The Comparison of RGB 564 and RGB 573 Band Composite of Landsat 8 for Mangrove Vegetation Distribution Identification on Pahawang Island, Lampung

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Abstract. Remote sensing technology has been widely used for the identification of natural resources in the coastal and marine areas. Visual interpretation method (photo-interpretation) of Landsat 8 OLI satellite image data is one of the common methods for classifying mangrove vegetation areas, especially in the coastal area, since this method is less expensive compared to the conventional methods of field measurement. However, in its technical process, it needs a combination of several satellite imagery bands to produce optimal colour images as a reference for delineating mangrove and non-mangrove areas. This study was aimed to identify mangrove cover areas and its distribution in Pahawang island, Lampung using visual interpretation method. In this study, RGB 564 and RGB 573 composites were utilized. We compared both RGB to find the most suitable composite for identifying mangrove distribution. Composites Landsat 8 OLI satellite image data produced a red-black mangrove distribution that requires bands with visible wavelengths (bands 2.3 and 4); bands with near-infrared (NIR) (bands 5); and short-wave infrared (SWIR) (bands 6 and 7). The results showed that 564-composite type produced optimal colour images to facilitate the process of interpreting the distribution of mangrove vegetation. In addition, our study revealed the total distribution area of mangrove vegetation in Pahawang Island is 51.3 Ha with the most significant area located in the western part of Pahawang Island at 39 Ha. The mapping accuracy test of the 564-composites type was 86.6% while the 573-composites type was 47.5%. This indicated that the 564-composites type likely provides more reliable mangrove vegetation distribution information.

Keywords: Mangrove, Visual Interpretation, Composite, RGB, Landsat

1. Introduction

Pahawang Island is part of the administrative area of the Pesawaran Regency. It has one of the natural resource potentials, the mangrove ecosystem. According to Bengen [1], the mangrove ecosystem has ecological benefits for a wave damper, abrasion protector, and feeding, nursery, and spawning ground for many aquatic organisms.

Visual interpretation is one of the most common methods for image classification of the mangrove ecosystem. Users could visually inspect images and identify mangrove habitats using this method. Image data could be interpreted visually in the form of satellite image data and be processed through contrast sharpening processes to identify the desired habitat. The procedure for visual interpretation involves wavelengths or by doing composites that will produce optimal color combinations to identify the desired habitats [2].

It is possible to identify mangrove habitat using the satellite image processing method as mangroves have chlorophyll contained in their leaves and located on the coastal. These both characters are important for detecting mangroves since chlorophyll provides optical properties and for image processing, it is easier to distinguish coastal
vegetation since it is located in between land and water. The optical properties of chlorophyll typically absorb the red light spectrum and reflect strongly on the infrared spectrum [2] in [3].

The geographical location of mangrove ecosystems can be easily recognized because they are located in the transitional areas of land and sea, which provide a unique recording effect when compared to terrestrial vegetation objects [4]. Mangroves can be identified by the dark red color in the compositied images. The red colour is the vegetation reflectance that is visible in the image with infrared bands, while the darkn colour is the reflectance of aqueous soil that is visible in the image with the red band [5].

Identification of mangrove ecosystems using Landsat 8 satellite imagery employs three different bands, namely band 4 with red sensitivity and wavelength of 0.630-0.680 μm; band 5 with infrared color sensitivity and close to wavelength of 0.845-0.885 μm; and band 6 with color sensitivity of shortwave infrared 1 to wavelength of 1,560-1,660 μm [6]. These three types of bands are often employed by researchers, including Setiawan [7], Waas [3], Emiyati [8], and Purwanto [9] with a combination of bands 564. Moreover, the other three bands (band 3 with a green color sensitivity with the wavelengths of 0.525-0.600 μm; band 5 with an infrared color sensitivity close to the wavelength of 0.845-0.885 μm; and band 7 with an infrared color sensitivity of short wave 2) were also used for determining the distribution of mangrove ecosystem. These bands were used by Marini and Anggraini with combination of bands 573 in their published works.

The wavelength type and the function of each band are the basis for identifying the mangrove distribution using 564 composite types. Based on USGS [6], the function of band 5 is to emphasize the contents and boundaries of biomass; band 6 is to distinguish soil water content, vegetation, and thin clouds; and band 4 functions is to distinguish vegetation based on its slope. On the other hand, 573 composite types, according to Marini [10], works based on the Optimum Index Factor (OIF) technique. High OIF values point out that bands contain ample information characterized by high standard deviations with few duplications marked by low correlations among the bands. Therefore, this study was conducted to (1) compare two types of composite (RGB 564 and 573) and identify the most optimum composite in interpreting the distribution of mangrove and non-mangrove vegetation and (2) understand the distribution and total areas of mangrove ecosystems in Pahawang Island.

