Mapping of Changes in the Marine Physical Properties of the Batam Island

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Abstract. Batam Island is one of the islands in the Riau Archipelago, which is rich in natural resources, especially mangroves and coral reefs. These two aspects are very influential on changes in the ecosystem found in the sea, but there are several locations of mangroves and coral reefs that have been damaged by human and natural causes; namely, some of the physical properties of seawater include sea surface temperature, salinity, and total suspended sediment. Therefore, a study was conducted to determine changes in the area of mangroves and coral reefs on Batam Island by utilising Landsat 8 image recordings in 2017 and 2021. So changes in mangroves, coral reefs, and physical properties of seawater can be known from the results of this study.

Keywords: Mangrove, Coral Reef, Sea Surface Temperature, Salinity, Total Suspended Solid.

1 Introduction

Batam Island itself is one of the islands in the Riau islands that are rich in natural resources, the area of Batam island waters reaches 66,867 ha, including coral reefs, seagrasses, and dunes reaching 47,500 Ha, one of the natural wealth owned by Batam Island is Mangrove [1]. Mangrove serves as seawater intrusion, coastal abrasion prevention, a place of life, and the source of several marine animals. However, the condition of mangroves in Batam Island is currently damaged every year. Head of non-governmental organisation Air Lingkungan dan Manusia/Alim Kepri, explained the damage to mangrove or mangrove forests per year in Riau Islands, including Batam, Bintan and Tanjung Pinang reached 40%[2].

Hydro-oceanographic conditions are an important factor in the survival of marine ecosystems. among others salinity, sea surface temperature, tidal wave currents, as well as meteorological factors and human activities on lands such as indiscriminate waste disposal or waste disposal can also affect the condition of marine waters and coral reef ecosystems. [3]; [4]; [5].

The distribution of mangroves and coral reefs in Batam Island needs to be known in advance before prevention and damage management efforts can be overcome. One way is to do

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mangrove and coral reef mapping with remote sensing technology. In addition, we also need to find about some properties of seawater physic such as salinity, sea surface temperature (SST), and total suspended solids (TSS) After knowing information about changes in mangroves, coral reefs, as well as some properties of seawater physic needs to be presented good information, the author uses information presentation in the form of a map.

2 Basic Theory

2.1 Classification of Multispectral Imagery (Mangrove)

In the Supervised method (supervised classification) the analyst first determines several training areas (sample areas) in the image as an object of appearance. This determination is made based on the analyst's knowledge of the area in his mind regarding land cover areas. The pixel values in the sample area are then used by the computer software as a key to recognize other pixels. Areas that have similar pixel values will be included in a predetermined class [6]; [7].

2.2 Lyzebga Algorithm (Coral Reef)

This research lyzenga algorithm used is Lyzenga Wouthuyzen algorithm 2001 [8]:

$$Y = (\ln Li) + (\frac{ki}{kj} \times \ln Lj) \quad (1)$$

Information:

Y = Image extracted from the bottom of the waters

Li = Value of blue channel (Band 2) Landsat image 8

Lj = Value of green channel (Band 3) Landsat image 8

$\frac{ki}{kj}$ = Attenuation coefficient value

To get the value of $\frac{ki}{kj}$ value determined by the value a, the value of a is obtained by extracting the digital values on the blue child and the green channel at the same geographical position through the processing of training sample areas in the form of points. The formula looks up the variant value, covariance, variable variance of covariance, and the coefficient of attenuation value, obtained from [9]

The formula for finding variant values is:

$$S^2 = \frac{n.\sum_{i=1}^{n} Xi^2 - (\sum_{i=1}^{n} Xi)^2}{n(n-1)} \quad (2)$$

Information:

S^2 = Value of Variance

xi = Value x to i

n = Number of Samples

The formula for finding the covariance value is:

$$C = \frac{\sum(Xi-\bar{X})(yi-\bar{y})}{(n-1)} \quad (3)$$

Information:

