Mapping of Water Quality as Aquaculture Media, Comparative Study on Three Rivers in Riau Province

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Abstract. Kampar River, Siak River, and Rokan River have different watersheds, and the water from these rivers is not interconnected. The results of this study can be used as a basis for managing aquatic resources in the Kampar River, Siak River, and Rokan River, Riau Province, Indonesia. This research was conducted in April 2017 – March 2018. The collection and measurement of water quality for each river consisted of three stations which were carried out based on SNI through the survey method twice, namely in the dry season and rainy season. The observed water quality parameters include physical, chemical, and biological parameters. The results of the next analysis are calculated using the STORET method using a value system from the United State-Environmental Protection Agency (US-EPA) which is adjusted to the Class III Water Quality Standard based on PP. 22 of 2021. The results of the analysis of the rain index value in the highest dry season is a score of -44 on the Rokan River, classified as class D with a score of -31 heavily polluted. The STORET score in the Kampar River and Siak River obtained -24, each classified as Class C, is included in the moderately polluted category. Meanwhile, in the rainy season the pollution index with the same pattern is highest in the Rokan River -40, then Kampar River, and Siak River each -20. The water quality standard used in this study is class III because it still supports fish farming activities. Based on Government Regulation Number 22 of 2021 concerning water quality standards, class III is water whose designation can be used for freshwater fish aquaculture, animal husbandry, and gardens irrigation. The Storet method is carried out by collecting water quality data and measuring data from each water parameter compared to the value of class III water quality standards.

1. Introduction
Riau waters on the island of Sumatra have four major rivers, namely the Kampar River, Siak River, Rokan River, and Indragiri River. Geographically, Kampar River, Siak River, and Rokan River have different watersheds. The three rivers have the same characteristics, which are influenced by the flow of peat swamps. The river flows from the Bukit Barisan plateau which stretches on the border between Riau Province and West Sumatra Province to the east and empties around the Malacca Strait. These rivers function as transportation infrastructure, inland fisheries, irrigation, energy sources, and source of drinking water.
Kampar River, Siak River, and Rokan River have different watersheds, and the water from these rivers is not connected. The types of fish that have potential and have high economic value live and develop in the river so that they can support the fishing activities of fishermen [1]. In addition to fishing activities, these rivers are also often used as a medium for carrying out aquaculture activities such as floating net cages or KJA.

The flow of the Kampar River, Siak River, and Rokan River is very long and passes through various vegetation and topographic characters as well as varied utilization patterns. All of these factors are expected to give rise to differences in water quality between each river. Information about the quality of these waters is very important to know so that fishing activities carried out in these rivers can be carried out properly. This can provide information about the feasibility of water bodies from rivers that will be used as a medium for aquaculture activities. The results of this study can be used as a basis for the management of aquatic resources in the Kampar River, Siak River, and Rokan River, Riau Province, Indonesia.

2. Material and Methods

This research was conducted in April 2017 – March 2018. The collection and measurement of water quality for each river consist of three stations. This number is expected to represent the state of the river. Kampar River Station I Coordinates 00°22'12.85''N and 101°54'40.34'' East Longitude, Station II Coordinates 00°22'37.31''N and 101°54'54.59'' East Longitude, Station III Coordinates 00°22'13.64''N and 101°54'11.97'' East Longitude. Siak River Station I coordinates 00°40'43.58''N and 101°17'05.37'' east longitude, Station II coordinates 00°41'10.55LU and 101°16'51.64'' east longitude, Station III coordinates 00°39'22.28''N and 101°17'28.67'' east longitude. Sungai Rokan Station 1 coordinates 01°22'44.78''N and 100°58'36.51'' East Longitude, Station II coordinates 01°22'33.65'' North Latitude and 100°58'29.76'' East Longitude, Station III coordinates 01°22 '16.76'' N and 100°58'21.85'' East.

Measurement of water quality at each observation station was carried out based on SNI [2], [3] through the survey method twice, namely in the dry season and the rainy season. The observed water quality parameters include physical, chemical, and biological parameters. Laboratory analysis was carried out at the Laboratory of Ecology and Aquatic Environmental Management, Faculty of Fisheries and Marine Sciences University of Riau.

