

Using Landsat-8 Imagery Data on Mapping of the Seagrass Distribution in Matahari Island, Pulau Banyak District, Aceh Province, Indonesia

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Abstract- seagrass meadow has important role as its high productivity in the coastal ecosystem. The reliable information about seagrass extent is essential for proper conservation and management process. Due to their submerged habitat, the seagrass distribution information yet still limited, particularly in Matahari Island, Aceh Province. The acquisition process of seagrass bed information requires remote sensing data along with local expertise and field sampling. The objective of the present study was to gathers information about the seagrass distribution area using the remote sensing that retrieved from Landsat-8 on 28th May 2014. Analysis of Landsat-8 image could be classified into 6 different classes; seagrass, coral reefs, sand, land, sea, and cloud. Ground check in ten sampling points was performed in 22-26 August 2014 to compare in situ evidence to image analytical results. The agreement between the processed image of seagrass bed and ground truth reference was 70%. The seagrass ecosystem is well distributed along the Matahari Island, with the total area approximately 44.0123 ha. There were five species found in Matahari Island Waters ie. *Cymodocea serrulata*, *C. rotundata*, *Enhalus acoroides*, *Thalassia hemprichii* and *Syringodium isoetifolium*

Keywords: Seagrass; Lyzenga algorithmic method; Unsupervised classification

Introduction

Seagrass is an angiosperm and one of the most productive ecosystem in shallow marine waters (Tomascik *et al.*, 1997). Seagrass plays the important role in aquatic systems, for example, produce and export organic carbon, nutrient cycle, producing oxygen in coastal waters, sediment traps and prevent coastal erosion, highly diverse, habitat for many fishes and transfer trophic to the adjacent neighborhood, especially in the tropics and temperate region (Kikuchi, 1980; Orth *et al.*, 2006; Hemminga and Duarte, 2000). In addition, related to the area of nursing, the seagrass has a vital function in diversity, abundance, growth, and survival of aquatic organisms (Coles *et al.*, 1993; Heck Jr. *et al.*, 2003). Seagrass requires special environmental conditions, differences in environmental conditions may cause variations in the distribution of seagrass species (Hemminga and Mateo, 1996). The present serious global problems is the increasing ecological pressures that can lead to degraded seagrass beds (Orth *et al.*, 2006).

Aceh Province has approximately 2.666 km of coastline and some areas are difficult to visit due to lack of infrastructure (Muchlisin *et al.*, 2013). Presently, there was no scientific report on the presence of seagrass ecosystem in the waters of Aceh until we conducted an expedition to the Matahari Island, Aceh Singkil. This report provides the information on the current condition and coverage areas of seagrass in Matahari Island, Aceh Singkil, Indonesia, and due to lack of facilities the examination was conducted using the remote sensing technique. The seagrass bed in Matahari Island is affected by the water of the Indian Ocean, whereas no river was observed being charged into Matahari Island waters.

According to Yang and Yang (2009) and Kuriandewa and Supriyadi (2006) the mapping and monitoring of seagrass ecosystems can be performed using the satellite imagery data. This technique has the advantages in large area covering and less costly and time-consuming (McKenzie *et al.*, 2001). The study of seagrass distribution using satellite imagery data in Indonesia is still limited, as many of its presence in remote areas (Roelfsema *et al.*, 2009). This is the first report on the seagrass distribution from Aceh Province, Indonesia. This information is very crucial to plan an effective management strategy for seagrass ecosystem (Sheaves, 2005; Short and Coles, 2004; Waycott *et al.*, 2004), especially in Aceh Province, Indonesia.

Materials and Methods

This study was conducted in Matahari Island waters, which is administratively located in the Pulau Banyak Sub-district, Aceh Singkil District, Indonesia. Due to its relatively small island, Matahari Island was uninhabited by human. This location was chosen after a preliminary study in order to ensure the existence of seagrass beds in the surrounding area. The Landsat-8 Satellite image data in 28th May 2014 was used in this study with 30 m spatial resolution. The band 2 (Blue) and the band 3 (green) were used to eliminate the influence of depth on seabed reflectance (Lyzenga, 1981) as follow:

$$Y = \ln (\text{Band 2}) + K_i/K_j * \ln (\text{Band 3})$$

Where, Y= Depth-invariant index, Band 2= Blue channel Landsat 8, Band 3= Green channel Landsat 8, K_i / K_j = Attenuation coefficient value.