C = Covariance Value

X = Value x-i*i*

$\bar{x}$ = Average value of all data x

y*i* = Value y to *i*

$\bar{y}$ = Average value of all y data

n = Number of Samples

The formula for finding covariance variance variables is:

$$a = \frac{(S^2\,x-S^2\,y)}{(2 \times C\,xy)} \quad (4)$$

Information:

a = Value of covariance variance variable

C*xy* = Value of Covariance *xy*

S^2 x = Variant Value x

S^2 y = Variant Value y

The formula for finding the attenuation coefficient value is:

$$\frac{ki}{kj} = a + \sqrt{a^2+1} \quad (5)$$

2.3 Salinity of Waters

Changes in salinity are more common in coastal waters than in offshore waters, this is because coastal waters receive more freshwater input through rivers and green water. Freshwater salinity value bias is less than 0.5 psu, brackish waters between 0.5 to 30 psu [10].

$$Cp = -142 \times ((-61{,}182 \times Bi^3)\,(+79{,}192 \times Bi^2) - (34{,}002 \times Bi) + 4{,}865) + 32{,}702 \quad (6)$$

Information:

B*i* = Blue chromatic value

Where the value of blue chromatic is searched by using the following formula:

$$Bi = (\frac{B2}{B2+B3+B4}) \quad (7)$$

Information:

B2 = Blue Channel

B3 = Green Channel

B4 = Red Channel

2.4 Total Suspended Solid (TSS)

Total Suspended Solid (TSS) or suspended solids are solids that cause water turbidity, are not dissolved, and cannot settle. In [11] research has found an appropriate empirical algorithm to suspect the concentration of TSS. Here's the algorithm:

a) TSS algorithm in the dry season (May-October)

$$Tss = (-26390 \times Bi^3) + (35823 \times Bi^2) - (16250 \times Bi) + 2468{,}4 \quad (8)$$

b) TSS algorithm in the rainy season (November-April)

$$Tss = 24197 \times Bi^3 + 22050 \times Bi^2 - 6813 \times Bi + 664{,}98 \quad (9)$$

Information:

Bi = Blue chromatization value

2.5 Sea Surface Temperature (SST)

By using Landsat-8 satellite imagery, water temperature identification can be carried out using certain algorithms, such as the algorithm developed using field data measured by [12]. The resulting algorithm is:

$$T = -0{,}0197 \times (B11)^2 + (0{,}2881 \times B11) + 29{,}004 \quad (10)$$

3 Research Methodology

3.1 Research Location

This research was carried out from May to August 2021 for the preparation of research reports, image processing, and map-making. The location taken in this research is Batam Island which is in Batam City, Riau Islands, Indonesia, or at 104° 1' 49.6452" E, 1° 2' 44.2536" N. In Figure 4 the research area of Batam Island below shows the location of the research location.

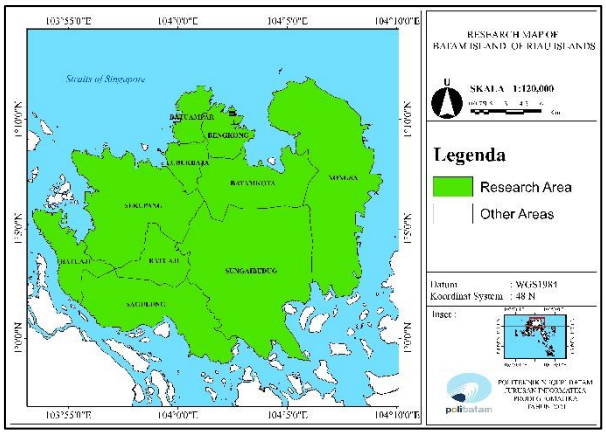


Fig. 1. Batam Island Research Area

3.2 Research Design

This research was carried out from May to August 2021 for the preparation of research reports, image processing, and map-making. The location taken in this research is Batam Island which is in Batam City, Riau Islands, Indonesia, or at 104° 1' 49.6452" E, 1° 2' 44.2536" N. In Figure 4 the research area of Batam Island below shows the location of the research location.