The materials used in this study were samples of Kampar River, Siak River, and Rokan River, MnSO₄, NaOH+KI, H₂SO₄ 8N, starch, (C₆H₁₀O₅)n, Na₂S₂O₃, Phenolphthalein (PP), Na₂S₂O₃ [3], Lugol 5%, Sodium Carbonate, biuret, and other chemicals [3]. The equipment to be used in the research includes BOD bottles, dropper, syringe, GPS, Sechi disk, Plankton net, DO meter, a set of glass equipment for water chemical analysis, van dorn water sampler, coolbox, thermometer, pH meter, spectrophotometer (SCILOGEX SP-V1100), microscope (Olympus SZ51), and Atomic Absorption Spectrometry (AAS) namely DW-AAS-200 and other equipment. Information about the measured parameters, tools, methods, units, and locations in this study is presented in Table 1.

Table 1. Method of measuring physical, chemical, and biological parameters of water

| Parameter              | Tools                | Methods                          | Unit   | Place  |
|------------------------|----------------------|----------------------------------|--------|--------|
| **Physics**            |                      |                                  |        |        |
| Temperature            | Thermometer          |                                  | °C     | Insitu |
| Turbidity              | Turbidity meter      | SNI 06-6989.11-2004              | NTU    | Insitu |
| Depth                  | wandscale            |                                  | M      | Insitu |
| Current velocity       | Buoys and ropes      |                                  | M/dt   | Insitu |
| Light intensity        | Secchi disc          |                                  | cm     | Insitu |
| Parameter        | Tools         | Methods         | Unit    | Place   |
|-----------------|---------------|-----------------|---------|---------|
| TDS             | Oven          |                 | mg/l    | Exsitu  |
| TSS             | Oven          |                 | mg/l    | Exsitu  |
| Conductivity    | TDS meter     | Electrochemistry| µs/cm   | Exsitu  |
| pH              | PH meter      | SNI 06-6989.11-2004 | - | Insitu  |
| Carbon dioxide  | Erlenmeyer    | SNI 06-2420-1991 | mg/l    | Exsitu  |
| Dissolved Oxygen| BOD Bottle    | SNI 06-6989.14-2004 | mg/l    | Insitu  |
| BOD             | BOD Bottle    |                 | mg/l    | Exsitu  |
| COD             | BOD Bottle    |                 | mg/l    | Exsitu  |
| Nitrate         | Spectrophotometer | Brucine    | mg/l    | Exsitu  |
| Phosphate       | Spectrophotometer | Sthannous chloride | mg/l    | Exsitu  |
| NH₃             | Spectrophotometer | Phenate   | mg/l    | Exsitu  |

**Chemical**

**Biology**

| Parameter       | Tools         | Methods         | Unit      | Place     |
|-----------------|---------------|-----------------|-----------|-----------|
| Plankton Density| Plankton net  |                 | Magguran, 1991 | Individual/l | Exsitu |

The results of laboratory analysis and calculations in the field are then tabulated and calculated using the STORET method using a value system from the United State-Environmental Protection Agency (US-EPA) [4] which is adjusted to the Class III Water Quality Standard based on Government Regulation No.22 of 2021, descriptive to determine the condition of the waters. According to the STORET method, the classification of water quality status is divided into four classes, namely:

- **Class A**: Very Good, Score = 0 (meets quality standards),
- **Class B**: Good, Score = -1 to -10 (lightly polluted)
- **Class C**: Medium Score = -11 to -30 (medium polluted)
- **Class D**: Poor Score = >-31 (severely polluted)

Biological parameters are plankton species composition (P), the diversity index (H'), similarity index (E), and dominance index (C) (Appendix 10). The composition of the type of plankton (P) in the three research locations is a comparison of the number of individuals of each species with the number of individuals of all species from the plankton samples that were captured [5], then analyzed using the formula [6] namely:

$$P = \frac{n_i}{N} \times 100\%$$

Information:
- P = Species Composition (%)
- nᵢ = Number of Individuals of each Type
- N = Number of Individuals of All Kinds

The species diversity index (H') is calculated based on the Shanon Wiener equation [6], namely:

$$H' = - \sum_{i=1}^{n} p_i \log_2 p_i$$

Information:
- H' = Shanon-Wiener diversity index
\[
\frac{N_i}{N} = \text{Number of individuals of the } i\text{-th type of species} \\
S = \text{Number of species}
\]

Based on [6] the classification of species diversity values is as follows; \( H>4 \), it is classified as high species diversity; \( 2<H<4 \), diversity is moderate; and \( H<1 \) diversity is low.

