Water quality assessment based on biological and chemical analysis as a parameter for development of fresh water fishery in Lubuk Karet River of Banyuasin District

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Research Paper

Water quality assessment based on biological and chemical analysis as a parameter for development of fresh water fishery in Lubuk Karet River of Banyuasin District

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Abstract

Lubuk Karet River is a river that surrounded by swamps with various kinds of plants and grasses. The Lubuk Karet River has the potential for the development of aquaculture which can be the business part of Lubuk Karet village community. This research was aimed to conduct an assessment effort in order to measure the capability of Lubuk Karet River for any aquaculture activities. The method used in this study is purposive sampling by conducting water quality assessment through biological and chemical parameters to support the development in that region. The results of this test can be a benchmark of fish species that can be cultivated in the Lubuk Karet River. The results of the chemical and biological parameters showed that the lowest DO content at station 2 was 3.11 mg/L and the highest BOD content at station 1 was 4.7 mg/L, the highest at station 1 was 606 mg/L, the highest TSS content 50 mg/L, the highest nitrate content at station 1 was 6,54 mg/L, the highest phosphate content at station 2 was 0.098 mg/L, the highest COD content at station 2 was 5,61 mg/L, Salinity was 0, the highest content at station 2 was 9,71 mg/L and the lowest pH value at station 5 was 2.96. From these results, it can be concluded that for further utilization for aquatic culture, some treatments must be conducted.

Keywords
river, exploration, fishery, chemical parameter, biological parameter

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1. INTRODUCTION

The Lubuk Karet river was surrounded by swamps and various plants such as Kumpai grass (Hymenachine amplexicaulis), Gelam (*Melaleuca sp.*), and nipah (*Nypa fruticans*). The area of swamp that surrounds the Lubuk Karet River ranges from 20-40 m^2. Swamps in the Lubuk Rubber River have the potential for the development of agricultural and fishery activities where the ownership of the land belongs to the government of Lubuk Karet village. Hence, it can be utilized by residents around the river that is domiciled in Lubuk Karet Village.

Most of the people around the Lubuk Karet River work as farmers and fishermen. The existence of the river can be utilized by the surrounding residents. Utilization of aquatic resources optimally and continuously can be developed to support the fishery sector in Lubuk Karet River. Fish cultivation in a cage can be used as one alternative source of income to improve the welfare of the community who generally work as farmers and fishermen. Water quality is the main factor that can influence optimal and sustainable fish management. The survival, development, growth and production of fish that can support the activities of fish cultivation in the cage (Cholik et al., 1986).

Considering the importance of the role of water quality to fishery activities in the Lubuk Karet River, hence the effort for assessing the water quality must be conducted. In this work, the water quality of the Lubuk Karet River was assessed according to the chemical and biological parameters. The chemical parameter assessment was carried out by measuring the dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solid (TDS), total suspended solid (TSS), salinity, ammonium content, and pH. The biological parameters analysis was carried out by measuring the diversity of fish, plankton, and bentos.

The goal of this research was to identify the characteristic of water quality of Lubuk Karet River. The results obtained from this research is hoped to be a reference and a benchmark for the exploration of the fish species that can be cultivated in the Lubuk Karet river.

2. EXPERIMENTAL SECTION

2.1 Research Location

This research was conducted in Lubuk Karet river located in Lubuk Karet village, Betung subdistrict of Banyuasin, South

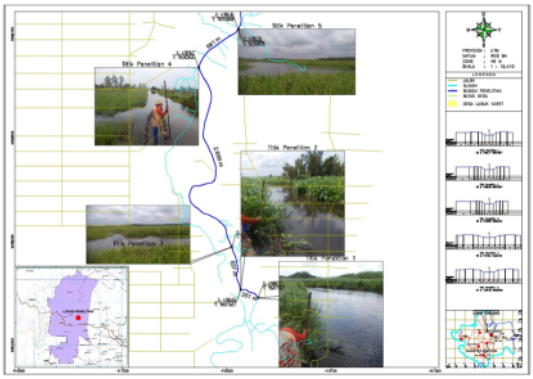

Figure 1. Sampling location

Sumatra (Figure 1). The whole research samples were collected on June to July 2017 at the rainy and dry season.