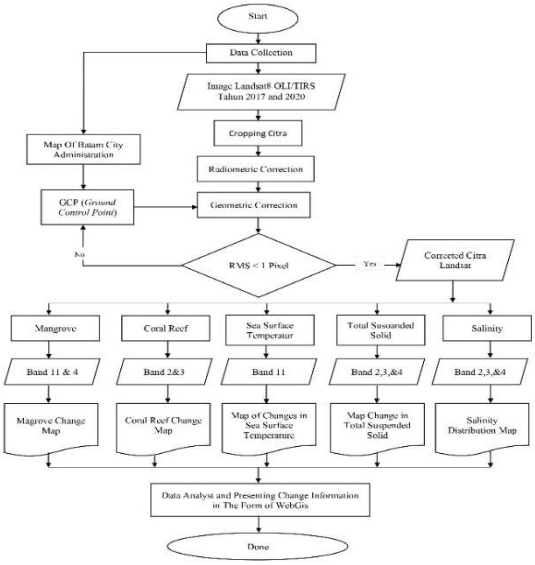


Fig. 2. Research Flow

3.2 Data Processing Techniques

All data processing in this study all use ENVI 5.3 application, before processing the author's data cropping an image, radiometric correction and also geometric correction, after that just do

data processing. Where to do mangrove data processing using supervised method (guided classification using bands 6,5, and 4. Coral reef data processing uses lyzenga transformation by using bands 2, and 3. Salinity data processing using

algorithms, total [10] suspended solid data processing (TSS) using the algorithm [11] where both algorithms use bands 4, 3, and 2, sea surfer temperature data processing (SST) using algorithms [12] using band 11.

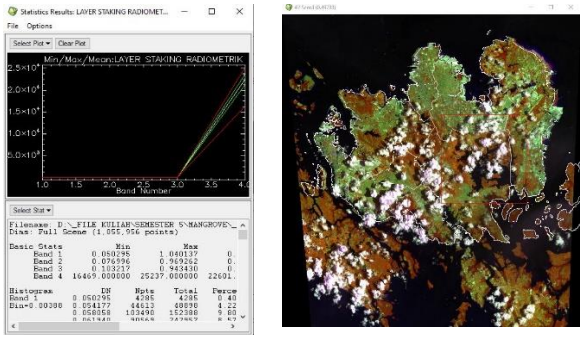
4 Result and Discussion

4.1 Image Cropping

The process cropping aims to cut the image that will be used and discard the image that is not used.

4.2 Image Correction

In the image correction process, 2 corrections are made, namely radiometric correction to correct the pixel value where the pixel value is initially more than 1, then it is changed to less than 1 and more than 0 are in Figure 3(a), and geometric corrections to improve the position of the image[R1] so that it can match the SHP or the actual coordinates are in Figure 3(b).



(a) Radiometric (a) Geometric

Fig. 3. Image Correction Results

4.3 Classification of Multispectral Imagery (Mangrove)

The method used is supervised classification. Using bands 5, 6, and 4.

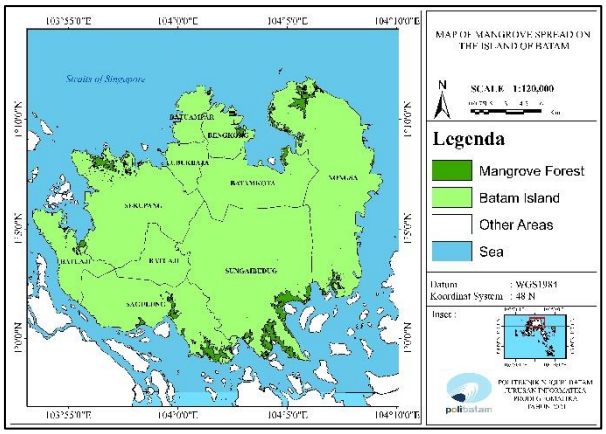


Fig. 4. Classification results of 2017 Image Supervision

4.4 Algorithm of Lyzenga (Coral Reef)

This algorithm intercepts material information covering the bottom of the water based on reality. This algorithm uses bands 2, and 3, and results in the conclusion that the distribution of coral reefs is found in the Nongsa area and also around Batam center area.