The similarity index \( (E) \) which increasingly shows an almost uniform and even abundance between species [6], the equation of the similarity index is as follows:

\[
C = \sum \frac{n_i^2}{N^2}
\]

Information:
- \( C \) = Simpson's Dominance Index
- \( N \) = Number of individuals of all species
- \( N_i \) = Number of individuals of the \( i\)th species

The dominance index category \( C \) value close to zero (0) means low dominance, no species dominate other species and the community structure is in a stable state. If tilapia \( C \) is close to one (1), it means that the dominance is high or there is a species that dominates other species and the community structure is unstable, due to ecological pressure (stress).

### 3. Results and Discussions

The measurement results of the analyzed physical, chemical, and biological parameters are presented in Table 2.

#### Table 2. The measurement results of the analyzed physical, chemical, and biological parameters

| Parameter                | Kampar River | Siak River | Rokan River | Government Regulation No. 22 of 2021 |
|--------------------------|--------------|------------|-------------|-------------------------------------|
|                          | dry season   | rainy season | dry season | rainy season | dry season   | rainy season |                           |
| **Physics**              |              |            |             |             |              |             |                           |
| Temperature              | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | D |
| Light intensity          | 60.6 | 64.25 | 56.2 | 62.25 | 47.75 | 60.75 | 34.80 | 3.06 | 47.8 | 63.5 | 49.7 | 57.0 |
| Turbidity                | 11.88 | 12.70 | 1.44 | 1.98 | 32.62 | 38.28 | 36.2 | 45.8 | 20.15 | 47.75 | 20.74 | 29.0 |
| Current velocity         | 0.05 | 0.07 | 0.06 | 0.12 | 0.10 | 0.38 | 0.29 | 0.33 | 0.13 | 0.44 | 0.31 | 0.56 |
| TSS                      | 13 | 28 | 3 | 8 | 8 | 21 | 12 | 27 | 28 | 34 | 8 | 13 | 400 |
| TDS                      | 5 | 971 | 108 | 165 | 77.7 | 90 | 47 | 91 | 146 | 164 | 50 | 116 | 1000 |
| Conductivity             | 22 | 77 | 0.10 | 0.11 | 46 | 52 | 0.00 | 0.13 | 56 | 62 | 0.10 | 0.20 |                           |
| **Chemical**             |              |            |             |             |              |             |                           |
| \( \text{pH} \)          | 5 | 6 | 5 | 5 | 5 | 6 | 5 | 4 | 5 | 3 | 5 | 6 s/d 9 |
| Oxygen                   | 6.5 | 7.32 | 3.71 | 3.89 | 4 | 5.2 | 6 | 6.6 | 3.6 | 4.4 | 5.5 | 7.46 | 3 |
| \( \text{CO}_2 \)        | 39.33 | 49.22 | 3.0 | 4.5 | 34.5 | 42.6 | 3.0 | 4.0 | 28.3 | 33.2 | 5.0 | 6.0 |             |
| BOD                      | 10 | 16.4* | 28.8 | 65.6* | 10.4 | 16.4* | 10.6 | 22.8* | 12.3 | 16.4* | 70.4 | 76.8* | 6 |
| COD                      | 25.6 | 51.2* | 2.0 | 11.0 | 22.4 | 51.2* | 10.0 | 25.0 | 38.4 | 51.2* | 5.0 | 12.0 | 50 |
| Nitrate                  | 2.40 | 6.10 | 0.61 | 0.79 | 4.24 | 4.71 | 0.42 | 0.52 | 7.94 | 0.71 | 0.79 | 0.85 | 20 |
| Phosphat                 | 0.24 | 0.41 | 0.30 | 0.37 | 0.31 | 0.38 | 0.26 | 0.29 | 1.28 | 1.43 | 1.46 | 1.60 |             |
| Ammonia (NH\(_3\))      | 0.09 | 0.17 | 0.11 | 0.20 | 0.05 | 0.13 | 0.04 | 0.21 | 0.07 | 0.17 | 0.09 | 0.14 | 0.02 |
| **Biology**              |              |            |             |             |              |             |                           |
| Plankton                 | 25000 | 36000 | 73250 | 70750 | 16750 | 18500 |                           |

\(*\text{values marked with}^*\)
Abundance

| Diversity Index | 2.30 | 2.59 | 1.85 | 1.60 | 2.51 | 2.19 |
|-----------------|------|------|------|------|------|------|
| Dominance I (C) | 0.26 | 0.25 | 0.39 | 0.44 | 0.19 | 0.29 |
| Similarity (E)  | 0.89 | 0.87 | 0.64 | 0.62 | 0.92 | 0.81 |

