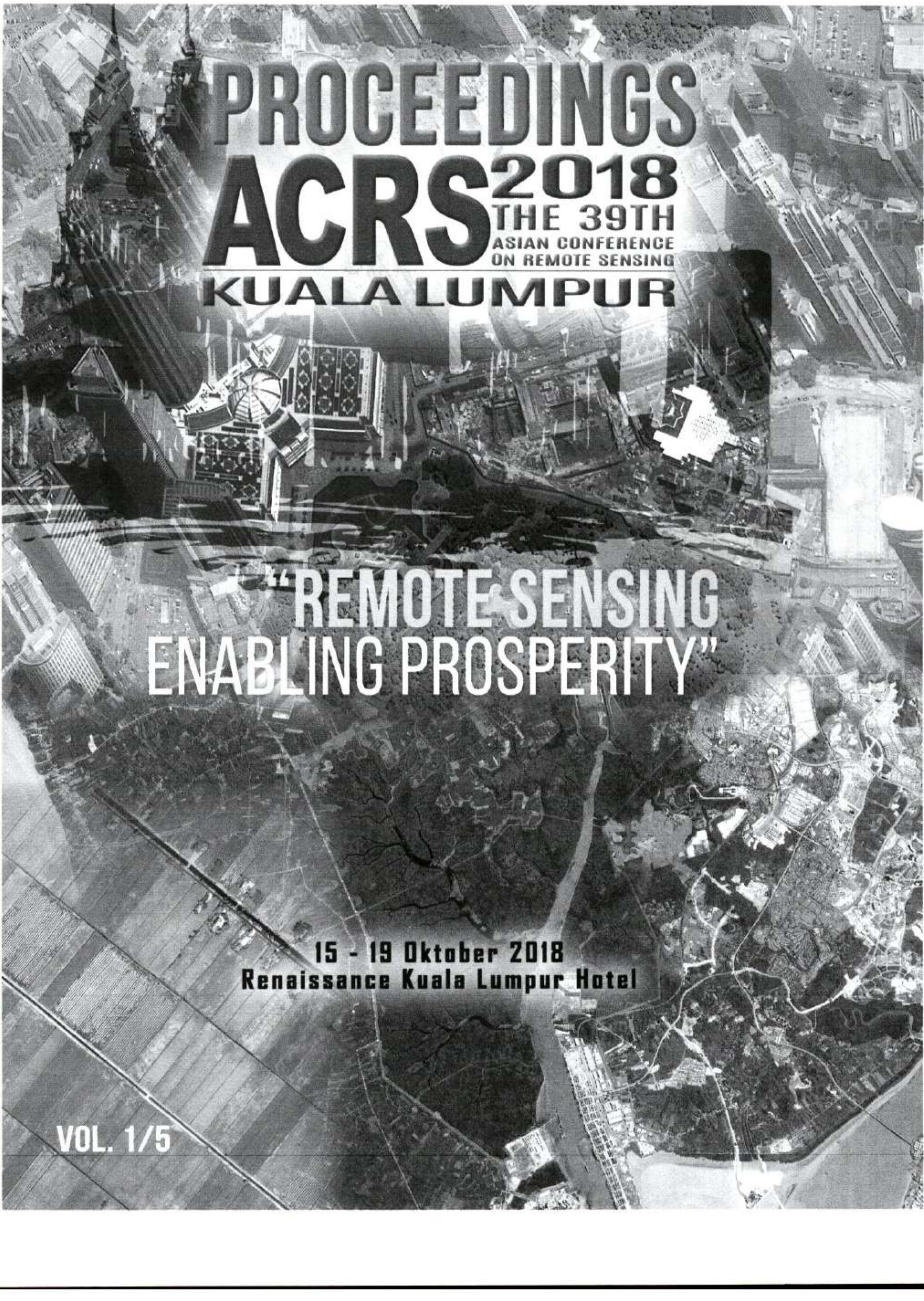

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Discriminating Seagrass Density from Satellite Imagery using Pixel and Object Based Classification Method on Small Island, Spermonde Archipelago-Indonesia

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KEYWORDS: SPOT 6, Sentinel-2A, Lyzenga, Seagrass,Spermonde

ABSTRACT: Remote sensing technology provides a reliable means of creating an inventory of coastal natural resources to assit with their management. The purpose of this study was to discriminate seagrass density using medium and high resolution satellite imagery. The field survey was conducted on Bahuluang island, Spermonde archipelago.Imageryof Sentinel-2a as medium resolution (10 m) and SPOT-6 as hight resolution (1.5 m) were used to discriminate the seagrass. Both pixel-based (k-Means). Object-based classification was used as an approach of *Nearest Neighbor* (KKN) methods using segmentation method before doing classification, and in this methode used parameters that must be determined in *example based feature extraction workflow* using *Edge scale level* dan *full lamda scale level* algorithm, namely parameters of *spectral, texture,* and *spatial*. Pixel-based classification methods provideds better over all accuracy than object-based classification and can be used for seagrass mapping in the Spermonde Archipelago. However, it is necessary to conduct a more detail assessments at different water depths.

