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ANALYSIS OF BUYAN LAKE: WATER QUALITY STATUS AND ITS MANAGEMENT EFFORTS TO SUPPORT SUSTAINABLE WATER RESOURCES

Kristiyanti Putu Lilik Pratami*, **Sastrawidana I Dewa Ketut**, **Atmaja Dewa Made**
Universitas Pendidikan Ganesha, Indonesia
*E-mail: lilik.kristiyanti@undiksha.ac.id

ABSTRACT
Lakes are one type of inland waters that have an important role in providing habitat for aquatic life (aquatic biota) and are often a source of water for humans and the surrounding ecosystem. Increasing human activities around the lake, such as agricultural activities, settlements, and tourism, trigger a decrease in water quality and will have an impact on the environment around the waters. This study aims to determine the water quality status of Lake Buyan, which is analyzed using the STORET method. Sampling in the study was carried out at four sample points, namely near agricultural areas, residential areas, forest areas, and in the middle of the lake, by analyzing nine parameters, namely Temperature, TSS, pH, COD, BOD, DO, total Nitrogen, total Phosphate, and fecal coliform in each sample. Based on the results of the study, the parameters whose values exceed the class 2 water quality standards according to Bali Governor Regulation No. 16 of 2016 are the COD, BOD, and Total Nitrogen parameters. Based on the results of the STORET analysis, the average STORET index value was -16, indicating that Lake Buyan is included in the moderately polluted category. The recommended strategy for handling the pollution of Lake Buyan is to utilize the area around Lake Buyan more optimally and sustainably, and in line with periodic lake rejuvenation efforts carried out to maintain the balance of lake water quality by the surrounding community and government.

KEY WORDS
Water, quality, Buyan Lake.

Water plays an important role in maintaining the balance of the global ecosystem and supporting human life and other living things. Water also plays a role in the hydrological cycle, which includes evaporation, cloud formation, and precipitation. A deep understanding of the types and interactions in aquatic ecosystems is one of the keys to maintaining environmental balance and sustainability. Lakes are one type of inland waters that play an important role in providing habitat for aquatic life (aquatic biota) and are often a source of water resources for humans and the surrounding ecosystem. The existence of lakes has a main function, namely as a reservoir for rainwater; besides that, it is also a provider of clean water, so that people around the lake do not experience a shortage of clean water supply in carrying out their daily activities. One of the lakes in Bali Province, which is located close to community activities, is Lake Buyan. Lake Buyan is one of 4 natural lakes owned by Bali Province. Lake Buyan is located in Pancasari Village, Sukasada District, Buleleng Regency, Bali. Lake Buyan, with its natural beauty, is now a tourist attraction, but it can also increase human activity around Lake Buyan, resulting in many problems with the quality of the lake's water. The community around Lake Buyan has been using the lake water for daily needs such as irrigation, agriculture, and tourism activities, and even some people use Lake Buyan water as a source of drinking water. In terms of its designation, the water quality of Lake Buyan should meet class II water quality standards based on Bali Governor Regulation No. 16 of 2016.

However, recently, the water quality of Lake Buyan has decreased due to water pollution in Lake Buyan. The decline in the quality of lake water can cause a decrease in the utility, efficiency, productivity, carrying capacity, and capacity of water resources, which will ultimately reduce the wealth of natural resources (Atmaja, 2019). Based on data and analysis of the results of water quality testing of Lake Buyan conducted by the Buleleng Regency

Environmental Service in 2023 at 4 locations, namely Buyan 1, which is near the agricultural area; Buyan 2, which is near the agricultural and residential areas, Buyan 3 is located in the middle of the lake, and Buyan 4 which is located near the forest area. From the 4 locations, water quality testing was carried out for seven parameters, including physical, chemical, and microbiological parameters. The test results showed that of the nine parameters tested, namely temperature, TSS, pH, COD, BOD, DO, Total Nitrogen, Total Phosphate, and Fecal Coliform, three parameters did not meet the requirements for class II water quality standards according to Bali Governor Regulation No. 16 of 2016, namely BOD 10 mg/L, COD 49 mg/L, Total Nitrogen 4 mg/L. The high concentrations of COD and BOD indicate that domestic activities of the community around the lake, such as the use of soap and detergent, restaurants, agricultural activities, cages, and lodging, produce waste with high concentrations of organic matter (Riki Saputra et al., 2017). Summary et al. (2020) stated that the high value of Fecal Coliform and Total Coliform bacteria in Lake Buyan in areas close to residential areas was 1600 MPN/100 ml. This condition is caused by liquid waste from community activities around the residential area, which has a high organic content. This causes the water quality of Lake Buyan to be in poor condition, and the water quality status category is class D, or the level of pollution is severe. Thus, the waters of Lake Buyan are no longer suitable for drinking water and are only suitable for irrigating agriculture. The importance of information regarding the water quality status of Lake Buyan is the main basis for this study. Water quality status is useful for describing the condition of pollution in a water body. By knowing the water quality status, officials can make policies related to improving water quality. This study uses the STORET method to analyze the water quality status of Lake Buyan. In accordance with the Decree of the Minister of State for the Environment No. 115 of 2003, the determination of water quality status can be done, one of which is by the STORET method. This method is used because the parameters tested can be used for all parameters in the water quality standards. By knowing the water quality status of Lake Buyan, pollution of Lake Buyan can be controlled properly so that the existence of Lake Buyan can become a sustainable water resource.

