Distribution patterns of chlorophyll-A based on Sentinel 2A images in the Estuarine waters of the Musi River, South Sumatra Province

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Abstract. The Musi River estuary is a part of the Musi River. This estuary is located in Sungsang and was the meeting point of some tributaries to the Bangka Sea. It is necessary to determine the chlorophyll-a concentration in the Musi River estuary using effective methods. The purpose of this study was to investigate the distribution patterns of chlorophyll-a in the Musi River Estuary using multitemporal sentinel 2a imagery. The study was conducted in February 2020 using 2018-2020 Sentinel-2a imagery. Methods were developed to achieve the objective. The method of field survey and processing of optical image data. These methods showed a correlation between insitu results and image processing results using the Pentury algorithm (1997) of r = 0.563, indicating a high relationship. The RSME value of the Pentury algorithm (1997) is 0.01, which proves that the result is very accurate. In 2018, the distribution of chlorophyll-a was rather low in the riverine areas and higher toward the sea. In 2019 and 2020, the distribution pattern of chlorophyll-a was almost identical, i.e. chlorophyll-a tended to be high in the river basins and lower toward the sea.

Keyword: Patterns of chlorophyll-A based, Sentinel 2A Images, Estuarine waters, The Musi River

1. Introduction

The Musi River estuary is a part of the Musi River that flows into the Bangka Sea, in the area of Sungsang. The Musi is a river that becomes the mouth of several large and small rivers in Bengkulu and South Sumatra. Various industrial activities such as mining, plantation, agriculture, domestic activities and natural activities entering the waters of the Musi River have an impact on aquatic biota and health [1].

Chlorophyll-a is one of the parameters that determine primary productivity in the sea. according to [2], the oceanographic conditions of the waters are closely related to the high and low distribution of chlorophyll-a concentration. The concentration of chlorophyll-a in water has a great influence on the fertility of water bodies. Nutrient input and waste from the community have a great influence on chlorophyll-a content. Estimation of chlorophyll-a concentration in Musi estuarine waters should provide information on the degree of aquatic fertility. Waters with sufficiently high chlorophyll-a content indicate that these waters are suitable as fish habitat because they provide natural food sources for these fish.

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Remote sensing is a method that provides information about the Earth's surface on an

increasingly large spatial and temporal scale. Sentinel-2a imagery has higher spatial resolution than Landsat-8 imagery, so more accurate results can be obtained, and the use of multitemporal

Sentinel-2A satellite imagery can help in the analysis of the distribution pattern of chlorophyll- a. This study aims to analyze the distribution pattern of chlorophyll-a using multitemporal Sentinel-2A imagery to estimate the concentration of chlorophyll-a in the waters of the Musi River estuary in South Sumatra province.

2. Research Methods

2.1 Research Site

This survey was conducted in February 2020 in the Musi River estuary in South Sumatra province (Figure 1). Sentinel-2A image data processing was performed at the Remote Sensing and Marine Geographic Information Systems Laboratory. Sample screening was performed at the Marine Bioecology Laboratory and chlorophyll-a content analysis was performed at the Oceanography and Marine Instrumentation Laboratory of the Department of Marine Sciences, Faculty of Mathematics and Science, Sriwijaya University.

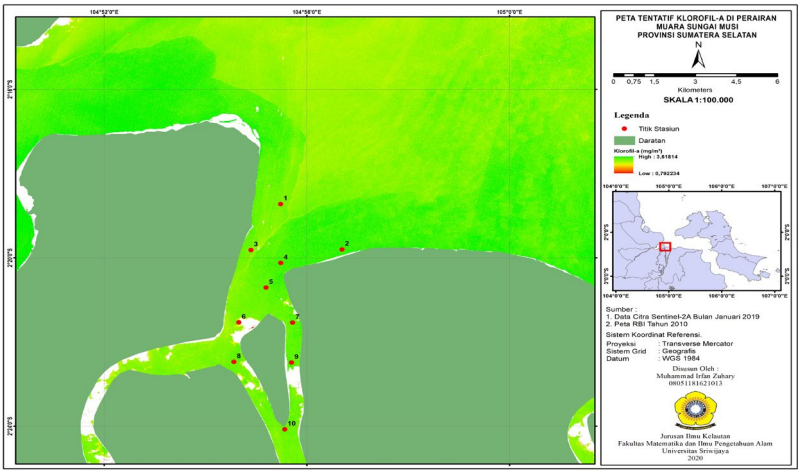

Figure 1. Research sites

2.2 Tools and Materials

The tools and materials used for data processing are laptop/computer, QGIS 3.6 software, ArcGIS 10.5 software, ER -Mapper 7.0 software, Microsoft Excel 2010, Sentinel-2A (Path 124/Row 62) image data in 2018, 2019, and 2020 in February. Tools and materials used in field sampling are GPS hand, 500 ml dark bottle, water sampler, cooler, slate/table sheets, compass, floating drawing, stopwatch, DO meter, hand refractometer, pH meter, Secchi disk, digital thermometer, boats, cameras, ice cubes, paper labels, tide prediction data. Tools and materials for water sample analysis are spectrophotometer, centrifuge, vacuum pump,