1. INTRODUCTION

The use of remote sensing technology is often used in identifying and monitoring the natural resources of an area. As an example of the target of attention to date is the existence of coastal ecosystems, such as mangroves, seagrass and coral.

The existence of remote sensing technology has been assessed to be effective and efficient in monitoring the bottom of shallow water habitat. Image recording results are able to distinguish both closed objects and certain depth limits called optical depth limits (Green, 2000). The application of the blue channel to get a description of the type of basic object of the water has been done using lyzenga algorithm (Nurdin 2009 and 2014). Whereas the application of object-based classification using the *K-nearest neightbour* (KKN) method has been carried out on the base object water cover (Hafizt, 2017) and pixel-based classification with the K-means method for the bothom of shallow water habitat closure using medium-resolution satellite imagery data

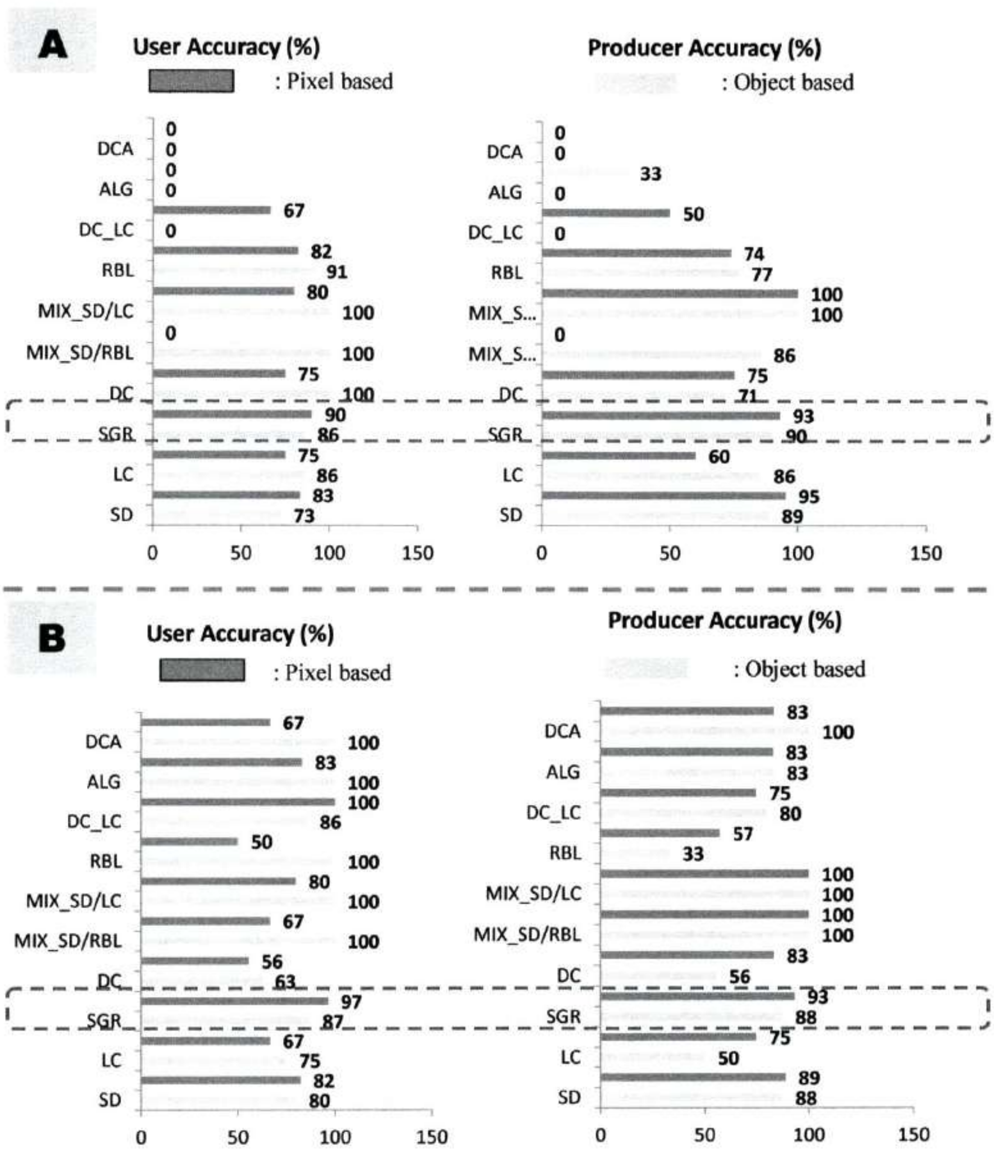

Figure 5. Result of producer and user accuracy values of each classes benthic habitat maps. A) Sentinel-2a imagery, B) SPOT-6 imagery. The description on the chart marked with a red square is a percent accuracy of seagrass.

Based on Figure 5, it can be seen the results of accuracy testing for Sentinel-2a and SPOT-6 imagery in classes that have a higher base using pixel, both from the accuracy of the producer and user. The map can be used for 85% and as data material for future data information needs. Anderson (1976) says that the thoroughness results of the classification must have a minimum value of 85% .