STORET Water Quality Status

| STORET Water Quality Status | -24 | -20 | -24 | -20 | -40 | -11s/d-30 |
|-----------------------------|-----|-----|-----|-----|-----|-----------|
|                             |      |     |     |     |     | medium    |
|                             |      |     |     |     |     | ≥-31 high |

3.1. Physics Parameter

**Temperature**
The water temperature of the Kampar River, Siak River, and Rokan River is relatively the same. During the dry season, the water temperature ranges from 29-30°C, and during the rainy season, it ranges from 29-31°C. The highest temperature is 31°C in the Kampar River in the dry season. The high temperature in Kampar waters is an open area with a river width of 200m. This is because the intensity of light from the sun is high enough to enter the water body. In addition, measurements were made at noon when the sun was not covered by clouds. Seasonal fluctuations are needed by aquatic organisms for activity and also affect the viscosity, density of water, and solubility of gases and nutrients in the water [7]. Many aquatic organisms take advantage of changes in temperature as an environmental signal for either fish spawning or the emergence of aquatic insects [8]. In general, the water temperature in the three rivers is still supportive for the life of organisms, and in the tropics, the temperature ranges from 25-32°C [9].

**Light intensity**
The light intensity of the waters of the Kampar River, Siak River, and Rokan River in the dry season, the water temperature ranges from 47.75 - 64.25 cm, and in the rainy season, the water temperature ranges from 34.80 -62.25 cm. The lowest water light intensity in the waters of the Siak River in the rainy season. The low light intensity of the waters of the Siak River may be influenced by the black color of the water, the intensity of sunlight, and the input of particles carried by rainwater. Boyd and Pillai [10] stated that the range of light intensity ranging from 30 - 60 cm is considered good enough for the life of fish and aquatic organisms. The value of the light intensity of the three river waters is still quite good for aquatic organisms.

**Turbidity**
The turbidity of the Kampar, Siak, and Rokan rivers in the rainy season ranges from 1.44 to 45.8 NTU, and in the dry season, it ranges from 11.88 to 38.28 NTU. The Siak River is highest in the rainy and dry seasons caused by soil particles carried by currents during rain, activities around the river, and characteristics of the waters. The characteristics of the waters of the Siak and Rokan rivers are peat swamps that are black water. High turbidity can disrupt the osmoregulation system and the visibility of aquatic organisms, as well as inhibit the penetration of light into the water[11]. Free carbon dioxide levels of 10 mg/L can still be tolerated by aquatic organisms, as long as it is accompanied by sufficient oxygen levels. Most of aquatic organisms can still survive until the free carbon dioxide level reaches 60 mg/L [9]. The maximum turbidity value of 25 NTU and the minimum value of 5 NTU is the turbidity tolerance value for aquatic organisms [12]. The waters of the Siak River and Rokan River are classified as unfavorable for the life of aquatic organisms because these rivers have turbidity levels exceeding the maximum value of water quality standards.

**Current velocity**
The current velocity of the Kampar, S. Siak, and Rokan rivers in the dry season is 0.05 – 0.44 ms⁻¹ and in the rainy season, the current velocity is 0.06 – 0.56 m/second. The current speed of each river varies, in the dry season the current is very slow in the Kampar River and the Rokan River with moderate currents. The rainy season has the highest speed in the Rokan River because the width of the
river surface is narrow 30 meters when compared to the other two rivers. In addition, the current velocity is also influenced by wind strength, topography, seasons, and substrate conditions at the bottom of the waters [13].

**Total Suspended Solid (TSS)**
The value of Total Suspended Solids (TSS) of Kampar River, Siak River, and Rokan River in the dry season ranges from 8 to 34 mg/L, and in the season it ranges from 3 to 27 mg/L. The TSS value tends to be higher in the dry season, but the TSS value is still within the tolerance limits of fish organisms, not exceeding the class III water quality standard which requires a TSS value of 400 mg/L. TSS values between 25 - 80 mg/l will have little impact on fishery interests, as TSS values consist of mud and fine sand and micro-organisms, which are mainly caused by soil erosion or soil erosion carried into water bodies[11].