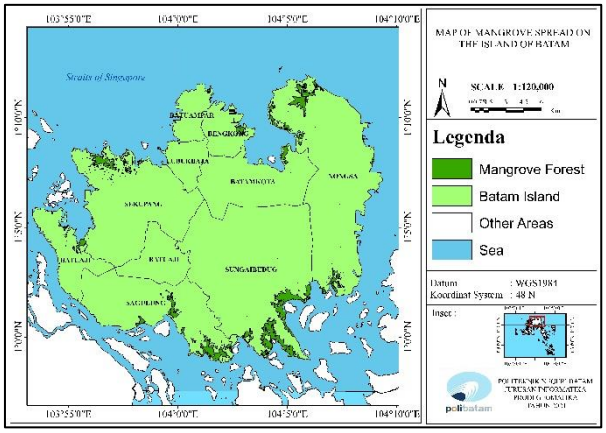


Fig. 5. Map of Batam Island Coral Reefs in 2017

4.5 Salinity of The Waters

The image transformation in this study using bands 2, 3, and 4. resulted in the conclusion that the coastal area of Nongsa, Batam Center coast, and Piayu waters have the highest salinity value, which is around $37^{o}/_{oo}$.

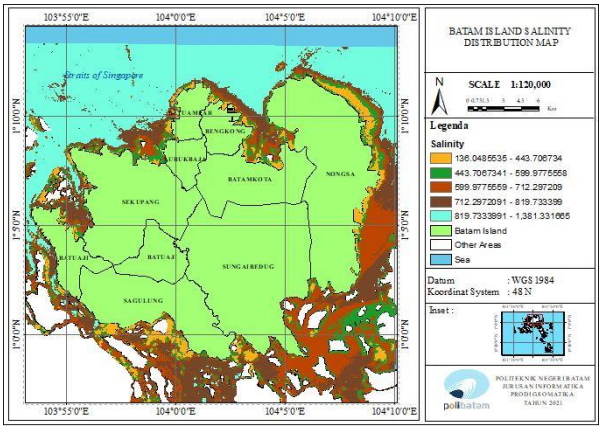


Fig. 6. Map of Batam Island Salinity Distribution in 2017

4.6 Sea Surface Temperature (SST)

This transformation uses band 11 as the basis, resulting in poor results. Convincing because there are so many clouds that cover the surrounding area so it is difficult to identify the sea surface temperature[R1]. The highest value of temperature according to the sample point is at a temperature of 31° C and the lowest temperature is 29° C.

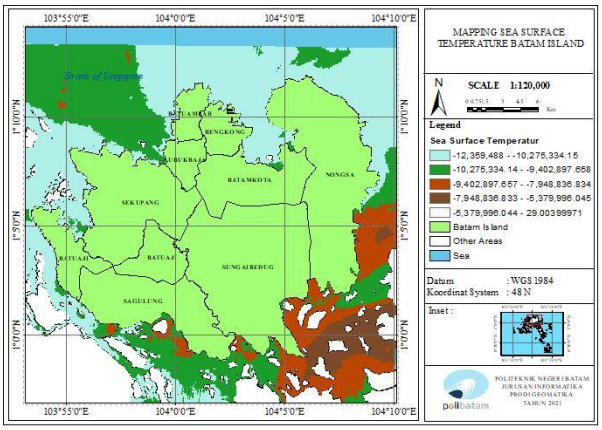


Fig. 7. Map of Sea Surface Temperature Distribution Batam Island in 2017

4.7 Total Suspended Solid (TSS)

The transformation for this image uses bands 2, 3, and 4. Then we convert it to blind chromium and plug it back into the TSS formula. In this image, the highest Total Suspended Solid values are in the Nongsa waters, and the Piayu waters, which range between 0,07-0,5 mg/l.

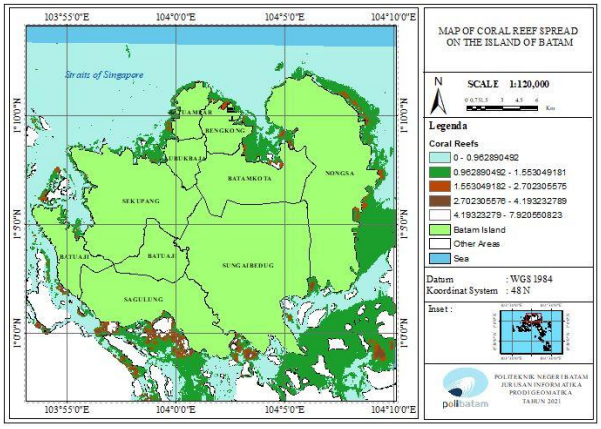


Fig. 8. Map of Total Suspended Solid Distribution Batam Island in 2017

5 Conclusion

Based on the results of mangrove research, coral reefs, as well as some properties of seawater physicists conducted in Batam Island, it can be concluded that. The mangrove area in 2017 was 120.64 ha, with the most distribution in coastal areas such as Tanjung Piayu and Nongsa areas.