refrigerator, Millipore 0.45 filter paper, test tube, Erlenmeyer, measuring cup, dropper, aluminum foil, water sample, distilled water, blank solution, 90% acetone solution, writing materials.

2.3 Research Procedure

The steps in this research are chlorophyll-a analysis in the laboratory to determine the chlorophyll-a concentration and processing the sentinel-2A image data to determine the distribution pattern of chlorophyll-a.

2.3.1 Pre-processing of Sentinel 2A image data

Sentinel-2A image data extract downloaded image data is a compressed file in *.rar data format, data extraction must be done to open *.rar files. In addition, the processing of Sentinel-2A image data downloaded from the link https://scihub.copernicus.eu/ can be done through QGIS so that it is immediately corrected for atmospheric and reflectance values. The bands are then merged (stacked) and cropped to facilitate data analysis so that all bands are combined into a single image. Cropping is used to crop the image to the study area. The image is then masked to separate land and ocean objects by setting the land value to 0 and the ocean value to match the spectral value.

2.3.2 Station Point Determination

Determination of station points by the random sampling method, taking into account the area extending from the mouth of the Musi River and still influenced by the tides. The location was determined based on the results of the pre-processing of the Sentinel-2A image data in January 2019, since there were no cloud-free image data in the study area in the western season in 2020. The determination of station locations was done to see the influence of community activities (transport pathways). in these waters on the concentration of chlorophyll-a.

2.3.3 Insitu Data Collection and Measurement

Sampling and measurement of environmental parameters at high and low tide. Collection of water samples for analysis of chlorophyll-a content using the composite sampling method. A black polyethylene bottle was sterilized with 70% alcohol at each station. Water samples were collected three times with a water sampler at a depth of 1 meter and then placed in a bucket. The dark bottle is then filled to the brim with water and sealed in the water. The bottle, already filled with water, is then stored in a cooler that was filled with ice [3].

2.3.4 Analysis of Chlorophyll-a

According to [4], the method for measuring chlorophyll-a concentration is based on the absorption of 3 wavelengths (trichomotric), namely 664, 647 and 630 nm using acetone as solvent.

2.3.5 Data Analysis

Concentration values from in situ and satellite images processed with ER -Mapper 7.0 software to obtain chlorophyll-a concentrations were compared with each station point (validation). Data regression is performed after analyzing the image data with algorithms and field data. The data regression aims to determine the accuracy between the field data and the image data using the equation:

Linear Regression : $y = a + bx$
Pol. Order 2: $y = a + bx2 + cx$
Pol. Order 3: $y = a + bx3 + cx2 + dx$
Information :
y : dependent variable (field data)
x : Independent variable (image data)

3. Results And Discussion

3.1 Estimation of Chlorophyll-a Concentration at the Musi River Estuary Using Sentinel-2A Imagery

Estimation of chlorophyll-a concentration in the Musi River estuary using Sentinel-2A satellite imagery with an acquisition time of March 3, 2020. In this study, the imagery data should be used in February or in the western season, but in this season the cloud cover is more than 30%, so it is difficult to estimate. data processing is performed. The use of algorithms is carried out to determine the value of chlorophyll-a concentration in the waters of the Musi River estuary, several algorithms are used are the algorithms [5], [6], [7]. The map for estimating the distribution of chlorophyll-a concentration using the 3 algorithms is shown in Figure 2.

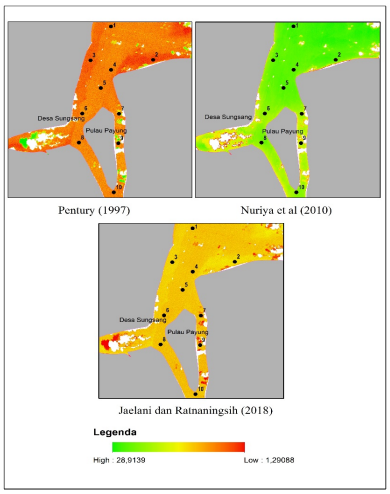

Figure 2. Map of estimating the distribution of chlorophyll-a concentration using the Pentury, Nuriya, Jaelani and Ratnaningsih algorithms.