2. Method

2.1 Research location

This research was located in Pahawang Island, Marga Punduh Subdistrict, Pesawaran Regency, Lampung Province with the coordinates of 5° 40' 28.560" S 105° 13' 11.568" T (Figure 1). Landsat 8 OLI satellite image acquisition data in 2019 was gathered from USGS.
2.2. Images Pre-processing

2.2.1. Geometric correction

Geometric corrections was the initial stage in analysing satellite imagery data. It was aimed to fit the position of the satellite imagery to the actual geographical position. Image-to-map rectification method using polynomials (control points) or linear geocoding was performed to reconfigure an image into a datum and to project the map using ground control points (GCP) from a 1: 25,000 RBI map [11].

2.2.2. Radiometric correction

Radiometric corrections was carried out following the geometric correction to correct the pixels towards atmospheric disturbances such as clouds and haze [12]. In addition, radiometric correction aims to change digital number data into reflectance values of satellite images so that it is close to the actual values of objects on the earth surface [13]. The following equation was employed to transform the digital number value to TOA Reflectance [6].

\[ \rho'_\lambda = M \rho Q_{cal} + A \rho \]

Where: \( \rho_\lambda \) = TOA reflectance, without correction of sun’s angle, \( M \rho \) = REFLECTANCE_MULT_BAND_x ,

where x is band number,

\( A \rho \) = REFLECTANCE_ADD_BAND_x , where x is band number,

\( Q_{cal} \) = digital number value (DN)

Correction to the sun’s angle:

\[ \rho_\lambda = \frac{\rho'_\lambda \cos(\theta_{SZ})}{\sin(\theta_{SE})} \]

Where: \( \rho_\lambda \) = TOA reflectance, \( \theta_{SE} \) = Sun’s elevation angle,

\( \theta_{SZ} \) = Zenith angle; \( \theta_{SZ} = 90^\circ - \theta_{SE} \)

2.3. Image Processing

2.3.1. Band composite

Band 3,4,5,6 and 7 representing the band for visible light, near-infrared, and short infrared wavelengths was performed in this study. Of the five bands, the RGB 564 and 573 were compiled to visually identify the distribution of mangrove vegetation. To interpret the data, colour contrast of both composites were performed. An composite will result in a colour hue that contrasts among the habitat covers so that clear zone boundaries among habitats were obtained.

2.3.2. Visual interpretation

Satellite image data that had been composited were then interpreted to distinguish the distribution of mangrove and non-mangrove areas. The distribution of mangrove areas was characterized by a dark red colour that is naturally located in the intertidal zone. Delineation of mangrove and non-mangrove vegetation was then carried out with the digitization method based on the characteristics of mangrove features and the boundary between mangrove vegetation and non-mangrove vegetation.
2.3.3. Composite accuracy test

Ground truth data were carried out to visually validate the distribution of mangrove vegetation resulted from the composite RGB 546 and composite 573. A total of 102 observation points were used to validate data from the results of visual analysis to compare the accuracy level of the results from visual interpretation of the two types of composites.

3. Result and discussion

3.1. Composite band

The use of composite 573 was employed by Marini [10] to identify the mangrove ecosystem at Subi island, Natuna using the OIF (Optimum Index Factor) technique based on [14] in [10]. This study used statistical values as a reference to determine the combination of 3 bands in the images which contained the most optimum colour display. A high OIF value indicates a band with plentiful information marked by a high standard deviation with little duplication characterized by a low correlation among bands. A combination of bands 3, 5, and 7 showed the highest OIF values in this study.

According to USGS [6], band 3 (green) was used to map the upper part of the vegetation using wavelength range of 0.525-0.600 µm; band 5 (red) was utilized to map the contents and edges of biomass with a wavelength range of 0.845-0.885 µm; and band 7 (SWIR-2) was employed to map soil moisture, vegetation, and thin clouds with a wavelength range of 2,100-2,300 µm. The results of this study showed that composite 573 presented a less clear boundary between areas of mangrove and non-mangrove vegetation (Figure 2a). Both mangrove and non-mangrove vegetation produced similar dark red colour in the images which make it difficult to distinguish mangrove and non-mangrove vegetation.

Composite RGB 564 was arranged base on 3 bands, including visible spectrum, near infrared, and shortwave infrared bands. This type of composite is commonly employed by researchers to identify the distribution of mangrove cover, including Setiawan [7], Waas [3], Emiyati [8], and Purwanto [9]. Landsat 8 composite utilized
band 4 with red colour sensitivity of 0.630 – 0.680 µm wavelength, band 5 with near infrared colour sensitivity of 0.845 – 0.885 µm wavelength, and band 6 with shortwave infrared colour sensitivity of 1.560 – 1.660 µm wavelength.