The unsupervised classification techniques automatically classifying similar pixel spectral based on reflected objects (Green and Mumby, 2000). A total of 19 regions was set based on Lyzenga algorithm training site, and it was later set into six classes using unsupervised classification. The extraction results divided into: seagrass, coral reef, sand, mainland, sea and the clouds (Figure 1).

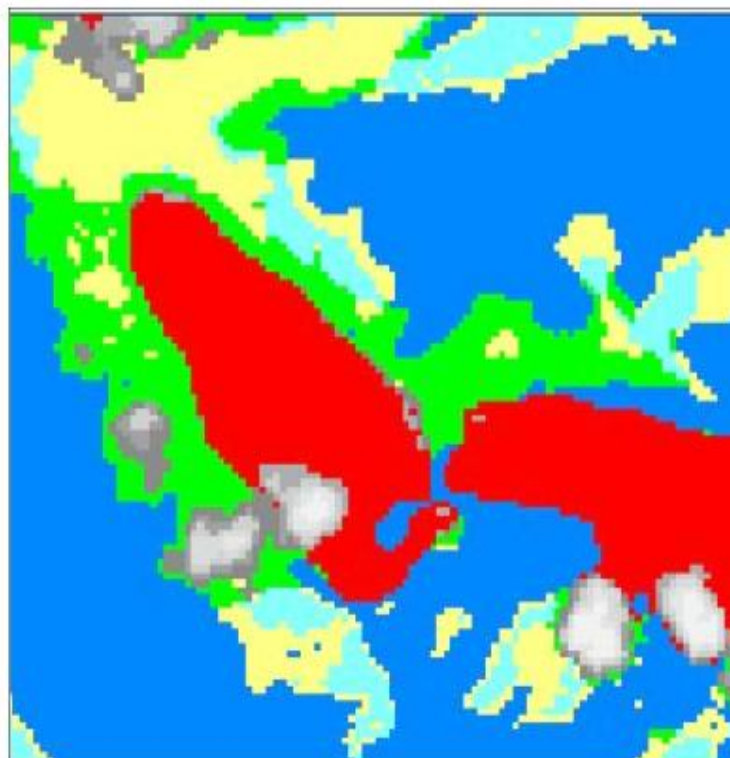


Figure 1. Classes of classification: the seagrass ecosystems (light green), the coral reef ecosystem (bright blue), sand (yellow), the mainland (red), sea (blue) and the clouds (white).

The ground checking was conducted during August 22-26, 2014 to validate the model. The validation process in the field is important in order to validate the obtained results from the model (Yahya *et al.*, 2014). Total of 10 points were chosen purposively to validate the digital data compared with the ground data, and the accuracy test was performed to determine the level of accuracy of seagrass distribution based image classification results with the existing conditions in the field (Figure 2). Test results of the classification accuracy, using the equation:

$$KI = \frac{JKI}{JSL} \times 100\%$$

Where, KI = Accuracy of interpretation, JKI= Total of truth interpretation, JSL= Total of field sample

Results and Discussion

Based on field observations, five species of seagrass were found in the waters of the Matahari Island i.e., *Cymodocea serrulata*, *C. rotundata*, *Enhalus acoroides*, *Thalassia hemprichii* and *Syringodium isoetifolium*, where the south side of Matahari Island provides the occurrence of all these species. The northeast side of Matahari Island provides the highest density of seagrass, with *Enhalus acoroides* was found in dominant. Various parameters such as sandy substrate, shallow water, and conjunction to coral reef were assumed gave advantages for growth of seagrass in the northeast side of Matahari Island. Sediments have a significant influence on the growth and distribution of seagrass, therefore sediment stabilization also plays an important role (Erftemeijer and Herman, 1994; Newell and Koch, 2004). A high abundance of aquatic plants is naturally found in relatively steady water conditions (Madsen *et al.*, 2001). Purnawan (2015) stated that seagrass habitat adjacent to coral reef may result in more stable condition as the coral reef deliver a steady flow through it.