3.2 Discussion

Pixel-based classification method that has a higher overall accuracy value compared to the results of object-based classification still has errors. Errors in clarity occur between coral reef classes and seagrass beds. These differences can be seen in Figure 3. The results of classification of seagrass beds on SPOT-6 images detected coral reefs and dead corals on the classification results using Sentinel-2a imagery. This is because both objects have relatively similar spectral patterns (Hafizt and Danoedoro, 2015). The similarity in spectral values possessed by these two objects causes the classification errors between the two objects to still exist. So that the sampling of field data for these two objects must be really good. In addition, in this study there are differences in pixel-based classification results using two different imagery data. In the use of SPOT-6 image data, there are new object classes, namely algae (ALG), dead coral-live coral (DC-LC), and dead coral algae (DCA) classes. For more details can be seen in Figure 4. This is caused by the spatial resolution of SPOT-6 imagery data that is higher than Sentinel-2a imagery data.

In this study object-based classification has not been able to classify objects according to the class built in the field. Especially the cover of the mixed class of seagrass meadows made in one class object from the classification results, both using Sentinel-2a and SPOT-6 image data. This can be seen in the object classification accuracy value in Figure 5. Producer accuracy and low user value for seagrass class compared with homogeneous class cover such as sand, mixture of sand and live coral, and sand mixture with rubble. Low accuracy values on the classification results using object-based classification method is caused by several factors, both image processing techniques and the quality of field samples used when performing classification and accuracy testing processes. In this method many spectral, spatial, and texture parameters are used as a reference in producing the segmentation polygon-polygone form. This approach is different from the results of pixel-based classifications that use pixel values as a reference in classifying objects (Hamylton, 2017). Therefore the selection of other algorithms as well as parameter attributes in object-based classification methods allows it to produce good accuracy values. In addition, in this study there are differences in object-based classification results using two different imagery data. In the use of SPOT-6 image data, there are new object classes, namely algae (ALG), dead coral-live coral (DC-LC), and dead coral algae (DCA) classes. For more details can be seen in Figure 4. This is caused by the spatial resolution of SPOT-6 imagery data that is higher than Sentinel-2a imagery data.

Another thing that can be seen from the results of object-based classification is the result of the overall accuracy test that has the same percentage of both the Sentinel-2a and SPOT-6 imagery which is equal to 80.85%. The similarity of the percentage value is caused by the uneven distribution of field sample data collection. In addition there is the influence of cloud shadow on the SPOT-6 imagery, especially in the study area, where when recording the Orientation angle conditions are at + 183.08 ° and Inncidence angle is at + 26.22 ° (metadat SPOT-6 image products issued by LAPAN). So that the results of the classification for the sand class wider in the SPOT-6 image are compared to the Sentinel-2a image (Figure 4).

4. CONCLUSIONS

The use of Sentinel-2a and SPOT-6 image data can be used to map benthic habitat in the shallow waters of Bahuluang Island, Spermonde Archipelago-Indonesia by using an pixel-based and object-based classification approach. Pixel-based classification using the *K-means* method is considered to be better, although it still has a classification error with an accuracy value above 85% and can distinguish more object classes according to the conditions in the field. Whereas the habitat class produced by object-based methods cannot accommodate class findings in the field, so it needs to be classified, so that it requires attribute parameters that are suitable for the next classification system.

Spatial information generated from object-based classification uses Sentinel-2a and SPOT-6 image data lower than pixel-based. However, these results can provide an overview of the condition of the shallow waters of Bahuluang Island in May 2018. Improvement of methods for using other algorithms in object-based methods needs to be improved to obtain high accuracy. If the accuracy is accuracy of object classification is higher than pixel classification, so it can be used as a reference for the use of intermediate image data such as Sentinel-2a to monitor changes in conditions and the extent of benthic habitat of an island or shallow water.

ACKNOWLEDGEMENTS

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(Thalib, 2018). So the use of methods in this technology needs to be developed to be able to obtain spatial information which can later be used as basic information in future research.

The SPOT-6 satellite is a SPOT generation with a relatively high image resolution and the first generation has a large multispectral color channel with a wavelength of 0.450-0.520 μm. This blue spectral channel is often used to detect the bottom of shallow water habitat in processing satellite imagery data. Other multispectral canals with 6 m resolution are green canals (0.530-0.590 μm), red (0.625-0.695 μm) and NIR 0.760-0.890 μm), while panchromatic channels that have a spatial resolution of 1.5 m with wavelengths 0.450-0.745 μm (Hellmann, 2015).

Medium image types that have a spatial resolution of 10 meters are Sentinel-2a. As with SPOT-6, this type of image has blue multispectral channels (490 nm), green (560 nm), red (665 nm) and NIR (842 nm) (ESA, 2012). Based on the results of this image processing, Sentinel-2a was able to detect the basic objects of the waters, especially seagrasses (Thalib, 2018). Therefore in this study it is considered able to see the difference in the use of medium and high resolution image data in classifying pixel-based and object-based in monitoring the condition of the bottom of shallow water habitat.

2. MATERIAL AND METHODS

This section discusses are the location of the research, the type of data used and how the data is processed.

2.1 Study area

This research on 24th March 2018 was conducted in shallow waters of Bahuluang-Spermonde Islands in Takalar section with 594 Ha with a geographical location of 119 ° 13'50. 67 BT and 5 ° 27 '20.58 "LS (Figure 1).