**Total Dissolved Solid (TDS)**
Total Dissolved Solid values of Kampar River, Siak River, and Rokan River in the dry season ranged from 5-971 mg/L, in the rainy season it ranged from 47-165 mg/L. The highest and lowest TDS values are in the dry season in the waters of the Kampar River and also the highest in the rainy season. While the lowest TDS value is in the waters of the Siak River. However, in general, water conditions can still support the life of aquatic fish organisms, because they do not exceed the water quality standard based on Government Regulation No.22 of 2021, concerning water quality management and water pollution control. Class III water quality used for fishery activities requires that the TDS value (Total Dissolved Solid) is 1000 mg/L.

**Conductivity**
The conductivity value of Kampar River, Siak River, and Rokan River in the dry season ranges from 22-77 mhos/cm and in the rainy season, it ranges from 0.00 – 0.2 mhos/cm. The highest and lowest conductivity values are in the dry season on the Kampar River, because the waters of the Kampar River are still used as a means of transportation so that they tend to cause metal materials and ship fuel materials. In addition, around the waters, there are companies and residential locations. The lowest conductivity value in the rainy season on the Siak River is A. Siak River so it is not used as a means of transportation. In addition, the location of A. Sungai Siak is in an oil palm plantation area that is not densely populated. In general, the three rivers tend to be natural waters and support the life of fish organisms. The natural water conductivity values range from 20-1500 mhos/cm [14].

### 3.2. Chemical Parameter

**Degree of Acidity (pH)**
The degree of acidity (pH) of the waters of the Kampar River, Siak River, and Rokan River during the dry season ranges from 4 to 6. While during the rainy season it ranges from 3 to 5. In general, the pH values for the two observation seasons are similar. The highest pH value was in the Kampar River, followed by the pH in the Siak River and the lowest in the Rokan River. The high pH in the Kampar River is influenced by high and low tides because the location of the observation of the watershed downstream of the river empties into the Malacca Strait. The influence of tidal currents from the Malacca Strait causes the mass of seawater to enter the upstream of the river which causes an increase in the pH value from acid to alkaline. At low tide, the pH value tends to decrease due to the influence of humic acid from peat swamps upstream of the river[15]. On the other hand, the observation locations on the Siak River and Rokan River are not affected by the tides, because the location is far from the river mouth. However, the same characteristics between the Siak River and the Rokan River are influenced by the peat swamp around the river. Swamps around rivers produce humic acid from the decomposition of organic matter by microbes from the surrounding peat swamps [16].

The lowest degree of acidity is in the rainy season in the Rokan River with black water characteristics that characterize the research location. Blackwater has a unique characteristic, namely a low pH [17]. Low pH conditions in the Rokan River are thought to be one of the factors that cause stunted fish
growth because the acidity needs of an organism are not met. The pH level that supports better growth of cultured fish is the pH of neutral to alkaline water [18]. Low pH can inhibit fish growth [19].

**Dissolved Oxygen (DO)**

Dissolved oxygen was found to fluctuate by season (Table 2). The average oxygen concentration in the dry season in the Kampar River, Siak River, and Rokan River is 6.5 - 7.32; 4 - 5.2 and 3.6 - 4.4. The highest dissolved oxygen concentration was recorded in the Kampar River, while the lowest was in the Rokan River, which is a watershed close to timber companies and oil palm plantations. The company's sewerage and plantation waste enter the Rokan River. The decay of dissolved organic matter from soil caused by wastewater is the main factor affecting low oxygen concentrations [16].

The concentration of dissolved oxygen in the rainy season in the Kampar River, Siak River, and Rokan River ranged from 3.71 to 7.46. The highest oxygen concentration in the Rokan River is due to the effect of the narrow riverfront area and the observation location is at the estuary of the tributary water source entering from the main river so that stirring and mixing by strong currents at the mouth of the river causes high oxygen content. Based on Government Regulation No.22 of 2021 (class III), DO must be > 3 mg/L, wherefrom the observations the oxygen concentration from the Kampar River, Siak River and Rokan River still meets water quality standards.

