Comparison of seagrass cover from multi-scale imagery

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Abstract. Mapping of seagrass bed can be done by using different characteristics of satellite images data such as Landsat-8 and Sentinel-2. However, there has been no research compared to the results from those images in Indonesia. This study aims to analyze and compare spatially the condition of seagrass bed from Landsat-8 and Sentinel-2 imagery covered Kodingareng Lompo island. Spatially sharpened (Pan-sharpening) Landsat-8 imagery from 30 to 15 meters resolution in four spectral bands (visible and NIR) were used in this case. The results showed the four classes seagrass cover percentage consisted of sparse class (0 – 25%), medium-class (26 – 50%), dense class (51 – 75%), and very dense class (76 – 100%). Classification of seagrass cover class and water column correction (Depth Invariant Index) value differed between the two imageries. Accuracy test of seagrass cover classification from Landsat-8 (88.1%) and Sentinel-2 (89.2%) were both suitable to use since they were higher than the standard value (>85%). Differences in the characteristics of both images cause differences in the results of the seagrass cover classification.

1. Introduction

Seagrass, commonly known as seaweeds, is the only group of flowering plants that live in the sea. This plant lives in shallow coastal habitat [1] and is a supporting component of coastal areas that have various ecological functions [2].

The role of this ecosystem is among others to support the integrity of the coastal area from the threat of sedimentation, namely by the function of seagrass roots that can reduce the strength of wave energy and currents towards the coast. In addition, seagrass ecosystems have an important function in the ecosystem cycle in the sea, namely the availability of nutrients, food, and shelter for marine biota [3].

One way to monitor seagrass beds is by mapping seagrass conditions using remote sensing technology. The advantage of using remote sensing technology is that it is easy to obtain information in a broad scope and in accordance with the time required. To support the accuracy of remote sensing data field surveys are needed.

Research on mapping and monitoring of shallow water ecosystems (coral, mangrove and seagrass) has been widely carried out using satellite imagery data. There are various sources of imagery that can be used to study coastal areas, but what is used in this study is satellite imagery that can be obtained free of charge with the medium resolution, namely Landsat-8 and Sentinel-2. However, the two images have different spatial resolutions, resulting in different outputs.

Seagrass mapping using Landsat-8 OLI (Operational Land Imager) by processing spatial sharpening satellite images (pansharpening). The four spectral bands at a spatial resolution of 30
meters are blue (450-515 nm), green (525-600 nm), red (630-680 nm) and near-infrared (845-885 nm). Then, the processing of pansharpening was conducted in this study so that it became 15 meters. Sentinel-2 imagery can also be used to map seagrass beds because it has four spectral bands at the 10-meter spatial resolution, namely classic blue (490 nm), green (560 nm), red (665 nm) and near-infrared (842 nm) (ESA 2012) so that this Sentinel-2 image might be used in the identification of seagrass cover. Based on the different characteristics of the two images above, spatial seagrass conditions were monitored in the waters of Kodingareng Lompo Island by comparing the results of image analysis obtained from Landsat-8 and Sentinel-2.

2. Method

2.1. Time and Place
Retrieval of field data on August 25-30th 2018 in Kodingareng Lompo Island, Kodingareng Village, Ujung Tanah District, Makassar.

2.2. Tools
The tools used in the field survey activities consisted of 50x50 cm² transects as a tool to limit the sampling area; Global Positioning System (GPS) to determine the position of the research location and coordinates of seagrass cover sampling; Digital camera for taking pictures of seagrass documentation and field activities; Basic diving equipment for seagrass observation; Seagrass identification sheet to assist in identifying seagrass types; Slates and writing tools to record data; and Tagging to mark photos of seagrass transects.

2.3. Materials
The material used in the form of Landsat-8 OLI image data path/row 114-64 with 30 meters resolution and pansharpening so that it becomes 15 meters with the acquisition of April 25, 2018, and Sentinel-2 image data with the acquisition on April 25, 2018, were cloud-free recording time, both of these images obtained from the download on the link (http://glovis.usg.gov).
2.4. Procedures
Some of the steps undertaken in conducting this research procedure are 1) Image Processing, 2) Field Survey, and 3) Data analysis and presented in Figure 2.