3.2 Distribution Pattern of Chlorophyll-a Concentration of Sentinel-2A Multitemporal Image Using the Pentury Algorithm (1997)

Determination of the distribution of chlorophyll-a concentrations in the estuarine waters of the Musi River based on the regression results according to the algorithm [5]. The algorithm uses polynomial regression of order 3, then the equation model is applied to the Sentinel-2A image with path 124 lines 62 with acquisition dates 09 December 2018, 08 January 2019 and 03 March 2020. The distribution of chlorophyll-a concentrations in Musi River Estuary waters using Sentinel-2A imagery in 2018, 2019, and 2020 is shown in Figure 3.

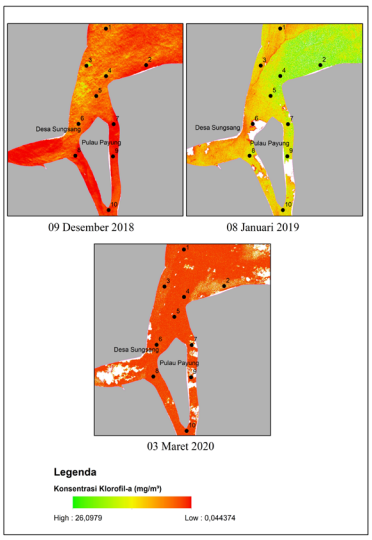

Figure 3. The distribution pattern of chlorophyll-a concentrations in the waters of the Musi River estuary using Sentinel-2A imagery in 2018 - 2020.

Table 1. Concentration of chlorophyll-a in the Musi River estuary in 2018 - 2020

Station	December 2018	January 2019	March 2020
1	1.01	8.12	0.94
2	1.18	20.29	1.16
3	1.08	11.46	0.98
4	1.1	19.47	0.95
5	1.05	12.83	0.92
6	1.02	4.5	0.94
7	1.28	12.78	0.70
8	1.29	13.93	0.94
9	1.27	10.22	0.92
10	1.22	15.61	0.92
Average	1.15	12.92	0.94

The value of chlorophyll-a concentration in the waters of Musi River Estuary, Banyuasin Regency, South Sumatra Province, ranges from 0.04 - 26.09 mg/m³ in total during 2018 - 2020. The fluctuations in chlorophyll-a concentration for 3 years were up and down, in 2018, the average chlorophyll-a concentration was 1.15 mg/m with the lowest value of 1.01 mg/m and the highest of 1.29 mg/m³. In 2019, the chlorophyll-a concentration increased to an average of 12.92 mg/m, with the lowest value of 4.5 mg/m and the highest of 20.29 mg/m. In 2020, on the other hand, there was a decrease in chlorophyll-a concentration. The average value of chlorophyll-a concentration was 0.94 mg/m, with the lowest value being 0.70 mg/m and the highest being 1.16 mg/m³.

The value of distribution of chlorophyll-a in 2018 tends to be low compared to the estuary to the branch of tributary to enter the river basin, and the value of distribution of chlorophyll-a increases toward the sea around Cape Carat. In 2019, the distribution value of chlorophyll-a tends to be high, but if we look more closely, the value of chlorophyll-a is higher in areas near the mainland of Upang. This is because there are no residential areas in this area, so residential activities do not affect the chlorophyll-a value, and it is lower in the area from Cape Carat to the Breech area, in the tributaries and around Payung Island.

According to [8], there was a positive sea surface temperature anomaly in the central equatorial Pacific Ocean (El Nino) in January 2019, which led to drought in the area. According to [9], a strong El Nino along with an IOD (+) leads to higher sea surface temperatures. The low precipitation resulted in higher effective radiation intensity and a calm sea surface, which allowed heat to penetrate the water, causing the surface temperature to reach its maximum, resulting in the high and low chlorophyll-a concentrations from December 2018to January 2019. Meanwhile, in 2020 The value of the distribution of chlorophyll-a in the river body up to the mouth is low, but tends to increase closer to the mainland at the branch of the tributary.

4. Conclusions

Based on the results of surveys conducted in the waters of the Musi River Estuary, Banyuasin Regency, South Sumatra Province, the following conclusions were drawn in 2018: Chlorophyll-a distribution tends to be low in riverine areas and higher towards the sea. In 2019 and 2020, the distribution pattern of chlorophyll-a is almost identical, i.e. chlorophyll-a tends to be high in riverine areas and lower towards the sea.

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