Analysis of shallow water benthic using of SPOT-6 imagery data on Miang Besar Island, Kutai Timur, Indonesia

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Abstract. Potential observation of coastal waters habitat by an extensive coverage difficult reached by in-situ observation methods, so that using image data is expected to study of data in a short time and broad scope. SPOT-6 satellite multispectral imagery as imagery data was used in this study to interpret habitat conditions spatially. Research was conducted on Miang Besar Island, East Kutai by imagery data processing and field survey. Field surveys in shallow waters to observe the appearance of coral objects, seagrass, and mangroves. Imagery data processing stages by radiometric and geometric correction and transformation of lyzenga algorithm by supervised classification methods. The classification results in 3 community schemes namely; coral, seagrass and mangrove on coastal of Miang Besar island showed a presentation of mangrove communities distribution area 29.000 m² and percentage cover 54% by Rhizopora apiculata, Seagrass community distribution area 8,900 m² and percentage cover 76% by Enhalus acorides, and coral community distribution area 5,800 m² and percentage cover 62% by Hard coral.

1. Introduction
Administratively, Miang Besar Island is located outside the Estuary of Sangkulirang River and southwest of Miang Kecil Island and geographically it is situated at logitudes 118° 2'35.3037" E and latitudes 0° 46'37.2969" N with territory area of ±727.00 Ha [1]. Coastal resources and small islands up to now haven't given a real contribution to regional income due to lack of information on the existence of the area. Benthic Habitat Mapping using remote sensing data is the first step in habitat data collection related to the distribution and extent of habitat which is then visualized in maps form, and identification of habitat to obtain the percentage of island habitat cover. Mapping the spatial characteristics and distribution of these habitats is of vital importance for environmental analysis and management of costal and marine environment Rapid development of remote sensing techniques has enhanced the capacity to characterize seafloor and associated habitats [2].

The information in the form of benthic habitats distribution in coastal areas and small islands was limited available, because the area is widespread and difficult to access. Satellite remote sensing is a useful technology to monitor such coastal shallow ecosystems [3] Therefore, the remote sensing data is crucial, this technology is able to cover a large area and provide spacial data (temporally), so that this technique is considerably as an efficiently method to map a large region (Cite some references here). However, this data has to validate; therefore remote sensing data needs to be integrated with
field or ground checking data [4]; cite more references, for example this paper). Satellite-based multispectral remote sensing images provide routine multitemporal spatial information [5], manage areas that are difficult to access, load large areas, provide data at various levels of detail and increase the amount of data that must be accessed through field surveys [6].

Research was conducted using SPOT-6 satellite imagery data [7] as the initial data that has been corrected, part of the corrected part it was different so that the land and sea parts must be separated (masking area). Then the classification based on predetermined habitat, so as to provide information on the existence of spread and extent of benthic habitats of this island based on identification in order to obtain the percentage value of habitat cover and then visualized in the map form.

2. Materials and Methods

2.1 Imagery data processing

Research started by processing of Spot-6 imagery multispectral classification. The processing consists of radiometric correction, geometric correction, imagery cutting (cropping), separation of land and water areas (masking area), supervised classification, and field surveys. Benthic habitats mapping procedure, presented on diagram of data processing flow in Figure 2.

Geometric correction aims to improve object position or location so that the coordinates are in accordance with geographic coordinates (actual position on the earth) [1]. This equation uses infrared channels as a correction factor by dark objects was a deep and clear waters area. The equation used is: Rc: R-Rsi, Rc: atmospheric corrected reflectance, R: TOA reflectance; Rsi: (Mean Rw- 2*StDev Rw), Rw: reflectance of deep and clear water, Mean: average, and StDev: standard deviation.

Atmospheric correction conducted to improve imagery quality by reducing interference in the water column by collecting pixel samples on different sand depths. Sand at different depths is easily recognized in composite images. The technique commonly used for correction of water columns is based on the algorithm [7].