**Carbon dioxide**

The results of measuring CO2 levels in the waters of the Kampar River, Siak River, and Rokan River in the dry season ranged from 28.3 to 49.22. The highest CO2 levels are in the Kampar River. High CO2 content will suppress the respiratory activity of fish, so they can experience stress and pressure and can even cause death [19]. In the rainy season, the free CO2 content ranges from 3 to 6. CO2 levels in the rainy season are low due to an increase in the volume of river water, thus dissolving organic waste materials and anthropogenic waste. In addition, the concentration of water mass during the rainy season is not thick; it can reduce CO2 levels in the waters. The concentration of free CO2 levels for fisheries is < 5 mg/L, but aquatic organisms can survive up to 60 mg/L of free carbon dioxide[10]. In general, free carbon dioxide in the three rivers in the dry season and the rainy season still supports the life of organisms in these waters.

**Biochemical Oxygen Demand (BOD)**

The value of Biochemical Oxygen Demand (BOD) of Kampar River, Siak River, and Rokan River in the dry season ranged from 10 – 16.4 mg/L, in the rainy season 10, 6 - 76.8 mg/L. The BOD of the three rivers varies. The highest and lowest BOD values in Kampar River waters are probably caused by community activities along the river. These activities include bathing, washing, latrines, household waste, factory waste, and excess feed residue from cultivation activities. In addition, high BOD values can reduce the quality of river waters by decomposition of organic matter and then will reduce dissolved oxygen content [20]. BOD In this study, BOD values were not found within the recommended limits based on Government Regulation No. 22 of 2021 (class III).

**Chemical Oxygen Demand (COD)**

COD concentration in Kampar River, Siak River, and Rokan River in the dry season is 51.2 -22.4 mg/L and rainy season 25.0 - 2 mg/L. In general, COD concentrations tend to increase in the dry season and decrease in the rainy season. The maximum COD level in the dry season indicates a higher level of pollution associated with reduced water volume during the dry season, compared to the wet season. The concentration of COD in the water increases with the increase in the concentration of organic matter [9]. The high COD value of the waters indicates the occurrence of organic matter pollution that enters the waters. Domestic and/or industrial waste can also increase COD levels in the waters. COD can be used as a key parameter for determining the water quality of the Siak River. The range of COD values has exceeded the water quality standards that have been set. In addition, COD is commonly used to measure organic pollution and is an important indicator for measuring river pollution[21].
Nitrate
The concentration of nitrate in this study varied greatly in the dry season from 2.4 to 10.71 mg/L and in the rainy season from 0.42 to 0.85 mg/L. In general, nitrate concentrations were highest in the dry season in the Kampar River. It is possible the presence of domestic waste and agricultural waste. Throughout this area, oil palm plantations are found. Nitrate concentrations may be increased by domestic sewage around river areas and the use of inorganic nitrate fertilizers. On the other hand, the lowest nitrate concentration is in the rainy season in the Siak River [22]. Nitrate is an important nutrient for aquatic plants and seasonal variations can be caused by plant growth and decay and are a major source for the growth of phytoplankton, algae, and other plants [23][22]. The nitrate level should be 20 mg/L so that the nitrate in the Kampar River, Siak River, and Rokan River is within the quality standard.

Phosphate
Phosphate values of Kampar River, Siak River, and Rokan River in the dry season ranged from 0.24 - 1.43 mg/L and in the rainy season 0.26 - 1.60 mg/L. The highest phosphate values tend to be in the rainy season, due to anthropogenic activities [24]. Sources of phosphate pollution in the waters mostly come from household waste and the remnants of fertilizer from oil palm plantations carried by rain. High concentrations of phosphate are often found in residential, industrial, and agricultural areas [25]. The lowest phosphate concentration is in the Kampar River because it is a river that is close to the estuary which is influenced by the ebb and flow of the mixing of fresh water and seawater, thereby reducing the concentration of phosphate in the water [24]. The total phosphate value was found to be within the permissible limits under Government Regulation No. 22 of 2021 (Class III).

Ammonia
In general, the ammonia concentration of Kampar River, Siak River, and Rokan River in the dry season was 0.05 - 0.17 mg/L and 0.04 - 0.21 mg/L in the rainy season. The highest concentration of ammonia in the rainy season is in the Siak River. Ammonia is one of the components of inorganic nitrogen dissolved in water and is the main end product of the decomposition of organic matter by heterotrophic bacteria. Baum and Rixen [24] reported that one of the important factors affecting Siak inorganic nitrogen is the decomposition of dissolved organic matter (DOM) with the surrounding peat swamp. Furthermore, Liebezet and Wostmann[26], also reported that organic matter in the mouth of the Siak River came from the upper reaches of the river, especially the two tributaries of Tapung Kanan and Mandau. In addition, the highest ammonia in the river (estuary) may be caused by organic matter from upstream released from the peat swamp deposited in the estuary. In addition, the highest ammonia in the estuary correlates with increasing the pH value (Yuliati et al. 2018). Ammonia values in the Kampar River, Siak River, and Rokan River were not found within the permitted limits of Government Regulation No. 22 of 2021 (Class III).