METHODS OF RESEARCH

The research conducted was descriptive research with quantitative and qualitative approaches. Descriptive research with a quantitative approach is reviewed from the results of the lake water quality status which provides data in the form of numbers. This research is also supported by qualitative data that provides a description of the analysis results in a narrative manner regarding community activities that cause pollution in Lake Buyan. The subject of this study was the water of Lake Buyan, while the object of this research was the water quality status and environmental conditions of Lake Buyan. This research was conducted in Lake Buyan, Pancasari Village, Sukasada District, Buleleng Regency. Lake Buyan has an area of 301.84 hectares and is flanked by two other lakes, namely Lake Tamblingan to the west and Lake Beratan to the east. In this study, four sampling points will be carried out, namely, point Buyan 1 is located near the agricultural area, Buyan 2 is near the residential area, Buyan 3 is in the middle of the lake, and Buyan 4 is located near the forest area (Figure 1).

Measurement of the quality and level of lake water pollution was carried out by analyzing the chemical, physical, and microbiological parameters of lake water samples and then comparing them with the water quality standard parameters of class II according to Bali Governor Regulation No. 16 of 2016 concerning Environmental Quality Standards and Environmental Damage Standard Criteria. Determination of the level of lake water pollution was analyzed using the STORET method. The STORET method is a method used to determine the status of water quality using water quality parameter data and comparing it with the applicable quality standards (Decree of the Minister of Environment No. 115 of 2003). The STORET method uses a method of giving points that exceed the quality standards. The number of values will determine the level of pollution that occurs.

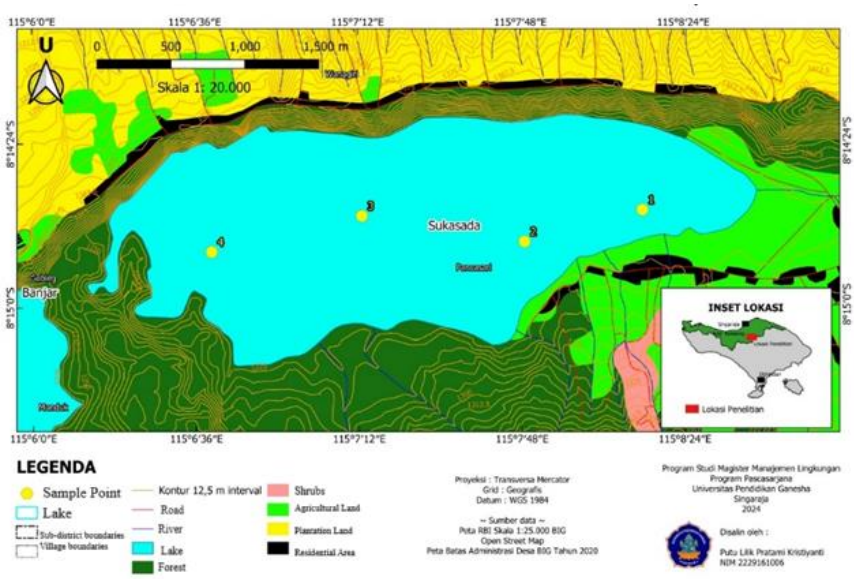

Figure 1 – Location of Sample Points for Research on Lake Buyan, Bali

Table 1 – Value system for determining water quality status

Number of examples	Score	Parameter		
		Physics	Chemistry	Biology
< 10	Maximum	-1	-2	-3
	Minimum	-1	-2	-3
	Average	-3	-6	-9
≥10	Maximum	-2	-4	-6
	Minimum	-2	-4	-6
	Average	-6	-12	-18

All negative values from all parameters are added up and then the total value is compared with the water quality/pollution level conditions using the US-EPA score (Table 2).

Table 2 – Classification of Water Quality in the STORET Method

Class	Class Category	Score	Category
A	Very Good	0	Meet the quality standard
B	Good	-1 s/d -10	Light pollution
C	Average	-11 s/d -30	Moderate pollution
D	Bad	≥ -31	Heavy pollution

The method for determining the status of water quality using the STORET method is as follows: Water quality data is collected periodically to form data over time. The measurement data for each water parameter is compared with the quality standard value that corresponds to the water class, namely the class II water quality standard. Furthermore, the measurement results whose values meet the water quality standard value are given a score of 0, while the measurement results whose values do not meet the water quality standard are given a score according to Table 1.