2.2 Data Collection

The main types of data are satellite image data obtained free of charge and data obtained from the National Institute of Aviation and Space (LAPAN Pare Pare - Indonesia). There are two types of image data used, namely Sentinel-2a (medium resolution) satellite image with acquisition on 5th May 2018 and SPOT-6 satelite image (high resolution) with acquisition on 15th May 2018. The sensor characteristics used can be seen in Table 1.
Scane ID Sentinel-2a:

"S2A_MSIL1C_20180505T022331_N0206_R103_T50MQV_20180505T035631"

Scane ID SPOT-6 :

"ORT_SPOT6_20180515_020054000_000"

While the secondary data used is in the form of tidal data released by the Geospatial Information Agency (BIG) Indonesia. This data is used to determine the condition of the waters with the condition of satellite imagery when recording.

2.3 Processing Imagery

The study area in this study is located in the Bahuluang-Spermonde Islands which focus on the bottom of shallow water habitat area by utilizing Sentinel-2a and SPOT-6 imagery data. The selection of two imagery data is based on the aim of the authors who want to see the comparison of the results of the results of the classification of medium and high resolution image data using pixel-based methods and objects.

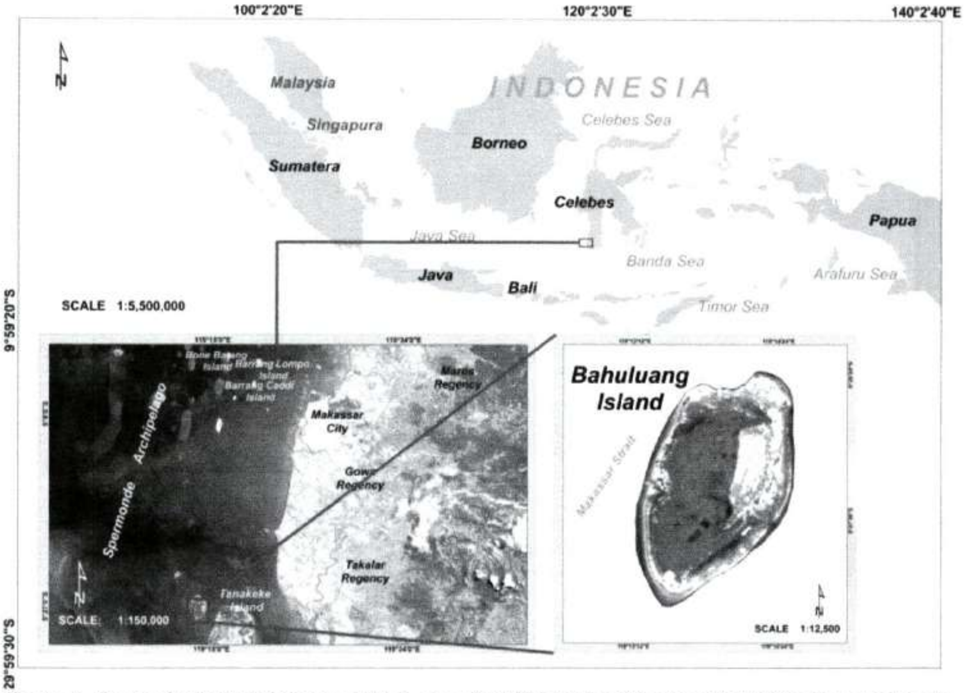


Figure 1. Research site is Bahuluang Island, one of small island on Spermonde Archipelago-Indonesia

This study consists of three stages: initial image processing, field survey and advanced image processing. In the initial image processing, the process of atmospheric correction uses the *Dark Object Subtraction* (DOS) method which is done to clarify visuals of an image, so as to provide an object that is better than before. It aims to facilitate the process of interpreting objects. This correction can also eliminate invasion errors as a result of atmospheric scattering (*path radiance*) during the image recording process. As a basis for this method is "*that the number of pixels taken from deep water and the Digital Number (DN) value are then deducted from each band*". The formula can be seen in Equation 1 (Green, et al., 2000).

$$Li - Lsi \qquad (1)$$

Where:

Li : pixel of radiance band i and

Lsi : the average value of light for the water column in the band i

The pixel value that has been converted into a surface reflectance value or $\rho_{surface}$.will be used later in the water column correction process so that this reflectance value is then the initial data to enter data into the Lyzenga algorithm. But before applying the algorithm, first know the land and sea limits. So that the water column correction process focuses on shallow water areas where there are coral reef habitats and wilderness areas. Then cropping the image to facilitate image processing and reduce the size of the image that is too large so that it only focuses on the study area. In this scane, Bahuluang Island is located at position 119 ° 13'50. 67 BT and 5 ° 27 '20.58 "LS, as shown in Figure 1. The geometric corrections for the two types of images used are not performed. Both types of images are corrected outputs. Sentinel-2 image types are corrected image outputs. geometric and radiometric (ESA. 2012), while SPOT-6 is an image product that has been corrected by Ortho by National Aeronautics and Space Agency (LAPAN Pare Pare-Indonesia).

