Trophic status of Limboto lake in Gorontalo Province

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Abstract. Limboto Lake were on the worried condition now. It happened because of the process depreciation and sedimentation which caused by sedimentation and waste ground that threaten the existence of ecosystem in the future. The purpose of the research is to determine trophic status of Limboto Lake in Gorontalo Province. Measurements of several water quality parameters were carried out in situ at 8 (eight) stations conducted by sampling and laboratory analysis of several parameters of water quality carried out at the Manado Research and Standardization Research Centre. To determine the trophic status of Limboto Lake waters calculated using the Trophic State Index (TSI) of Carlson. The results showed that the average value Trophic State Index (TSI) of Limboto Lake range from 50.3071 – 61.9297. This shows that the trophic status of Limboto Lake waters is classified as eutrophic.

1. Introduction

Limboto Lake is one of the natural resources assets of Gorontalo Province. The area of Limboto Lake covers 920 km² and there are around 23 rivers and tributaries that enter the lake. Limboto Lake functions as providers clean water, plant and animal habitat, regulator of hydrological functions, natural disaster prevention, stabilization of systems and natural processes, producer biological natural resources, transportation, recreation and sports, fisheries resources (agriculture and capture fisheries), source of income, flood control, research and education.

Limboto Lake is in a very worrying condition at this time because it experiences shrinkage and siltation due to sedimentation, which threatens its existence in the future. The decreasing area of lake waters has caused the decline in the function of the lake as a water storage area, which has the potential to cause flooding around the lake area even outside the Limboto Lake area.

In 1932 the depth average of Limboto Lake was 30 meters with an area of 7,000 hectare, and in 1961 the depth average of Limboto Lake was reduced to 10 meters and the large area became 4,250 hectare. While the years 1990 - 2004 the depth average of the Limboto Lake is 2.5 meters with the large area of 3,000 hectare. The siltation of Limboto Lake was mainly caused by erosion and sedimentation due to agricultural efforts that did not heed the conservation of land and forest logging activities (illegal logging) in the upstream area (water catchment), especially in the Limboto watershed. Because of the siltation of Limboto Lake, most of the areas that used to be lakes turned into residential settlements or converted into agricultural businesses [1].

Eutrophication and water pollution are environmental problems that affect the waters of the lake in general where the consequences will affect the survival of human life. Therefore, the problem around Limboto Lake currently is the uncontrolled growth of water hyacinth, poison fishing (Potassium Chlorida), fish bombs and large-scale fishing devices that have caused a decrease in the genetic diversity of fish and other aquatic organism, and decreased lake water quality.

The conditions that occur at this time are inseparable from the activities of the surrounding communities such as shifting cultivation activities that have been going on for a long time. As a result, environmental damage was marked by erosion, flooding during the rainy season, and drought in the dry season in the Gorontalo Province in the last 2 years. The direct effect that occurs in waters of Limboto Lake is silting and eutrophication because of increasing nutrients and pollutants into the bodies of the lake waters. The fast process of eutrofication and sedimentation in Limboto Lake has
caused the main function of the lake to decrease, such as a flood damper in the rainy season and a provider of water in the dry season, as well as a habitat for several species of fish. Based on these problems, the research was carried out with the title trophic status of Limboto Lake in Gorontalo Province.

2. Method
2.1. Research Locations
This research was conducted at Limboto Lake with take measurements of some parameters the quality of water in 8 (eight) station and testing the other parameters of water quality carried out in Laboratory Manado Research and Standardization Research Centre.

![Figure 1. Map of sampling location](image)
Table 1. The Condition of Water Sampling

| Station | Location   | Position            | Description                        |
|---------|------------|---------------------|------------------------------------|
| Tabumela| Village    | N 0° 36’ 25,10"    | Outlet Limboto Lake                |
| Hutuo Village | Village | N 0° 36’ 12,09"    | Agriculture Area                   |
| Dembe   | Village    | E 122° 59’ 39,13"  | Central Cage and Fisheries         |
| Lekobalo| Village    | E 122° 59’ 38,67"  | rumpon activity                    |
| Lupoyo  | Village    | E 123° 00’ 01,07"  | Housing Area                       |
| Kayu Bulan | Village | N 0° 36’ 02,43"    | Water Hyacinth Area                |
| Hunggaluwa | Village | E 123° 00’ 24,09"  | Water Hyacinth Area                |
| Hunggaluwa | Village | N 0° 35’ 54,74"    | Housing Area                       |
| Villages | Village    | E 122° 59’ 18,70"  | Estuary Biyonga River              |
| Kayu Bulan | Village | N 0° 35’ 35,10"    |                                      |
| Kayu Bulan | Village | E 122° 58’ 33,59"  |                                      |
| Kayu Bulan | Village | N 0° 36’ 25,10"    |                                      |

2.2. Sample Collection And Measurement Water Quality

Water quality parameters measured in situ consist of temperature, pH, brightness and dissolved oxygen (DO). Taking water samples is done using a point sampler at a depth of 5 meters from the surface water. Water samples that have entered the point sampler are transferred to the sample bottles which have been labeled according to the sampling station. The sample bottle containing the water sample is wrapped in aluminum foil and stored in the coolbox so that the water sample is protected from bacterial contamination and the sample water quality conditions do not change the sample.

