrates the waters (Maniagasi, 2013).

The brightness values ranged from 11.33-5.67 cm, while the average brightness was 8.87 cm, the lower brightness was thought to be due to the large number of dissolved solids and suspended solids originating from waste from human activities. According to Sulardiono (2009) in Haro, et al, (2013), the decrease in brightness level due to floating net cage activities is caused by suspended feed residues and high levels of micro-organisms such as plankton. These results indicate that the brightness of the waters in Lake Limboto is not good for the development of aquaculture.

The highest depth measurement was at Station II of 1.77 m while the lowest depth is at Station I of 1.44 m. The average depth value is 1.58 m. This shows that the entire stations are not suitable for the development of aquaculture because it has an average depth of less than 2 meters. This is in accordance with the opinion of Utomo et al., (1997) in Akrimi and Subroto (2002), that sufficient water depth for aquaculture is at least 2 meter so that it does not experience drought in the dry season.

The results of the measurement of the highest Total Dissolve Solid (TDS) were at Station V with a value of 85.3 mg/l while the lowest was at Station II with a value of 4.03 mg/l. The average value of Total Dissolve Solid (TDS) is 29.60 mg/l. Based on the water quality standard PP No.82 of 2001 (class III), the permissible value is 1000 mg/l, so the TDS value in the waters of Lake Limboto is still below the specified quality standard. Based on these results, the TDS value in the waters of Lake Limboto is still good for the development of aquaculture. Total Dissolve Solid (TDS) is usually caused by dissolved organic materials in the form of ions commonly found in waters and is influenced by weathering of rocks (Effendi, 2003 in Oviantari, 2011). The amount of dissolved solids in the water is also very influential on light penetration. The higher the dissolved solids, the more it will inhibit the penetration of light into the waters (Fitra, 2008).

The laboratory test results showed that the highest Total Suspension Solid (TSS) value was at Station III with a value of 305.33 mg/l while the lowest was at Station IV with a value of 140.33 mg/l. The average value of Total Suspension Solid (TSS) is 215.53 mg/l. Based on these results, the TSS value in Limboto Lake is still feasible for fishery development because it is below the quality standard. Based on the water quality standard PP No. 82 of 2001 (class III), the permissible value is 400 mg/l.

There is an increase in the value of the Total Suspension Solid (TSS) of Lake Limboto at Stations II and III, due to the large number of land conversions around the lake, causing an increase in soil solids entering the lake through river flows.

The acidity degrees at Stations I to V is relatively the same, namely 6. The average pH value is 6. Based on the water quality standard PP No. 6 – 9. According to (Pescod, 1973 in Akrimi and Subroto, 2002) that the ideal pH for fisheries is 6.50 - 8.50. This shows that the pH in Limboto Lake is still within natural limits and is still feasible for aquaculture activities. The waters of Lake Limboto at each station show a pH value of 6, so the waters tend to be acidic. The low pH of Limboto lake water is caused by pollution from human activities. According to Mahida (2001) that industrial and household waste can affect the pH value of the waters.

Laboratory results showed that the highest Chemical Oxygen Demand (COD) value was at Station III with a value of 160 mg/l and the lowest was at Station IV with a value of 77.5 mg/l. The average value of Chemical Oxygen Demand (COD) is 107.78 mg/l. Based on the water quality standards that have

been set by PP No. 82 of 2001 the permissible value is 50 mg/l so that the value of Chemical Oxygen Demand (COD) in the waters of Lake Limboto has exceeded the quality standard. So it is not good for the development of aquaculture. It is suspected that there is a buildup of organic matter originating from activities in the lake's waters. Effendi (2003) in Mazida (2012), states that the value of Chemical Oxygen Demand (COD) will increase in line with the increase in the value of organic matter in the waters.