Table 1.Sensor characteristics

Charasteristics	**Sensor**	
	Sentinel-2a	**SPOT-6**
Temporal resolution (day)	5	26
Spatial resolution (m)		
- Multyspektral	10	6
- Pankromatik		1.5
Acquisition	05th May 2018	15th May 2018
Spectral (nm)		
- Blue	450-520	490
- Green	530-590	560
- Red	625-695	665
- NIR	760-890	842
- Pankromatik	450-745	-

The new channels that have become reflectance values are then corrected using the Lyzenga algorithm. This correction aims to correct errors in pixel values that occur due to the effect of energy attenuation by the water column (attenuation). Weakening of the values in the water column causes differences in pixel values on the same object and at different depths. There is an assumption that the deeper the waters, the resulting reflectance value will be smaller in each visible channel (Green, 2000). So that the water column correction equation in each channel can be constructed from a simple linear regression equation between the visible channel combinations used in the form of equations like the following:

$$Y = a + bX \qquad (2)$$

Where:

Y : value ln (Bi)

a : ratio value of the reduction of the band-i variance and the band-j with the band-i and band-j value covariance

b : value Ki/Kj

X : value ln (Bj)

Value Ki/Kj are calculate using the equition :

$$Ki/kj = a + a\sqrt{(a^2+1)} \qquad (3)$$

$$a = \frac{(varXi - varXj)}{2\,covXiXj} \qquad (4)$$

Where:

Xi : Variance value of *band* i,

Xj : Variance value of *band* j and

XiXj : Covarianceof *band* ij.

The extraction results of reflectance values obtained from the same object reflectance value as a sample are objects of sand, because the appearance of sand objects that can be identified at different depths. These samples are selected as region of interest (ROI) on Sentinel-image data 2a or SPOT-6.

Then conducting field survey activities conducted in May according to the month where image data is obtained so that the proximity of field conditions is similar to the conditions in both image data when recording is done. This field survey aims to obtain the sampling point data as a reference when conducting the next classification process. As for sampling points at different depths in the area of sand objects taken as many as 15 points. Whereas sampling points of objects on the base cover in the shallow waters of Bahuluang island are 65 points. Everything will be used when doing pixel-based or object-based classification processes and when testing the accuracy of the classification results. Whereas field data retrieval in the form of photos of transects that have been modified (Roelfsema and Phinn. 2009). The sample data taken is in the form of images of object images recorded in the form of photographs using underwater kamrea. The description of the object is recorded manually which aims to control the errors when interpreting after survey in Lapanagan with the help of android-based application, namely the AVENZA App. The position of each object is also recorded using the *Global Possitioning System* (GPS) with an accuracy of 3 m. Based on the results of the field survey, the description of the basic objects of the waters will be known and then reinterpreted when conducting classification following the classification system in previous studies (Mumby. 2009).

Pixel-based classification method using an unsupervised classification approach, namely K-means. Classification method based on pixel is classification simply categorise pixel based on the internal statistical properties of an image. These operate in *feature space,* in which the response of an individual pixel is plotted as a function of reflectance corresponding to the different wavelengths of light detected. Pixel are plotted within an *n*-dimensional space that is governed by the spectral resolution of the sensor. Within this space, algorithm group clusters of pixel together based on the principle that similarities in their reflectance properties indicate similar ground cover types (Hamylton, 2017).

Object-based classification method using a segmentation approach. This segmentation process requires setting the Edge scale level, full lamda scale level, and kernel size to analyze pixel value limits between objects and used to adjust the polygone size resulting from the segmentation process, so that it will get an overview of the segments of the object captured by the image. So for the next classification process using the *nearest neighbor method* (KKN). This method uses all attributes in the form of *spectral, texture,* and *spatial*. In addition, it also requires segment polygons that are used as a sample or *area of interest* (AOI).

The next process is to make tentative maps of the basic habitat of Bahuluang Island waters through two different classification methods, namely pixel-based and object-based. Then look at the presentation value of the best classification results. The accuracy test uses matrix *confusion test table* (Richards, 2006).

3. RESULT AND DISCUSSION

3.1 Result

Image processing which consists of atmospheric correction, gradual attenuation correction and classification process. Corrections made to change the pixel value to reflectance are done automatically by the program. The attenuation correction is done by building the equation first by using the reflectance correction result input data. Furthermore, the classification process is also automatically carried out using the program by determining the value of the classification sample used.

3.1.1 Atmospheric correction

Atmospheric correction results using the "*Dark Object Subtraction* (DOS)" method can be seen from the changing pixel values. Previous pixel values in the form of reflectance values on satellites are then converted to *surface reflectance* values. So that the reflectance value of the surface ranges between 0-1. Where according to Green (2000) that the basic assumptions in the picture of several complete shadow pixels and radiances received by the satellite and caused by atmospheric scattering (*path radiance*). This assumption is combined with the fact that very few targets on the earth's surface are absolute black, so it is assumed that a minimum one percent reflectance is better than zero percent.