The sharpening process is a combining information process from 2 bands which aims to obtain a watershed habitat appearance based on the equation, [8] Y: ln-ki/kj ln, Y: water-base imagery extraction, TM1: Band 1 (blue), TM2: Band 2 (green), ki/kj: attenuation coefficient value; (ki/kj: a+√(a2+1), a: (var ln-Var ki/kj ln)/(2*Covar-ki/kj ln).

Imagery interpretation was detection process, classification, identification, and analysis. The main process in imagery interpretation which conducted by a digital were an imagery classification. Corrected imagery by supervised classification to study or analyze a large number of unknown pixels and share them in a number of classes based on grouping digital imagery values. After field data retrieving, the position point of the existence of habitat from each point is entered into each class the results of the supervised classification. Classification process was conducted by selecting the desired information category and selecting the training area for each category.

2.2 Field data retrieved

Ecosystem sampling was conducted by purposive sampling. According [9] to purposive sampling is a technique of determining samples based on, characteristic that are felt to be closely related by the characteristics of a population that has been previously known. Ecosystem samples are based on land use namely mangroves, seagrasses, and coral reefs. The research location were located on Miang Besar Island by setting 4 sampling stations, as shown in Figure 1.
Figure 1. Location point for observing mangrove, seagrass and coral communities

Research community was mangrove vegetation, seagrass, and coral by purposive sampling as the sampling technique. Data retrieval location are 4 stations using the transect method with a square area of 10x10 m for trees, 5x5 m for saplings and 2x2 m for seedlings. Mangroves density provide an overview of the number of individuals in the plot. Seagrass observations was conducted by visually in the same plot covering the number of species and coverage percent of each species in the transect, as stated by English [10]. Observations were conducted at 4 stations, and each station consisted of zones, namely Reef Crest zones with 1-3 m depth. Transect installation were placed parallel to the coastline and follows the contour. Determination of location were intended to get a general picture of the coral community structure which is in the waters of Miang Besar Island. Data analysis is calculated by the [5] namely:

\[ C: \frac{N}{A} \times 100\% \]

3. Results and Discussions

3.1 Mangrove

Mangrove cover is the density of a species stands in a unit area. There were six species of mangrove findings and distributions profile as showed in Figure 2. The *Rhizophora apiculata* was predominant as in Figure 3, shows that this species is indeed better able to adapt well and generally exists in the frontier zone of the mangrove line facing directly towards the sea.

Figure 2. Distribution of mangrove species
Figure 3. Percentage coverage of mangrove species and mangrove graph area

The high value of the *Rhizophora apiculata* species of mangrove is due to its growing location getting sufficient fresh water supply. In addition, this species of mangrove grows along the beaches that are protected from large wave activity and the strong tidal currents and substrate needed for the place of mangrove growth are very suitable. According to Nontji [11] said that in muddy and soft soil overgrown by mangrove species *Rhizophora apiculata* with a uniform and broad spread, while in coastal areas that are sandy and large wave, growth of mangrove vegetation is not optimal. The percentage of mangrove coverage area, coastal of Miang Besar Island were presented in Figure 3. In addition, [12] also stated that the dependence of pioneer plant species on soil type was indicated by the genus Rhizophora. Mangroves adaptability to the extreme conditions where new mud shoals will be dominated by plants with the most propagules [13].

The cause of the low mangrove vegetation is due to the inhibition of seed dispersion caused by water flow that cannot penetrate to other locations, so that it can inhibit the growth of mangrove vegetation [14]. Stated that the low diversity indicates that the ecosystem was under pressure or its condition was decreasing. Mangrove forests vegetation was a system that always develops according to the state of its habitat. The mangrove vegetation specifically shows the zonation pattern. This is closely related to soil type (mud, sand or peat), openness (to waves), salinity and tidal influences [15].

3.2 Seagrass

Seagrass were found on Miang Besar Island were a mixed species seagrass or several species association. Species association between *Enhalus acoroides* and *Syrgnidium isoetifilium*. Species percentage was the total number of seagrass stands in a unit area (retrieval data station), seagrass data is presented based on the number of seagrass stands per type of observation location. In this case there are 3 species of seagrass findings, namely Enhalus acoroides, Syrngidium isoetifilium, and Halodule uninervis with a distribution profile as shown in Figure 4.