2.2 Materials and Instrumentation

Materials used in this work including various kinds of chemical for water quality test. The DO analysis was conducted using DO meter ES-70, BOD analysis was conducted in the environmental agency (BLH) laboratory of Banyuasin district. pH value of the water samples was measured with Lutron PH 222 instrument. The biological parameters of plankton and benthos was collected using plankton net and the sampling location was determined using GPS Garmin Map 62Sc.

2.3 Method

The research method used in this work was a survey method that used a purposive sampling. The determination of station conducted by considering the properties of the river that represented the whole river that will be used as fisheries activities). For the data survey, the tabulation and regression and direct sampling at the stationary points and direct observation in the field, data collection and laboratory analysis based on insitu and exsitu method. The variables used in this work including water quality based on the chemical and biological analysis. The chemical analysis of the samples including DO, CO2, BOD, TDS, TSS, nitrate, phosphate, COD, salinity, and ammonium content analysis. The biological analysis was conducted by analyzing the presence and the abundance of fish, plankton, and benthos in the collected water samples. Water sample collection was divided into five observation stations in which the distance of each station was ±6 km and each station was named as station 1, 2, 3, 4, and 5.

2.4 Analysis of plankton data

Identification of plankton diversity in the collected sample was conducted in the lab with the accuracy of the analysis was determined to the genus stage. The procedure of the plankton analysis was conducted as follow. The bottle containing plankton sample was shaken gently until homogenous. Then the sample solution was taken using a pipette and dropped to the Sedgwick Rafter Counting Cell with maximum capacity 1 mL. The observation of the sample then carried out using a microscope with magnification 10 x 10 mL.

2.4.1 Plankton abundancy analysis

The plankton abundancy was described as the individual per liter. The plankton abundancy can be measured by the following equation (Junaidi et al., 2013):

$$N = \frac{N_s \times v_a}{V_s \times v_c} \quad (1)$$

Where N is the plankton abundancy per liter of sample (ind./L), N_s is the amount of plankton at the Sedgwick Rafter Counting Cell (Individual), v_s is the volume of water at the Sedgwick Rafter Counting Cell (mL), v_a is the volume of water concentrated in the sample bottle (mL), and v_c is the volume of filtered water (L).

2.4.2 Species diversity index

The index of species diversity was calculated according to the following equation.

$$H^1 = -\sum p_i \ln p_i \quad (2)$$

Where p_i is equal with ni/N. N is the number of total individual in the community. H^1 is the diversity of species or Shanon index and Ni is the number of individual of each species. The value of H^1 then grouped in the the following criteria. $H^1 < 1$ means that the biota community is not stable. $1 \leq H^1 \leq 3$ means that the biota community in average of stability. $H^1 > 3$ means that the biota stability is in good condition or highly stable.

2.4.3 Domination index

The domination index of Simpson can be described by the following equation.

$$C = -\sum (p_i)^2 \quad (3)$$

Where pi equal to ni/N, C is the domination index, ni is the number of individual of each species. N is the number of total individual within the community. The value of C can de separated according to the following criteria. The value of C between 0 to 1, if the C value approaching zero, it means that there is no dominating species. However, if the C value is approaching 1, it means that there is a dominating species.

3. RESULTS AND DISCUSSION

3.1 Assessment of water quality in Lubuk Karet River

The assessment of water quality in the Lubuk Karet river was carried out by two kinds of parameter i.e., chemical and biological parameters. All of these water quality assessments were

conducted in the two season, rainy season and dry season. This test is conducted to study the water quality of the Lubuk Karet River and the potential of fisheries that can be developed in the river.

3.1.1 Chemical parameter analysis

The content of DO on the Lubuk Karet River shows that some types of fish are able to develop well. There are several types of fish that can survive with low DO content. Some fish can live well on oxygen content of less than 4 ppm, especially fish that have additional breathing apparatus. This extra breathing apparatus helps the fish take oxygen directly from the air. Catfish (*Clarias, sp*), Three spot gourami fish (*Trichogaster, sp*), snakehead fish (*Chana striata*) and gouramy (*Osprhronemus gourami*) are fish with additional breathing apparatus (Effendi, 2003).