3.1.2 Water column correction

Before correcting the water column, *masking* the land and sea boundaries needs to be done to facilitate the transformation and classification process. The method used is by digitizing the land part in the image. So that the sea area is allowed to continue to carry *surface reflectance* values, while the land area is left to have a value of 0 (*null*) so that at the time of transformation and classification there is no interference from the land value.

Furthermore attenuation correction begins with the selection of sand samples at different depths in the form of *region of interest* (ROI). The difference in depth in the sand object has a relationship with the channel that is normalized process (ln) which can be seen in the regression graph (Figure 2). The relationship is directly proportional, so it might be used in equations 2-4.
A total of 22 sample points from the field survey results are used as ROI used in attenuation correction. By using equations 3 and 4, the Ki / Kj value is 0.9102 for Sentinel-2a and 0.7464 for SPOT-6 imagery data. This value is used in the Lyzenga algorithm in the program.

The results of the correction of the water column in the form of a new channel from the inter-channel combination results appear in the Sentinel-2a and SPOT-6 imagery (blue channel and green channel). The water column attenuation correction image results then becomes the same input data for two different classification techniques, namely pixel-based classification using the k-means method and object classification through the example *based feature extraction workflow*.

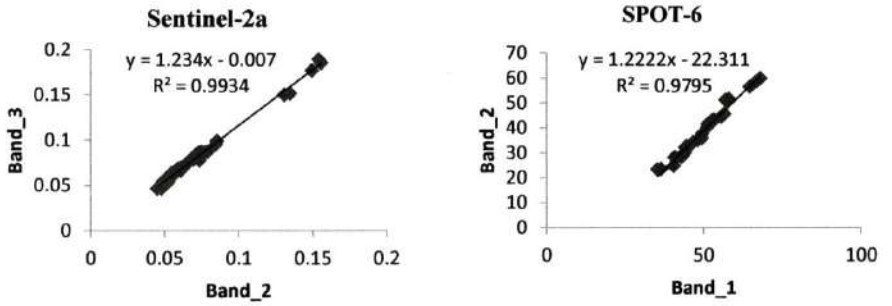


Figure 2. Regression plot between two visible bands (normalized in *ln*) collected from sand samples at different depth on survey.

3.1.3 Field survey

Field sampling resulted in 112 sample points used for the classification process and accuracy testing. Variations in sample classes can be seen in Table 2 which are built based on objects in the field. The class variation is a variation of benthic habitat cover that can be found when making data collection directly in the field.

Table 2. Details of The Bothom of Shallow Water Habitat Classes from Field Survey, May 2018

Class of Benthic Habitat	Classification Method Based			
	Pixel		Object	
	Sentinel-2a	SPOT-6	Sentinel-2a	SPOT-6
SD	√	√	√	√
LC	√	√	√	√
SGR (Seagrass Cover)	√	√	√	√
- Class 1 (>75%)	√	√	√ (just one class of seagrass)	√ (just one class of seagrass)
- Class 2 (50.5-75.5%)	√	√		
- Class 3 (25.0-50.4%)	√	√		
- Class 4 (5.5-25.4 %)	√	√		
- Class 5 (<5.5 %)	√	√		
DC	√	√	√	√
MIX-Sand/RB	√	√	√	√
MIX-Sand/LC	√	√	√	√
RB	√	√	√	√
DC-LC	-	√	-	√
AL	-	√	-	√
DCA	-	√	-	√

Note : SD= Sand, LC= Life Coral, SGR= Seagrass, DC= Dead Coral, RBL= Rubble, ALG= Algae, DCA= Dead Coral Algae.

3.1.4 Classification

Pixel-based classification uses sample classification data by setting the desired *number of Classes* that will be automatically formed by the program. The value used is equal to 20 (used for Sentinel-2a and SPOT-6 image data) with the assumption that the result of this pixel-based classification results in a total of 20 basic object classes which are then reclassified according to the variation of object classes found during the field survey. From the results of pixel-based classification for Sentinel-2a image data, the number of basic object classes is 11 classes, namely Sand; Life Coral; Dead Coral; Mix-Sand and Rubble; Mix-Sand and Life Coral; Rubble; and 5 classes of Seagrass. Whereas for SPOT-6 image data, there are 14 classes of basic object classes, namely Sand; Life Coral; Dead Coral; Mix-Sand and Rubble; Mix-Sand and Life Coral; Rubble; and 5 classes of Seagrass (Figure 3). This condition is obtained from the classification by calculating the classification area for each class on the imagery recording at low tide (BIG, 2018).