The distribution of coral reefs also follows the distribution of mangroves itself because of the results of research on the distribution of the most coral reefs in The Tanjung Piayu and Nongsa areas. Because as we know that most mangrove forests grow on coral reefs as a place where they stand or lengthen their roots.

For the physical properties of seawater on the island of Batam greatly affect the development of ecosystems in the sea because some of the physical properties of seawater affect the growth of chlorophyll which has a direct impact on marine ecosystems such as mangroves and coral reefs.

References

[1] Gustin, O. And Roziqin, A.: Detection of land use changes in Batam Island coastal using remote sensing. IOP Conference Series: Earth and Environmental Science Science. Vol. 375. pp. 012001 (2019)

[2] Kherjuli: 26 November 2015; Tanjung Pinang Pos, Tanjung Pinang (2015)

[3] Insanu, R.K. And Prasetya, F.V.A.S.: Pemetaan Sebaran Suhu Permukaan Laut (SPL) Sebagai Parameter Penentuan Potensi Perikanan Dan Budidaya Di Pesisir Perairan Delta Mahakam, Kalimantan Timur. Vol 4, No. 1, pp. 1-8. Elipsoida: Jurnal Geodesi dan Geomatika. (2021)

[4] Prasetya, A.S., Sukojo, B.M., And Handayani, H.H.: Analisa Penentuan Lokasi Budidaya Rumput Laut dengan Parameter Fisika maupun Kimia Menggunakan Citra Terra Modis di Daerah Selat Madura. pp. 3-5. Surabaya: Institut Teknologi Sepuluh Nopember. (2013)

[5] Suproharyono. Pelestarian Sumber Daya Alam di Wilayah Pesisir Tropis. Jakarta: PT Gramedia Pustaka Utama, Jakarta (2002)

[6] Prasetya, F.V.A.S.,& Rajab, A.: Analisis Distribusi Parameter Fisika Dan Kimia Pada Kawasan Budidaya Rumput Laut Di Provinsi Jawa Timur Dengan Menggunakan Citra Satelit Terra MODIS. Vol 1, No. 2, pp. 56-63. Elipsoida: Jurnal Geodesi dan Geomatika. (2018)
[7] Roziqin, A., Gustin, O., Irawan, S., Lubis, M. Z., Henora, C. S., & Wulandari, D. A. S: PEMETAAN PENGGUNAAN LAHAN DI WILAYAH KEPESISIRAN SEMBULANG PULAU GALANG KOTA BATAM. Jurnal Integrasi, Vol. 12(1). Pp. 83-87 (2020)
[8] Sari, D.P., & Lubis, M.Z.: Pemanfaatan Citra Landsat 8 Untuk Memetakan Persebaran Lamun Di Wilayah Pesisir Pulau Batam. pp. 39-45 (2017)
[9] Rachmawati, D.N.: Studi Perkembangan Terumbu Karang Di Perairan Pulau Panjang Jepara Menggunakan Citra Sentinel-2 Dengan Metode Algoritma Lyzenga. Semarang: Universitas Diponegoro (2018)
[10] Yanti, M.: Struktur Komunitas Lamun Pantai Sakera Kecamatan Bintan Utara, Kabupaten Bintan. Jurusan Ilmu Kelautan. Universitas Maritim Raja Ali Haji, Tanjung Pinang (2015)
[11] Lestari, I. B.: PENDUGAAN KONSENTRASI TOTAL SUSPENDED SOLID (TSS) DAN TRANSPARANSI PERAIRAN TELUK JAKARTA DENGAN CITRA SATELIT LANDSAT (2009)
[12] Syariz, M.A., Jaelani, L.M., Subehi, L., Pamungkas, A., Koehardono, A., & Sulisetyono, A.: Retrieval of Sea Surface Temperature Over Poteran Island Water of Indonesia with Landsat 8 TIRS Image: A Preliminary Algorithm. pp. 87-90. ISPRS Annals of Photogrammetry, Remote Sensing and Spatial Information Sciences, volume XL2(W4) (2015)