The results of BOD parameter analysis in the study sites showed a range of values of 1.6 mg/L - 4.7 mg/L. The results obtained in the study are still above the water quality standard specified for freshwater fish activities according to the standard quality of PERGUB LH. NO. 16. YEAR 2005. According to Zonneveld (1991) states that the standard content of BOD in a water for freshwater fish is 6 mg/L, good for the continuity of fish farming activities.

The content of TDS in the Rubber Lubuk river as a whole has an excellent value for fish farming with a range of 51 mg/L - 606 mg/L. The content of TDS in the river Lubuk Karet is included in the value of quality standards. PERGUB LH.No.16.Tahun 2005 states the requirement of TDS content does not exceed 1000 mg/L. In accordance with Khairuman and Amri (2003) also states the range of TDS for fish cultivation activities that is 1000 mg/L where the value of good TDS can support the activities of aquaculture.

3.1.2 TSS (Total Suspended Solid)

The content of TSS in Lubuk Karet river has a value between 5 mg/L - 50 mg/L where the content of TSS is still good. PERGUB.LH.NO.16. Year 2005 states maximum content for TSS 20 mg/L. So the value of TSS in the river lubuk rubber can be said good and feasible for aquaculture where the content of TSS can support the phytoplankton life process. High concentrations of suspended solids greatly reduce the penetration of sunlight into the water so that the heat received by surface water is not effective enough for photosynthesis (Tarigan, 2010).

3.1.3 Nitrate content

The content of nitrate in the highest dry season at station 5 is 0.199 and the lowest at station 3 is 0,094 mg/L. In the rainy season, the highest nitrate content at station 1 is 6.54 mg / L and the lowest at station 4 is 2.07 mg/L. From the existing content of both dry and rainy season can still be said to be good category according to quality standard for aquaculture (PERGUB.LH.NO.16.2005) .The level of nitrate toxicity of fish is very low, mortality caused by fish when the concentration reaches 1000 mg/L, while the maximum value of concentration for fish culture is 60 mg/L according to wyk F. and scarpa (1999).

Phosphate content in rainy season and dry season in Lubuk Karet River is the highest in station 2 with value 0,098 mg/L and in rainy season there is at station 3 with value 0,081 mg/L. In dry season the lowest phosphate content is found in station 3, that is 0,014 mg/L and in rainy season at station 1 is 0,015 mg/L. The results of calculations during the rainy and dry seasons indicate that the value of phosphate quality standard in the waters of river lubuk rubber is included in the quality standard (in accordance with the standard quality standards according to PERGUB.LH.No.16. Year 2005). According Nuryanto et al. (2015) suggests that the phosphate content of more than 0.051 mg/L then the waters can be said to be good.

The highest COD value during the rainy and dry season is at station 2 with a COD content of 56.1 mg/L and at station 1 with a content of 44.7 mg/L. The lowest COD value in the rainy season is at station 3 of 29 mg/L and at station 3 of 4.48. The high value of COD at the research station is influenced by several factors: organic material that is not degraded or decomposed, one of which comes from the crude oil processing industry (CPO), in other words the source of organic material is derived particles that precipitate from the surrounding swamp empties into the river. According Nuryanto et al. (2017) industry is the main source of organic waste and is the main cause of high concentrations of COD in a waters.

Meanwhile, according to Yusuf and Handoyo (2004) the COD value for aquaculture is < 80 mg/L and ideally < 25 mg/L. The value of quality standard for COD according to PERGUB LH.NO.16 Year 2005 is less than 50 mg/L, this indicates that the COD content in the lubuk rubber river is good for aquaculture.

3.1.4 Salinity

The salinity value on the measurements of each sample and season shows the salinity content value of 0 mg / L. The results of this calculation indicate that the Lubuk Rubber River is not affected by salinity of sea water. According to Novotny and Olem (1994) salinity in waters is affected by heat flux, precipitation, river flow (flux) and current circulation patterns. Salinity according to Boyd (1982) based on the ability of fish that adjust to certain salinity, can be classified into fish that have a small salinity tolerance (stenohaline) and fish that have a wide salinity tolerance (euryhaline). According to PERGUB LH.no 16 Year 2005 salinity value in lubuk karet river during the rainy season included in the quality standard that is 0 whereas in dry season the salinity value is 0.1 which is still tolerable fish which categorized have very small salinity tolerance.