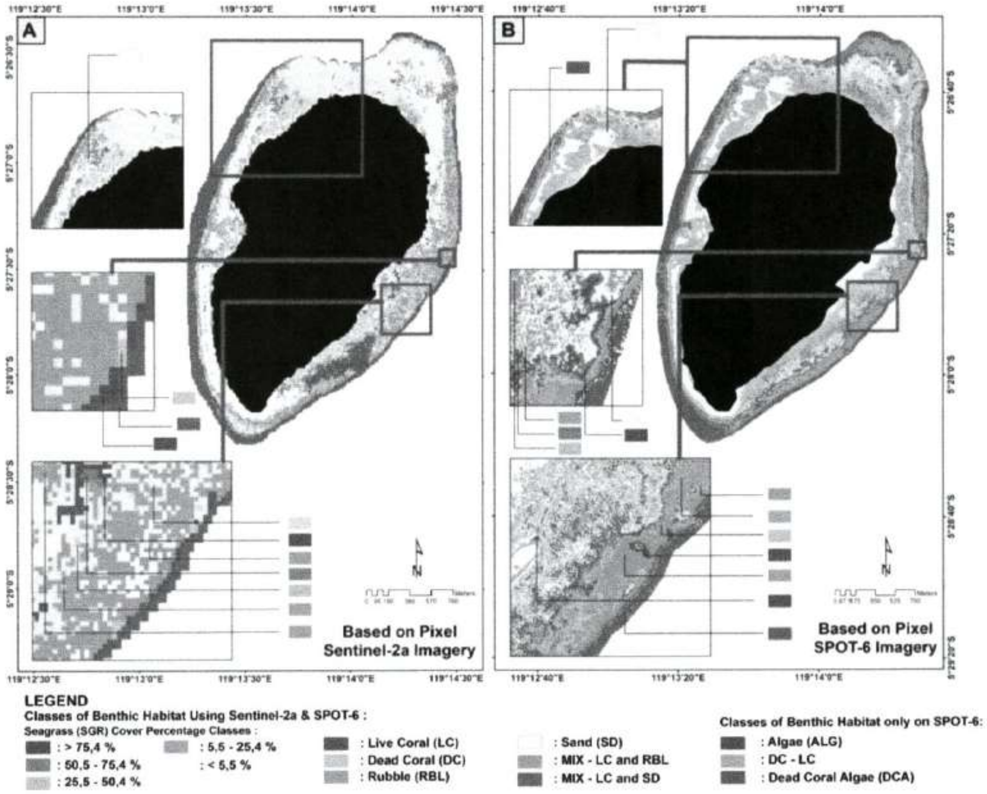


Figure 3. Result classification with the based on pixel. A) Classification based on pixel using Sentinel-2a, B) Classification based on pixel using SPOT-6,

Object-based classification results through two stages, namely segmentation and classification. For Sentinel-2a image data at the segmentation stage using an algorithm consisting of *Edge scale level* 30 and *full lamda scale level* 10, besides that the *texture kernel size* used is 3 with attributes consisting of *spectral, texture,* and *spatial* on all new channels resulting attenuation correction. Whereas for SPOT-6 image data in the segmentation stage using an algorithm consisting of *Edge scale level* 90 and *full lamda scale level* 30, besides that the kernel size texture used is 3 with attributes consisting of *spectral, texture,* and *spatial* on all new channels the attenuation correction results. In contrast, the classification phase uses the *K-nearest neightbour* (KKN) method for both types of image data (Figure 4). This condition is obtained from the classification by calculating the classification area for each class on the imagery recording at low tide (BIG, 2018).