Band 4 was employed to map vegetation changes based on slopes; band 5 was used to map the contents and boundaries of biomass; and band 6 is to distinguish soil water content, vegetation, and thin clouds [6]. Our study using composite 564 showed the colour contrast between mangrove and non-mangrove vegetation in the images. Mangrove vegetation represented with dark red colour while non-mangrove vegetation represented with orange colour. This clear boundaries between mangrove and non-mangrove vegetation make it possible to delineate each habitat coverage in the image. The differences in term of results from these two types of composite was from the different uses of bands in each composite. Composite 573 employed band 7 (SWIR-2) and band 3 (Green) while composite 564 employed band 6 (SWIR-1) and band 4 (Red).

Composite RGB 573 uses a visible light band on band 3 (Green). This aimed to map the upper part of the vegetation without considering the differences in the distribution of vegetation based on the slope like the band 4 (Red). Mangrove vegetation usually grows naturally on the coast with lower slope conditions than non-mangrove vegetation. It made RGB 573 composite showing less clear boundaries between mangrove vegetation with non-mangrove vegetation. Besides, differences in the use of shortwave infrared bands (SWIR-2) on composite 573 and shortwave infrared bands (SWIR-1) on composite 564 were resulted in the difference on the research outcomes. The uses of SWIR-2 canal is to map soil moisture, vegetation, and thin clouds, while the function of SWIR-1 canal is to map the differences on soil water content, vegetation, and thin clouds. Although SWIR 2 canal showed the highest OIF value, which typically contained more information, it is not suitable to distinguish mangrove and non-mangrove vegetation.

3.2. Accuracy test on mangrove vegetation cover

A total of 102 ground truth data was employed to validate mangrove and non-mangrove data within the study area. The accuracy test on the 564-composite type showed 86.6% accuracy for the mangrove class and 83% accuracy for non-mangrove vegetation with a total OA (the number of class x in another class) of 9 classes. On the other hands, the accuracy test of the 573-composite type was 47.5% for the mangrove class and 69.5% for the non-mangrove class of with a total OA (number of class x in another class) of 32 classes. Accuracy tests on the two types of composites showed that the 564-composite type resulted in the higher accuracy value compared to the 573-composite type. The following tables presented the accuracy tests of 564 and 573 composite on Pahawang Island.

**Table 1. The 564-composite accuracy test**

| Interpretation Result | Field Data | Mangrove | Non Mangrove | Total | Pixel Omission | MA (%) |
|-----------------------|------------|----------|--------------|-------|----------------|--------|
| Total/OA              | 59         | 43       | 102          | 9     | 85,0           |
| Pixel Omission        | 5          | 4        | 9            |       |                |

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|-----------------------|------------|----------|--------------|-------|----------------|--------|
| Total/OA              | 59         | 43       | 102          | 9     | 85,0           |
| Pixel Omission        | 5          | 4        | 9            |       |                |

**Table 2. The 573-composite accuracy test**

| Interpretation Result | Field Data | Mangrove | Non Mangrove | Total | Pixel Omission | MA (%) |
|-----------------------|------------|----------|--------------|-------|----------------|--------|
| Total/OA              | 59         | 43       | 102          | 32    | 61,4           |
| Pixel Omission        | 31         | 1        | 32           |       |                |

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The delineation process of the satellite image data using the 564-composite type was carried out after the accuracy test. The delineation results of the mangrove class showed that the mangrove total area on Pahawang Island was 51.3 Ha. Furthermore, the largest mangrove coverage was located in the western part of Pahawang Island with an area of 39 Ha. The following figure presented the mangrove distribution map on Pahawang Island.

![Mangrove vegetation distribution at Pahawang Island](image)

**Figure 3.** Mangrove vegetation distribution at Pahawang island

### 4. Conclusion

This study showed that the composite type 564 was the best composite used to evaluate mangrove vegetation distribution using visual interpretation method. Visual interpretation is a significant first step to determine the mangrove distribution. Afterwards, advanced image processing using vegetation index analysis, such as NDVI analysis and other vegetation analyzes, can be carried out. The results of visual interpretation showed that the mangrove cover in Pahawang Island in 2019 was 51.3 Ha with the most significant coverage area located in the western part of Pahawang Island at 39 Ha.

The composite 573, unfortunately, could not distinguish contrasting colour between mangrove and non-mangrove vegetation because of the use of canal type 3 (green), which only identify the presence of mangrove vegetation without distinguishing vegetation based on its slope. Moreover, band 7 (SWIR-2) is less sensitive to reflectance of watery terrestrial area so that it was difficult to distinguish mangrove and non-mangrove areas which resulted in the same dark red colour for both types of vegetation in this study.

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