3.1.5 Ammonium content

Ammonia content during the highest rainy season at station 1 is 2.73 mg / L and the lowest ammonia content at station 4 is 0.106 mg / L. Ammonia content during the rainy season has a linear regression value above 0.5 or close to 1. This indicates that the ammonia content in the Lubuk Karet River has a rela-

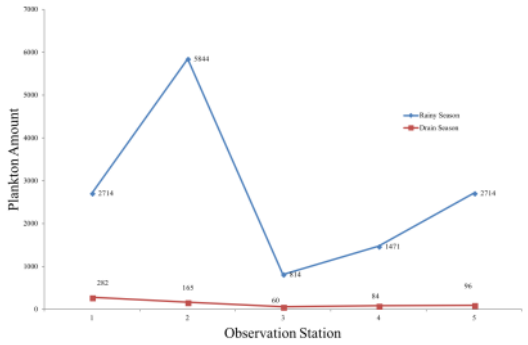

Figure 2. Amount of plankton in the rainy and drain season

onship between station 1 to station 5. During the dry season the highest value at station 2 is 9,71 mg / L and the lowest ammonia content at station 4 is 0,092 mg / L. Ammonia content in Lubuk Karet River is not included in the quality standard for aquaculture. According to Tarigan (2010) the factors affecting ammonia in waters are influenced by organic matter, dissolved oxygen and turbidity. This increased ammonia compound, will increase the growth and density of phytoplankton. The high density of phytoplankton leads to an explosion in population (blooming), followed by die-off of phytoplankton. Events of population explosions and mass mortality of phytoplankton will worsen the quality of river water. Decreasing the quality of river water can also spur the emergence of various diseases in fish.

The highest pH value during the rainy season is 5.68 at station 1 and the lowest at station 5 is 4.74. The pH value during the highest dry season at station 1 is 6.48 and the lowest at station 5 is 2.96. The pH value in Lubuk Karet River does not meet the established quality standard for aquaculture. At the point of station 1 dry season entering for the standard of aquaculture cultivation. The pH value of the Lubuk Karet River is influenced by the concentration of gases in rivers such as CO_2, the concentrations of carbonate and bicarbonate salts and the decomposition of organic matter in the bottom of the waters. Naturally, the pH of the waters is influenced by the concentration of carbon dioxide (CO2) and acidic compounds. Changes in pH become sensitive to most aquatic biota. Aquatic organisms prefer pH to neutral pH (Novotny and Olem, 1994).

3.2 Biological Parameters Assessment

The number of plankton during the highest rainy season at station 2 is 5844 species and the lowest number of plankton at station 3 is 814 species, the number of plankton in the Lubuk Karet River is different in the dry season. In the dry season the highest number of plankton at station 1 is 282 species and the lowest number of plankton at station 3 is 814 species. The number of plankton itself is influenced by various factors both physics and chemistry as shown in Figure 2.

The composition of plankton found in the dry season in the Lubuk Karet River consists of Zooplankton and phytoplankton. Zooplankton was found to consist of five classes: Mastigophora, Crustacea, Ciliata, Monogononta and Digononta, while Phytoplankton was found to consist of three classes: Bacillariophyceae, Cyanophyceae and Chlorophyceae. Plankton composition in the dry season more than in the rainy season. Seen in the dry season found eight classes consisting of Zooplankton and phytoplankton, but in the rainy season has more individual numbers of 13,557 individuals when compared to the dry season that only found as many as 687 individuals. Fluctuations in the presence of plankton in the Lubuk Karet River show that the season is very influential. As Barus (2004) points out, the seasons will affect environmental factors such as temperature, dissolved oxygen and current velocity, so that with seasonal changes it may also affect biota conditions in the area.