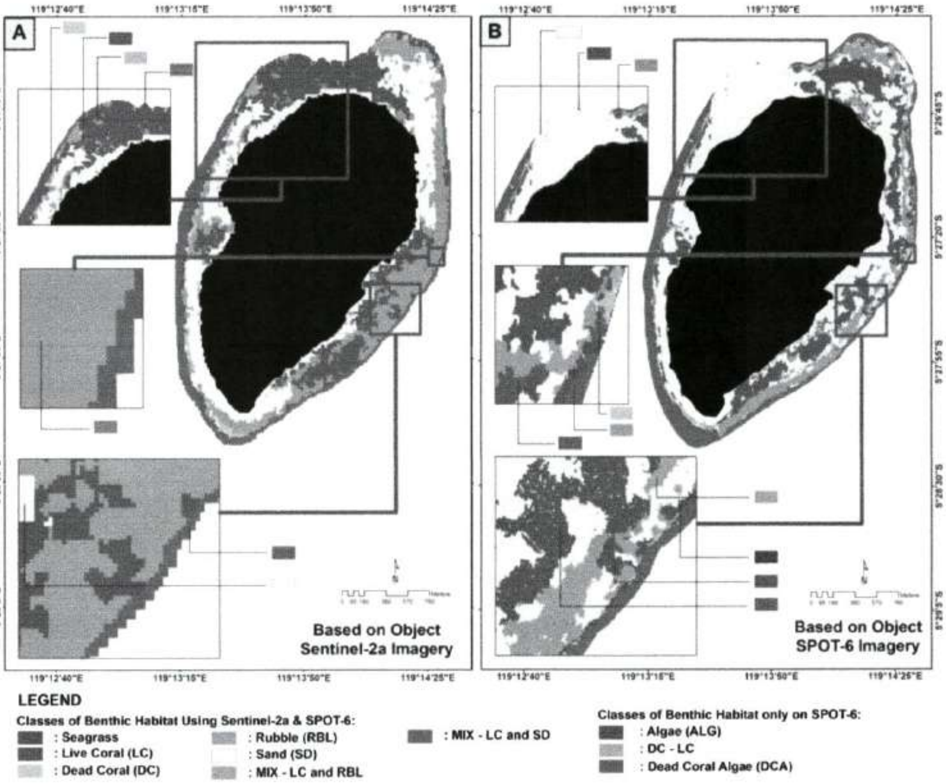
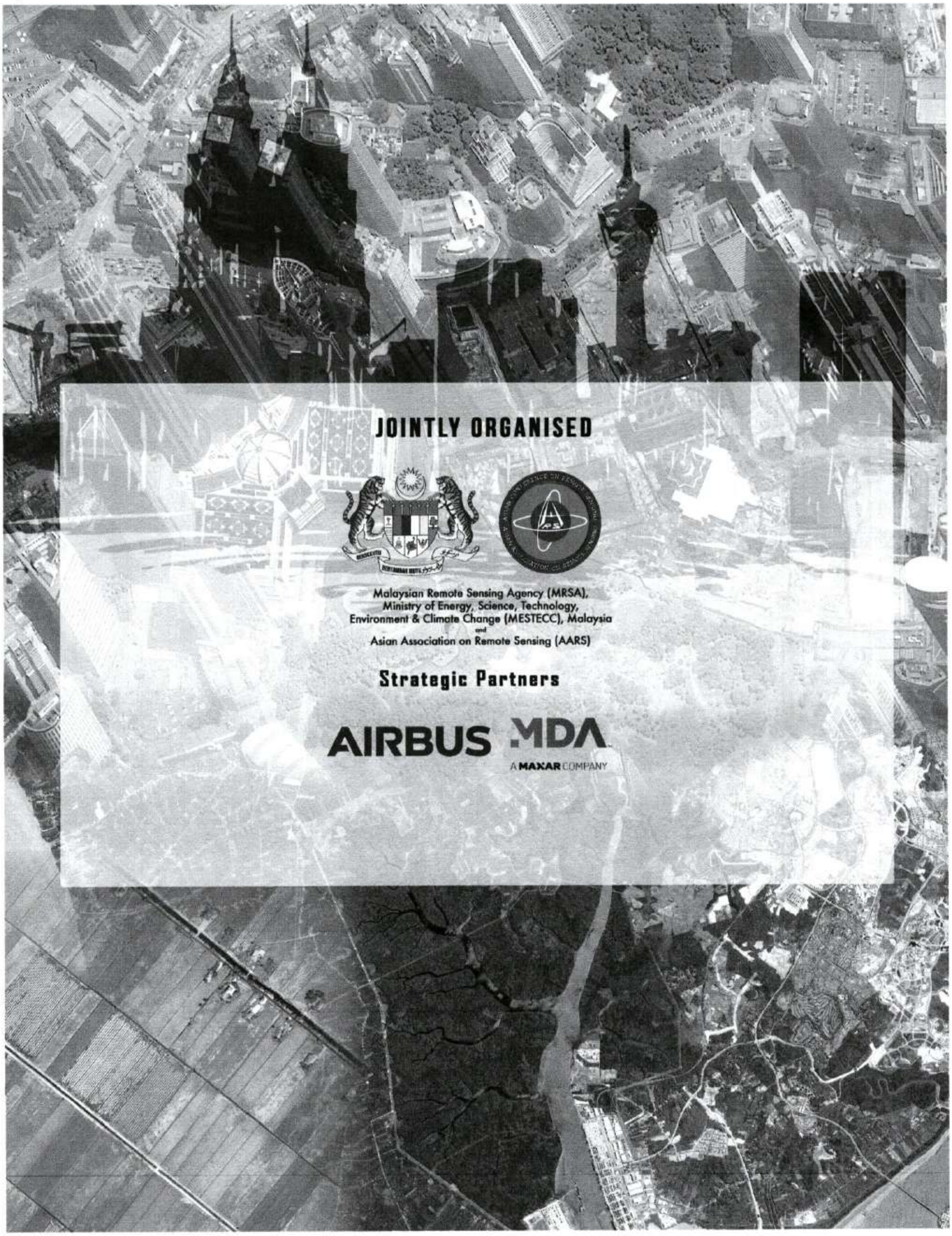


Figure 4. Result classification with the based on object. A) Classification based on object using Sentinel-2a, B) Classification based on object using SPOT-6,

3.1.5 Accurasi test

The overall accuracy value that can be evaluated with different average and average levels through the confusion matrix table. Producer accuracy shows the level of accuracy of objects mapped through image imagery, while user accuracy shows very large prices that are accurately controlled. Figure 5 shows the producer value and user accuracy of each class.

Pixel-based methods have higher accuracy test results than using object-based methods. In addition, the use of imagery used in this study has different accuracy test results. The test results of classification accuracy using SPOT-6 image data are higher than Sentinel-2a. The percentage value of the accuracy test results for SPOT-6 imagery is 86.17% (pixel-based method) and 80.85% (object-based method). While the percentage of accuracy test results for Sentinel-2a images is 85.11% (pixel-based method) and 80.85% (object-based method). To see the difference in the results of the accuracy test the results of classification from different methods can be seen in Figure 5.


JOINTLY ORGANISED
Malaysian Remote Sensing Agency (MRSA),
Ministry of Energy, Science, Technology,
Environment & Climate Change (MESTECC), Malaysia
and
Asian Association on Remote Sensing (AARS)
Strategic Partners
AIRBUS
MDA
A MAXAR COMPANY