Figure 4. Distribution of seagrass species

Overall, there are differences in the frequency of seagrass species occurrence in some stations, caused by several species of growing seagrass in separate groups and indeterminate numbers and
uneven distribution. Besides the substrate and environmental conditions, as well as the waters clarity also play a role in determining the frequency of species occurrence and seagrass coverage. According to Nurzahraeni [16], seagrasses usually thrive, especially in open tidal areas and coastal waters which are basically mud, sand, gravel, and dead coral faults.

![Seagrass Coverage (%)](image)

**Figure 5.** Percentage coverage of seagrass species and seagrass graph area

The average range of seagrass coverage on research location, Figure 5, determined by the average value of seagrass coverage from the lowest and highest value on Miang Besar Island, the average range of seagrass coverage 54.36 ± 0.87-90.91 ± 2.27%. Seagrass beds that have a high coverage area are found in areas that always flooded with sea water and protected from waves [17]. The percentage of seagrass coverage area, coastal of Miang Besar Island is presented in Figure 5.

The frequency of seagrass species occurrence on observation location shows that species can adapt to the characteristics of island waters habitat as stated, that Magnozosterid seagrass species such as Enhalus acoroides, seagrass with a leaf shape that is long and resembles a ribbon with leaves that are not too wide, [6] added that the morphology of Enhalus acoroides is a sturdy plant with long leaves, a smooth upper surface and the slender bony bottom can be found in shallow areas until the area exposed when the sea water recedes. According to. wave and storm attacks can cause damage and loss of seagrass beds ecosystems [12], so that the area that is open to wave action has a great chance of damage and loss (uprooted) of seagrass vegetation. In addition, competition among species in terms of space and nutrients is also the cause of the low density and percent seagrass coverage in this relatively open location.

### 3.3 Coral

Observation result at 1-3 depth, there are 14 species of coral were found in lifeform category with distribution profiles shown in Figure 6. Observations of corals are grouped into Dead coral, Hard coral, Others, and Abiotics, Figure 6. The condition of the waters with low turbidity levels makes it easy for sunlight to penetrate the water column so that it is sufficient for zooxanthella to conduct photosynthesis which of course greatly influences the growth of coral reefs [18-20].

The species has the most distribution and is commonly found in areas with low nutrient and high energy areas (waves and currents) the integration high levels of colonies and rapid local dispersion through fragmentation (asexual reproduction), so that habitats and growth are faster [21]. The percentage of over coral reefs, coastal of Miang Besar Island is shown in Figure 7.

The percentage of cover coral area of 5,800 m$^2$ in research location was classified as good on the standard criteria for coral reef damage which refers to the Decree of State Ministry for the Environment No. 4 year 2001, category very good ≥75%, good 50%<75%, moderate 25%<50%, and bad/damaged <25%.
The main cause of coral mortality is due to the large pressure caused by several factors, both natural causes as stated that one of the natural factors that causes coral animals to die is the presence of wrong coral competitors one is caused by algae. Green et al. [22] said that in addition to natural factors, the coral reefs damage was largely caused by human activities that damage the coral reefs themselves.

4. Conclusion
Research results in Miang Besar Island can be concluded several things, including: Based on the analysis of Spot-6 imagery, the distribution profile of coastal benthic habitat in Miang Besar Island was available was found on all island sides and each habitat area i.e. mangrove 29,500 m2 (68%), seagrass 8,400 m2 (19%), and coral 5,800 m2 (13%). Based on species cover percentage of benthic habitat coastal of Miang Besar Island, it was found that the mangrove cover percentage 54%, dominated by Rhizophora apiculata, the seagrass cover percentage 76%, dominated by Enhalus acoroides, and cover coral reefs percentage 62% was dominated by hard coral.

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