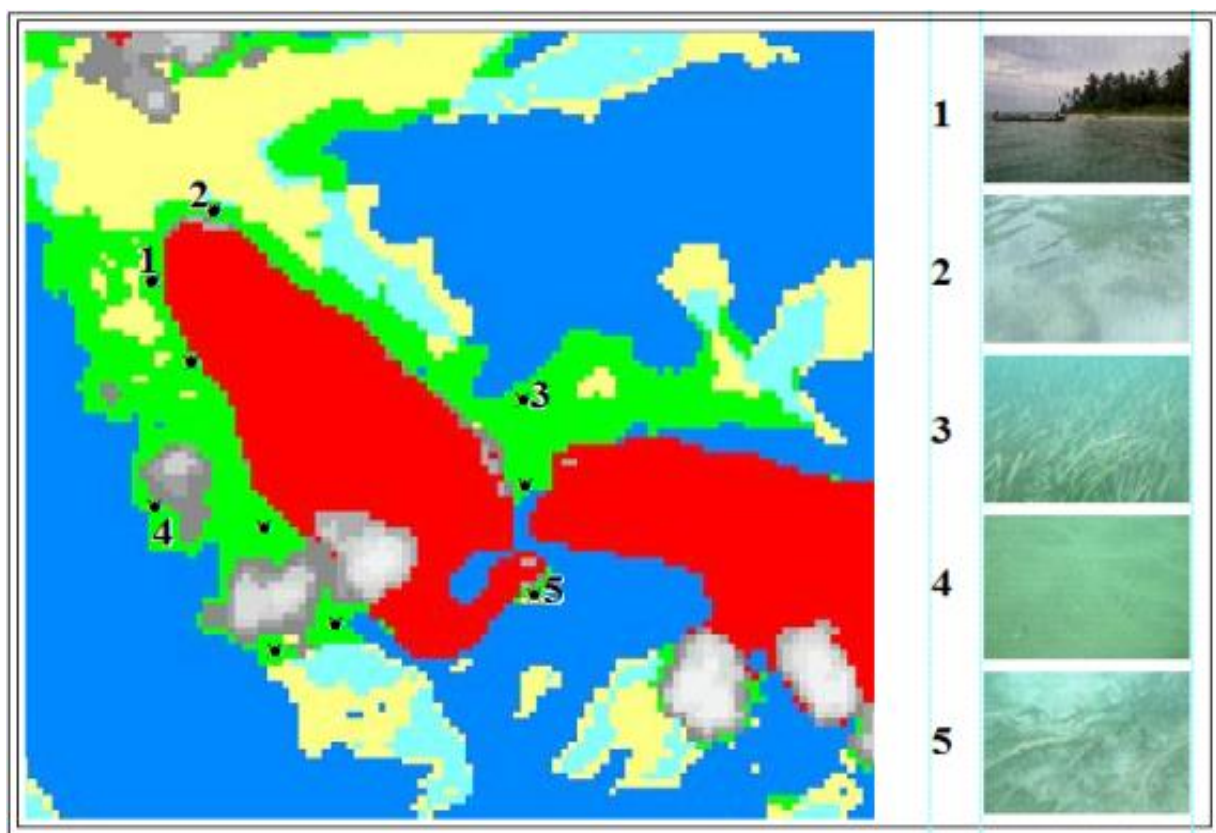


Figure 2. Five of ten points of *in situ* validation results. Description: point 1, 2, 3, and 5 are seagrass, while point 4 is sand.