The degree of diversity in the observations of each station can be seen in stations 1 and 3 where high phytoplankton diversity with values of 1.838 and 1.680 is inversely proportional to the low zooplankton values of 1.4075 and 1.0728. The diversity value at the high zooplankton station is 1.5614 and the value of the phytoplankton diversity of 0.713, the value can be interpreted the diversity of phytoplankton and zooplankton affect each other by each other. The value can be suspected that there are some high-diversity phytoplankton to zooplankton type which resulted in unstable plankton level existing in the observation station. At stations 2 and 5 the values of phytoplankton and zooplankton are more stable with each other ie 1.0734 and 1.5614. This is thought to be influenced by the presence of phytoplankton in these waters, in the food chain phytoplankton to be a source of food for zooplankton either directly or indirectly. Zooplankton which is heterotrophic will eat phytoplankton directly, while indirectly zooplankton herbivor will be eaten by zooplankton carnivores and other animals of larger size, including fish (Nuryanto et al., 2015).

The level of diversity in the observation of each station can be seen in station 2 where the high phytoplankton diversity with the value of 0.637 and zooplankton value 0. At stations 1, 4 and 5 the phytoplankton values are 0.803, 0.637 and 1.721. This is thought to be influenced by the presence of phytoplankton in these waters, in the food chain phytoplankton to be a source of food for zooplankton either directly or indirectly. Zooplankton which is heterotrophic will eat phytoplankton directly, while indirectly zooplankton herbivor will be eaten by zooplankton carnivores and other animals of larger size, including fish (Nuryanto et al., 2015).

3.3 Fish Diversity

Observations show that there are twelve species of fish found in the Lubuk Karet River of the whole species, meaning that the Lubuk Karet River has a high diversity of fish species. The results show the number of fish species ≥16. That number proves that fish species found in the Lubuk Rubber River are high. This is directly proportional to the statement of Nuryanto et al. (2015) that high species diversity can be ensured that support of good water quality.

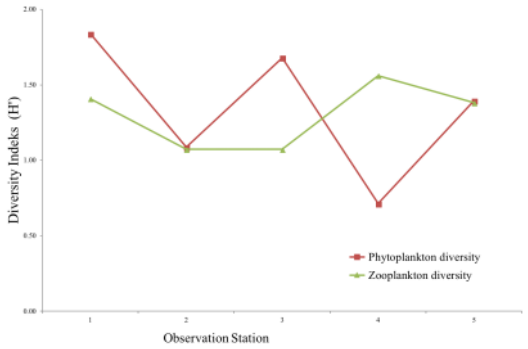

Figure 3. The comparation of diversity index of phytoplankton and zooplankton at the rainy season

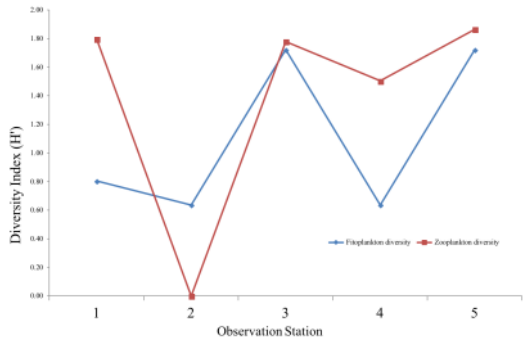

Figure 4. The ralationship of diversity index between phytoplanton and zooplanton

From the observations made in the river lubuk rubber the data obtained is inversely proportional to the statement of Nuryanto et al. (2017), the low diversity of fish species present in the Lubuk Karet River is influenced by several factors such as the declining quality of water by palm oil industry waste, pesticides and herbicides as well as fertilization in oil palm plantations during rainfall will affect water quality due to emptying into Lubuk Rubber River and catching fish using environmentally unfriendly tools (potassium poison) based on interviews with residents around the Lubuk Karet river it can be concluded that River Rubber holes are low in number of species.

4. CONCLUSIONS

From the results of observation and sampling field found only 12 species of fish. This is categorized as a river that has a low variety of fish species. Plankton from the observed samples taken were found from class 3 phytoplankton and 5 class zooplankton. From result of measurement of water quality of chemical parameter of Lubuk Rubet River both in rainy season and dry season show not included in standard class III standard in accordance with PERGUB LH 2005 for fishery cultivation. The results of the analysis indicate that the Lubuk Karet River needs water quality processing before conducting aquaculture. This treatment aims to produce optimal fish farming. Types of fish with tolerant values of low water quality conditions can be cultivated in the Lubuk Karet River. Types of fish such as catfish are the species that can be cultivated in the Lubuk Karet river.

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