Laboratory results show that the highest value of Biochemical Oxygen Demand (BOD) is at Station III with a value of 75 mg/L. While the lowest value is at Station IV with a value of 35.83 mg/l. The average value of Biochemical Oxygen Demand (BOD) in Limboto Lake is 50.43 mg/l. According to the water quality standard PP No. 82 of 2001 (class III), the value of Biochemical Oxygen Demand (BOD) for cultivation activities is 6 mg/l. This shows that the value of Biochemical Oxygen Demand (BOD) in Limboto Lake has exceeded the quality standard.

According to Rizki, et al, (2015) the high value of Biochemical Oxygen Demand (BOD) indicates that the amount of organic matter is decomposed by aerobic bacteria compared to other stations. The higher the Biochemical Oxygen Demand (BOD), the more polluted the waters will be. According to Haro et al, (2013) the accumulation of organic pollutants in the waters will cause the decomposition process by decomposing organisms to also increase, so that the concentration of Biochemical Oxygen Demand (BOD) also increases.

Laboratory results of nitrate levels measurements at Stations I to V are 1 mg/l. In accordance with these results when compared with PP water quality standards. No. 82 of 2001 (class III) that Lake Limboto is still suitable for aquaculture development. The presence of nitrate compounds in the waters is influenced by the discharge from industry, agriculture and domestic. Naturally, nitrate levels are usually low, but nitrate levels can be high in water bodies that receive the addition of nitrate/nitrogen fertilizers (Silalahi 2010 in Isnaini 2011).

The highest dissolved oxygen value was at Station V with a value of 8.05 mg/l, while the lowest was at Stations II and V with a value of 7.97 mg/l. The average value of dissolved oxygen is 8 mg/l. The DO values obtained show that dissolved oxygen in the five locations are still good for fish life, the DO value obtained ranges from 7.97-8.05 where the minimum DO value is good for fish farming activities according to PP No. 82 of 2001: water quality standard is 3 mg/L. The high and low value of dissolved oxygen is not very closely related to the movement of water in a waters. Dissolved oxygen in water is a limiting factor for aquatic organisms in carrying out their activities. The range of oxygen concentration values is quite low for public waters. The low oxygen concentration in the waters of Lake Limboto is due to the decomposition process of organic matter from dead aquatic plants and feed residues that fall into the water column (Aisyah and Subehi, 2012).

Pollution Index

Pollution index is one of the methods used to determine the water quality status of a water source. Water quality status indicates the level of water quality conditions of water sources in polluted conditions or good conditions. According to the Decree of the Minister of the Environment No.115 of 2003 concerning Guidelines for Determining the Status of Water Quality in Appendix 2 regarding the determination of the status of water quality using the pollution index method, it is explained about the range of pollution index values. Pollution indexes for stations are in Table 2.

Table 2. Pollution indexes in research stations

Stations	PI	Quality
I	3,66	Lightly polluted
II	2,28	Lightly polluted
III	4,71	Lightly polluted
IV	3,52	Lightly polluted
V	3,67	Lightly polluted

Based on the results of the analysis using a pollution index, physical and chemical parameters

that directly affect the condition of the waters of Lake Limboto originating from the aquaculture waste of the floating net cage system (KJA) and domestic waste originating from residential areas on the edge of the lake.

Conclusion and Suggestion

Physical and chemical parameters in Lake Limboto that support the development of aquaculture are temperature, pH, total dissolved solid (TDS), total suspension solid (TSS), dissolved oxygen (DO) and nitrate, while parameters that do not support the development of aquaculture fisheries, namely brightness, depth, chemical oxygen demand (COD), and biochemical oxygen demand (BOD).

There are several parameters whose values have exceeded the water quality standards that. Judging from the pollution index value that Lake Limboto is included in waters with lightly polluted conditions. So overall Lake Limboto is still good for the development of aquaculture.

It is necessary to conduct further research on biological parameters, to obtain some specific descriptions related to the contribution of pollutant materials in Limboto Lake. In addition, it is also necessary to monitor water quality continuously in the development of fisheries and sustainable management of Limboto Lake.

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