![Research flowchart]

**Figure 2.** Research flowchart
3. Results and Discussion

3.1. Percentage of Seagrass Cover on Kodingareng Lompo Island

The percentage value of seagrass cover is obtained through the interpretation of seagrass photo plots; interpretation is made by supervised spectral classification using ENVI software. Guided classification is the process of grouping pixel values in an image into certain classes based on a test sample specified by the user as a reference. Image pixel classification is based on the probability of a pixel value with respect to a particular class of pixel samples. There is a threshold value at the Maximum Likelihood that must be achieved so that the pixel can be explained.

Figure 3. The results of the classification of seagrass photos using ENVI software

Photo classifications are limited to the interior of the transect. Cropping the transect so that the image pixels outside the transect do not disturb the interpretation of the image. Calculated using a quick stat on ENVI to determine the percentage of photo pixels as seagrass class and sand class.

![Figure 3](image)

Figure 4. The average yield of seagrass cover at each station on Kodingareng Lompo Island

The results of the percentage of seagrass cover on Kodingareng Lompo Island in 5 observation

![Figure 4](image)
stations divided into two substations, and each substation consists of 6 plots based on the scale of seagrass cover conditions according to [4] on average at a level of 25-50% class is dominating at each research station. Stations 1 and 2 are dominated by sparse class types with a percentage of 0-25%. Stations 3 and 5 are dominated by medium class, with a percentage of 26-50%. Station 4 is dominated by dense classes, with a percentage of 51-75% (Figure 4). The high seagrass cover at Station 4 is due to the condition of the calm water without a lot of ecosystem disturbance, and the lowest seagrass cover is at stations 1 and 2 due to the condition of the station is a small fishing boat transportation area that will lean on Kodingareng Lompo Island.

Seagrass closure in the waters of Kodingareng Lompo Island, where areas that have been disturbed by human activity have the smallest percentage of closure. As in stations 1 and 2 caused by household waste disposal and community activities. Seagrass closure will be higher in natural areas, namely in areas far from the coast. According to [5], the area of cover and distribution of seagrasses can be influenced by the availability of nutrients on the substrate that is uneven so that seagrasses only grow at a certain point.

3.2. Seagrass cover area

| IMAGERY   | SEAGRASS COVER AREA (% COVER) |
|-----------|------------------------------|
|           | AREA OF CLASS SEAGRASS COVER IN KODINGARENG LOMPO ISLAND (LANDSAT-8) | |
| LANDSAT-8 | 0-25% (Sparse condition) | 0-25% (Sparse condition) |
|          | 26-50% (Medium condition) | 26-50% (Medium condition) |
|          | 51-75% (Dense condition) | 51-75% (Dense condition) |
|          | 76-100% (Very dense condition) | 76-100% (Very dense condition) |
|          | 19% | 19% |
|          | 1% | 61% |
| SENTINEL-2 | 0-25% (Sparse condition) | 0-25% (Sparse condition) |
|          | 26-50% (Medium condition) | 26-50% (Medium condition) |
|          | 51-75% (Dense condition) | 51-75% (Dense condition) |
|          | 76-100% (Very dense condition) | 76-100% (Very dense condition) |
|          | 26% | 26% |
|          | 14% | 14% |
|          | 62% | 62% |
From the results of the pie chart (Table 1), the difference in the extent of seagrass cover in Landsat-8 and Sentinel-2 images, it can be seen that the largest area-wide difference occurs in the medium class (26-50%). Because many of the seagrass classes are covered by sand substrate when collecting data in the field, so Landsat-8 cannot clearly detect seagrass cover and detect it as a class that approaches the pixel value of that class which is partially mixed with sand substrate.

This is supported by the results of research by [6] that Landsat-8 OLI produces a classification that is almost similar to Sentinel-2, but it is not appropriate to classify pixels that are close to the coastline due to mixing of pixels between seagrass and sand. So Landsat-8 causes more errors in classifying seagrass cover conditions than Sentinel-2.

The difference in interpretation results is due to differences in the characteristics of the two images, where the values of the Depth Invariant Index (depth correction) are both different, resulting in a different classification of seagrass cover. In addition, Landsat-8 imagery as a result of pansharpening has a spatial resolution of 15 x 15 meters, while Sentinel-2 imagery has a spatial resolution of 10 x 10 meters. This difference can cause a shift in the area for reading seagrass cover conditions.