3.3. Biological Parameters

Plankton Abundance
The abundance of plankton in the Kampar River, Siak River, and Rokan River during the dry season the highest abundance of phytoplankton in the Siak River was 73250 cells/L. The high abundance of plankton is influenced by the high organic matter in the waters [27]. The abundance of plankton is influenced by the high organic matter in the waters. The abundance of phytoplankton in the Siak River (73250 cells/L) was higher than the abundance of plankton in the Kampar River (25000 cells/L) and the lowest was in the Rokan River with an abundance of plankton (16750 cells/L). In general, during the rainy season, the abundance of phytoplankton increases. These results illustrate that in waters where the availability of organic matter is high, the abundance of phytoplankton > 12500 cells/L is included in the high category [27].

Diversity Index ($H'$), Dominance ($C$), Similarity ($E$)
Diversity of plankton in the Siak River, Kampar River, and Rokan River during the dry season the value of $H'$ 1.85; 2.30; 2.51 each. The lowest rainy season is the Siak River, Rokan River, and Kampar River with an $H'$ value of 1.60; 2.19; 2.59 each. In general, both the dry season and the rainy season are classified as good and are included in the moderate category. Shannon-Winner in his statement, if the value of $1 \leq H' \leq 3.0$ then the diversity of plankton organisms is moderate, meaning that the diversity is moderate with moderate distribution of individuals.

The plankton dominance index (C) in the dry season is 0.39; 0.26; 0.19 on the Siak River, Kampar River, and Rokan River. The value of the Dominance Index (C) of plankton in the rainy season is 0.44; 0.29; 0.25 (Siak, Rokan River, and Kampar River). In general, the dry and rainy seasons are relatively the same and are classified as good, which is close to zero. This zero value indicates that there is no dominant type of plankton. The zero dominance index in Jailolo waters indicates that the phytoplankton community structure does not contain species that extremely dominate other species [28]. The dominance index value of zero in the three rivers describes a stable environment for the survival of aquatic organisms, the environmental conditions are quite prime and there is no ecological pressure (stress) on aquatic biota [28].

The value of the Similarity Index (E) of plankton in the dry season of the Rokan River, Kampar River, and Siak River was 0.92; 0.89; 0.64 each. The value of the Similarity Index (E) of plankton in the rainy season on the Kampar River, Rokan River, and Siak River is 0.87; 0.81; 0.62 each. The similarity index value shows a value > 0.5 or close to 1 which indicates the waters are still classified as good. The value of similarity (E) is close to 0 then the value of similarity is getting smaller or lower in a population. Meanwhile, if the value of E is close to 1, it will show similarity, which means that the community has relatively even species [29]. In general, the condition of plankton in the three waters is still balanced, it can be said that the waters are still in a condition that is suitable for the life of aquatic organisms in the waters because many other factors can still support the life of the organism.

3.4. Determination of Water Quality Status with the Storet Method

Determination of the water quality status of the Kampar River, Rokan River, and Siak River using the storet method compared to Government Regulation No. 22 of 2021. The classification of water quality standards of Government Regulation No. 22 of 2021 has been adjusted to the designation of each class. The results of the analysis of the pollution index value in the highest dry season was a score of -44 on the Rokan River, classified as class D with a score of -31 heavily polluted. The STORET score in the Kampar River and Siak River obtained -24, each classified as Class C, is included in the moderately polluted category. Meanwhile, in the rainy season the pollution index with the same pattern is highest in the Rokan River -40, then Kampar River, and Siak River each -20.

The water quality standard used in this study is class III because it still supports fish farming activities. Based on Government Regulation No. 22 of 2021 concerning water quality standards, class III is water whose designation can be used for freshwater fish cultivation, animal husbandry, and irrigating gardens. The Storet method is carried out by collecting water quality data and measuring data from each water parameter and comparing it with the value of class III water quality standards.

4. Conclusion

From the results of this study, it can be concluded that all rivers in Riau Province are currently being polluted with the Rokan River as the river with the highest level of pollution, namely the heavily polluted category, while the Kampar and Siak rivers are in the moderately polluted category.

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