RESULTS AND DISCUSSION

Lake Buyan is one of the four natural lakes owned by Bali Province, which is located in the highlands. Geographically, Lake Buyan is located at 8°14'9″ – 8°7'9″ S and 115°5'18" – 115°11'20" E and is administratively located in Pancasari Village, Sukasada District, Buleleng Regency, Bali. This 301.84 Ha Lake is one of three twin lakes formed in a large caldera. Lake Buyan is flanked by two other lakes, namely Lake Tamblingan to the west and Lake Beratan to the east. The depth of Lake Buyan itself is estimated to be around 80 meters, where the depth of this lake once reached 140 meters before the lakebed became

shallow due to erosion (A, 2023). In general, the water of Lake Buyan is water that comes from rainwater, both rainwater that falls directly on the lake and rainwater that falls in the catchment area and becomes runoff. Lake Buyan is a closed lake, so its water sources only come from rainfall and runoff from the catchment area. Both parameters are inputs for Lake Buyan. The output or water output from Lake Buyan is mainly used for agricultural irrigation, household needs, and drinking water. In addition, there is also water lost due to evaporation.

The existence of Lake Buyan is believed to be a buffer for the water system in the upper reaches of the river in Buleleng Regency; this can be seen from several springs that appear on the surface, possibly originating from the lake. For this reason, efforts to preserve the environment of the lake around it are very necessary at all times, and it is necessary to anticipate the use of lake water so that the lake as a buffer for the water system can continue to be maintained and remain sustainable (Atmaja, 2016). Lake Buyan has 2 hamlets located near the lake area, namely Buyan hamlet and Dasong hamlet. Based on the results of interviews with village officials, the Head of Buyan Hamlet, the Head of Dasong Hamlet, and the local community, they stated that most of the community's livelihoods are farmers. Based on the 2024 Pancasari Village Profile Data, it was recorded that the type of community livelihood as farmers was 33.13%, farm laborers were 28.76%, and the rest was 38.11 as civil servants, self-employed, fishermen, laborers, and others.

Based on the results of a survey at the research location, the use of the lake by the community around the lake is for irrigation and agriculture, and residents use some as a source of drinking water, fisheries, and tourism activities. It was further stated that currently, fishing activities in Lake Buyan no longer use floating net cages (KJA) because there is an appeal from the government not to use floating net cages. Fishermen currently fish only by placing nets in the lake waters with the aim of trapping fish in the nets without maintaining and feeding them. Furthermore, tourism activities are usually in the form of providing a place on the edge of the lake for camping which KSDA manages. Determination of the water quality status of Lake Buyan was carried out by taking samples at four sampling points, namely Buyan 1 point, located near the agricultural area; Buyan 2, near the residential area (Figure 3.2); Buyan 3, located in the middle of the lake, and Buyan 4 close to the forest area. There are nine parameters analyzed, namely temperature tested using the SNI.06-6989.23-2005 method, TSS using the gravimetric method, pH tested using the SNI 6989.11: 2019 method, Total Nitrogen and total Phosphate tested using a spectrophotometer, BOD tested using the ApHA method, DO tested using the Electrometric method, COD using the SNI 6989.2: 2019 method, and fecal coliform using the ApHA 23rd edition 2017 method (section 9211 A, C and E).

Based on the research data, it shows that the condition of Lake Buyan waters at each sampling point with the smallest storet index is -10, the highest is -18, and the average is -16. Overall, the level of pollution of Lake Buyan is included in a lightly polluted condition because it has a storet index value of more than -16. Based on the results of the parameter tests whose values do not meet the water quality standard values for class II, namely the COD, BOD, and total nitrogen parameters. The high COD, BOD, and Total Nitrogen values are also caused by the accumulation of several pollutant wastes originating from waste from the surrounding community, both from agricultural activities, settlements/households, and tourism activities around Lake Buyan.

Based on research by Sumarya et al. (2020), it was stated that the source of water pollution in Lake Buyan is community activities in residential areas and agricultural areas; the results of water quality, in general, are in poor condition with the results of pollution levels in the severe category with a STORET index value of -40. Based on this, when compared to the results of previous studies, the current condition of Lake Buyan has experienced a decrease in the storet index value.

CONCLUSION

At four sample points that have been analyzed through 9 parameters, it is generally known that the level of pollution in Lake Buyan is included in the lightly polluted category with

a STORET index of -16. The strategy that can be used to maintain and improve the quality of lake water is to make efforts to improve the quality of Lake Buyan periodically to maintain the sustainability of Lake Buyan through synergy between the community and the government through a periodic lake maintenance program, in addition to creating an extension program for farmers to reduce the use of fertilizers and pesticides

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