According to [7], in general, the overall classification accuracy is positively correlated with the spatial resolution of the image. Then, [8] added that the smaller the pixel size, the more vegetation that can be identified. The difference in the extent of seagrass cover can be seen in the map overlay analysis results below (Figure 5).

3.3. Validation Test Results

An accuracy test is intended to measure accuracy in image interpretation. In this accuracy test, the classification results will be compared with the actual conditions in the field by reference to points taken in the field, and are considered to represent all categories of percent seagrass cover of sparse
classes (cover: 0-25%), medium-class (cover: 26-50%), dense class (cover: 51-75%), and very dense class (cover: 76-100%). The accuracy test results for Landsat-8 and Sentinel-2 images can be seen in the table below.

Table 2. The accuracy of Landsat-8 test results using the Blank Error Matrix

| LANDSAT-8 CLASSIFICATION RESULT | TOTAL LINE | USER ACCURACY |
|---------------------------------|------------|---------------|
| 1                               | 17         | 89.5          |
| 2                               | 4          | 77.8          |
| 3                               | 0          | 100           |
| 4                               | 0          | 100           |
| TOTAL COLUMN                    | 21         | 88.1          |
| PRODUCER ACCURACY               | 81.0       |               |
|                                 | 91.3       |               |
|                                 | 80         |               |
|                                 | 100        |               |
| OVERALL ACCURACY: 88.1 %        |            |               |

Table 3. The accuracy of Sentinel-2 test results using the Blank Error Matrix

| SENTINEL-2 CLASSIFICATION RESULT | TOTAL LINE | USER ACCURACY |
|---------------------------------|------------|---------------|
| 1                               | 21         | 87.5          |
| 2                               | 0          | 87.0          |
| 3                               | 0          | 100           |
| 4                               | 0          | 100           |
| TOTAL COLUMN                    | 21         | 89.2          |
| PRODUCER ACCURACY               | 100        |               |
|                                 | 87.0       |               |
|                                 | 70         |               |
|                                 | 100        |               |
| OVERALL ACCURACY = 89.2 %       |            |               |

Table 4. Class description of seagrass cover classifications

| CLASSIFICATION | SEAGRASS COVER |
|----------------|----------------|
| 1              | 0-25 %         |
| 2              | 26-50 %        |
| 3              | 51-75 %        |
| 4              | 76-100 %       |
|                | Sparse condition |
|                | Medium condition |
|                | Dense condition |
|                | Very dense condition |

The two tables above (Table 2 and Table 3) show the procedure test results obtained from the correct number of points in each field reference class divided by the number of columns, while user accuracy is obtained from each correct field reference class divided by the number of rows. Based on the results of the accuracy-test using the Blank Matrix Error table, it shows that the results of the classification conducted for Landsat-8 images in a percentage of 88.1%. While for Sentinel-2 imagery, it was 89.2%. This means that the results of the classification of the two images carried out in accordance with data in the field because it exceeds the value of the accuracy-test standard, according to Anderson (1976), which must have a minimum value of 85%. It can be seen from the results of the accuracy test of the two images; there is a very significant difference in the accuracy of the medium class (26-50%), where the Landsat-8 image has a much lower accuracy than the Sentinel-2 image for the class.

4. Conclusion

Based on the results of research conducted, the following conclusions are seagrass cover conditions...
that were the result of the classification of Landsat-8 and Sentinel-2 images on Kodingareng Lompo Island which dominated were sparse classes (0-25%), the extent of seagrass cover from 4 classes obtained differed between Landsat-8 and Sentinel-2, and the results of the accuracy-test for the classification of seagrass cover Landsat-8 and Sentinel-2 are both feasible to use because they have exceeded the value of the accuracy-test standard (> 85%).

**Suggestion**

Accuracy in the results of image classification will depend on the spatial accuracy of the image and the accuracy of the GPS used. Therefore, it is better to do the method of mapping seagrass conditions using high-resolution imagery and using GPS, which has high accuracy to minimize the shift in the extent of seagrass cover in the image.

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