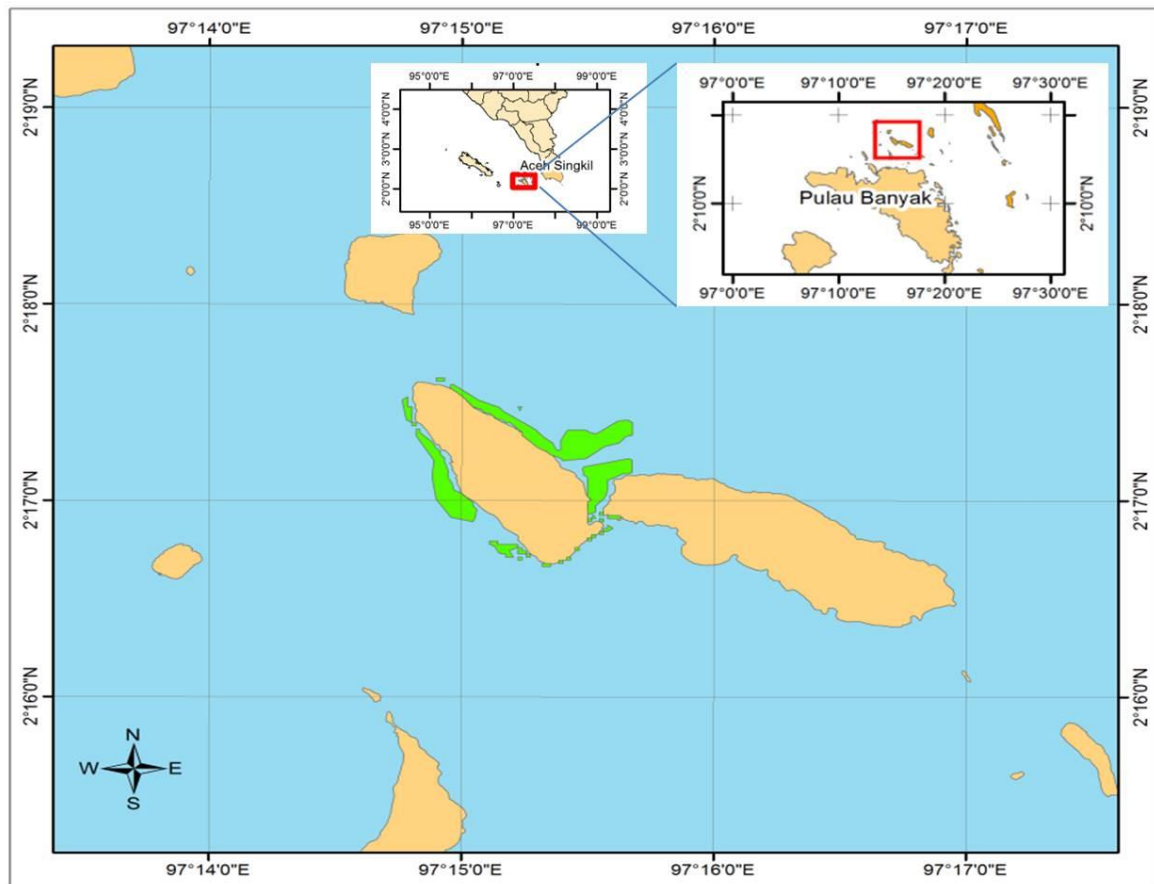


Figure 3. Distribution map of seagrass in Matahari Island, Pulau Banyak Subdistrict, Aceh Singkil

Table 1. The distribution of Matahari Island seagrass.

Site	Area (ha)
North east of Matahari Island	1.2069
West of Matahari Island	11.4054
South of Matahari Island	2.9180
East of Matahari Island	28.4820

Based on 10 ground checking points, the seagrass was present in 7 sampling points (Figure 2). So that the seagrass occurrence areas were classified at 70% overall accuracy of classification. A similar result was reported by Dekker *et al.* (2005) in Kenyan coast, they found the accuracy of classification was 76%. In addition, the higher classification accuracy (90%) was reported by Hashim *et al.* (2014) in Merambong Shoals, located in the Straits of Johor. Both studies used the similar satellite imagery data (Landsat-TM). However, the lower accuracy classification (56.69%) was reported Setiawan *et al.* (2012), this study used ALOS satellite with 10 meter spatial resolution. Compared to others, the results showed fairly good agreement with *in-situ* verifications.

Due to limited spatial resolution and spectral resolution, Landsat-TM result may has inadequate of satellite imagery acquired (Dahdouh-Guebas *et al.*, 1999). According to Ludin *et al.* (2011), research on seagrass use different remote sensing techniques, image classification accuracy ranged from 45% to 85%, although in some cases low resolution is major challenges in identifying the seagrass. In addition, the common problems related to seagrass habitat mapping, particularly in using Landsat imagery is the depth of the waters and turbidity, as decreasing of the signal (Moore, 1980; Roelfsema *et al.*, 2009). Moreover, Green and Mumby (2000) states that the type of imagery

that used can affect the level of accuracy is obtained, the better the spatial resolution of an image the better the value of accuracy that can be obtained. The use of imagery from the IKONOS satellite, which has a high resolution may provide solutions to improve the accuracy of image interpretation (Wabnitz *et al.*, 2008). In line with the statement of Yang and Yang (2009) where the results obtained using QuickBird more accurate than the Landsat-TM.

Based on analysis of satellite imagery (Figure 3), seagrass distribution seen in the waters around of Matahari Island. The northeast and south coast of the Matahari Island have a distribution of seagrass in smaller area, compared to the west and east coasts are vaster. The total area of seagrass based image interpretation is approximately 44.0123 ha (Table 1).

Conclusions

Based on the results of image processing it can be concluded that the total area of seagrass beds in the Matahari Island is approximately 44.0123 ha. The west side of Matahari Island possesses the highest extent of seagrass in the area of 32.0730 ha and the lowest is the northeast side with 1.2069 ha. Based on the accuracy test, the occurrence of seagrass areas were classified at 70% overall classification accuracy.

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