2.3. Measurement Water Quality in the Laboratory

Parameters of water quality measured in the laboratory consist of phosphate, nitrate, ammonia, chlorophyll-a, and Biological Oxygen Demand. The water from 8 (eight) station sampling analysed to each parameters.

a. Phosphate Analysis
   Testing the level of phosphate in water using spectrophotometry was carried out with a method of ascorbic acid.

b. Nitrate Analysis
   The sample was put into a tube reaction as much as 5.0 ml. and Bruchine solution was added as much as 0.5 ml. After that, a concentrated Sulfuric Acid (H₂SO₄) solution was added as much as 5 ml, then the nitrate content was measured using a spectrophotometry with a wavelength of 420 nm.

c. Ammonia Analysis
   Ammonia analyzed by using the method of the spectrophotometry fenat at wavelengths 640 nm.

d. Chlorophyll-a Analysis
   Measurement of chlorophyll-a were carried out by filtering water sample using whatman paper and than checking absorbance with a spectrophotometry at wavelengths 750 and 665 nm.
2.4. Data Analysis

To determine the trophic status of waters in Limboto Lake are calculated using the Trophic State Index (TSI) of Carlsons. Based on the absorption of radiation energy by different atoms at the basic power level. The formula of average Trophic State Index (TSI)

\[
\begin{align*}
TSI-P &= 14.42 \times \ln[TP] + 4.15 \, (\mu g/l) \\
TSI-Cla &= 30.6 + 9.81 \times \ln[Chlor-a] \, (\mu g/l) \\
TSI-SD &= 60 - 14.41 \times \ln[Secchi] \, (meters)
\end{align*}
\]

\[
Average \, TSI = \frac{(TSI - P + TSI - Cla + TSI - SD)}{3}
\]

Based on the TSI value obtained, trophic status of water classified into the ultra oligotrophic (<30), oligotrophic (30-40), mesotrophic (40-50), eutrophic (50-60), heavy eutrophic (60-70), hypereutrophic (70-80) and algae scum (>80).

3. Results And Discussion

3.1. Trophic Status of Limboto Lake

The results of the study show that the average value of the Limboto Lake Trophic State Index (TSI) of range from 50.3071 – 61.9297. This shows that the trophic status of waters in Limboto Lake is classified as eutrophic, that is, lake water contains high levels of nutrients, this status indicates that water has been polluted by increasing levels of nitrogen and phosphorus. This is in accordance with the opinion of Horne and Goldman [2] that waters are categorized as eutrophic if they have high nutrient depth of less than 10 meters. The high nutrient content causes abundant aquatic organisms, marked by algae blooms. Florida Lakewatch [3] which states that an eutrophic waters containing chlorophyll 25 mg/m³ can interfere with the lives of other aquatic organisms which can further disrupt the designation of the water body.

| Station | TSI TP (μg/l) | TSI Chlorophyll (μg/l) | TSI SD (m) | TSI Carlson |
|---------|--------------|------------------------|------------|-------------|
| 1       | 29.9872      | 53.5731                | 67.3610    | 50.3071     |
| 2       | 60.8469      | 58.9545                | 65.9876    | 61.9297     |
| 3       | 41.1366      | 55.6864                | 69.9883    | 55.6037     |
| 4       | 43.2001      | 55.5331                | 67.3610    | 55.3647     |
| 5       | 35.8340      | 59.9881                | 71.1898    | 55.6706     |
| 6       | 45.8292      | 58.1010                | 70.8799    | 58.2700     |
| 7       | 42.2052      | 56.5590                | 70.2794    | 56.3479     |
| 8       | 39.9824      | 62.6371                | 71.8303    | 58.1499     |
3.2. Water Quality

Table 3. The Condition of Water Quality Limboto Lake

| Parameters | Unit | Station | Quality Standard |
|------------|------|---------|------------------|
|            |      | 1 2 3 4 5 6 7 8 |                  |
| Temperature| °C   | 31 34 30 30 31 32 33 32 | 20-30            |
| pH         |      | 8.1 8.5 8.4 8.3 8.5 8 8 8.1 | 6-9              |
| DO ppm     |      | 14.4 19.8 14.6 9.8 18.7 10.3 11.8 12.3 | 4                |
| BOD ppm    |      | 13 13 7 7 7 26 40 50 | 3                |
| Nitrate ppm|      | 3.52 4.87 3.51 3.33 3.76 4.59 4.6 4.45 | 10               |
| Ammonia ppm|      | 0.060 0.028 0.024 0.0011 0.021 0.031 0.057 0.017 | 0.02             |

The result measurement of water quality (temperature, pH, and Dissolved Oxygen) in Limboto Lake ranged from 30-34 °C, 8-8.5 and 9.8-19.8 ppm. The pH conditions of Limboto Lake waters still in the normal range according to quality standards of PPRI No. 82 in 2001 for class II for freshwater aquaculture while temperature and DO have passed the standard quality standards of PPRI No. 82 of 2001 [4].

The result measurement of water quality (Biological Oxygen Demand, nitrate and ammonia) in the laboratory ranged from 7-50 ppm, 3.33-4.87 ppm, and 0.0011-0.06 ppm. The condition of biological Oxygen Demand in waters Limboto Lake had passed the quality standard of PPRI No. 82 in 2001, while nitrate and ammonia will continue to be around normal of quality standard by PPRI No. 82 in 2001.

The water quality in Limnoto Lake is very important to know, because Limboto Lake is one of waters potential to experience environmental changes due to the disposal of agricultural waste, industrial waste and household waste. Water quality plays an important role for the organism's ability to maintain its life [5].

Conclusion

Trophic State Index (TSI) of a Limboto Lake range 50.3071 – 61.9297 so trophic status waters of Limboto Lake is classified as eutrophic.

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