CORAL REEFS SURVEY AND MAPPING IN SELARU ISLAND, SOUTHEAST MALUKU REGENCY, MALUKU PROVINCE, INDONESIA

SYACHRUL ARIEF, SUWAHYUONO, NIENDYAWATI SALAM

Center for Marine Resources Surveys, National Coordinating Agency for Survey and Mapping, Indonesia

syachroel@gmail.com
wahyulaut@yahoo.com
niendya_salam@yahoo.co.id

Abstract

Coral reefs are an important resource for many tropical countries.Coral reefs and their associated habitats sand beach attraction is important for tourism as well as the main source of income for tropical countries. Indonesia is the world's largest tropical island, with a coastline that stretches more than 95,000 km with more than 17,000 islands. Indonesia has about 51,000 km ² of coral reefs (Burk et al., 2002), this figure does not include coral reefs in remote areas that have not yet surveyed and mapped. Therefore, survey and mapping of coral reefs in the area of the outermost small islands in Indonesia is required.

Dealing with coral reef monitoring program, the conventional method which is commonly used for mapping and monitoring coral reef habitats. In connection with this situation, remote sensing can provide the most appropriate tool for coral reef monitoring and management, especially for island countries. Remote sensing can identify a number of environmental variables associated with an indicator of potential habitat distribution and abundance of resources such as coral reefs, algae and sea grass. In this study, the ALOS-AVNIR 2 has been used to identify the habitat of coral reefs. GIS techniques and field data are also considered in this study. The research area is located on the island Selaru, which is categorized as one of the outermost islands in West Southeast Maluku district, Maluku Province, Indonesia. The survey results show that the condition of coral reefs on the east coast of the island Selaru better than the coral reefs on the west coast.

Key words: Survey, Mapping, coral reefs, small islands, ALOS Images

INTRODUCTION

Coral reefs are an important resource for many tropical countries.Coral reefs and their associated habitats sand beach attraction is important for tourism as well as the main source of income for tropical countries. Indonesia is the world's largest tropical island, with a coastline that stretches more than 95,000 km with more than 17,000 islands. Indonesia has about 51,000 km ² of coral reefs (Burk et al., 2002), this figure does not include coral reefs in remote areas that have not yet surveyed and mapped. Therefore, survey and mapping of coral reefs in the area of the outermost small islands in Indonesia is required.

Information about the objects of natural resources at the bottom of shallow waters are important information to know what type of ecosystem in the shallow waters, which in turn is useful as a material for the management of coastal and marine areas. Four ecosystems that serve as guidelines in the management of coastal and ocean ecosystems, among others: 1) coral reef ecosystems, 2) seagrass ecosystems, 3) mangrove ecosystems, and 4) ecosystem of estuaries (Dahuri, 1996). Coral reef ecosystems is useful as a natural wave absorbers, defend the coastline from erosion, as sources of food and medicines, and can be used as natural tourist attraction. For biota, coral reef ecosystem role as the place looking for food, protection, and as a regional care for the biota at a young stage. (BAKOSURTANAL, 2008).

Today, the need for data and information quickly and accurately a wide range of areas more urgent. Remote sensing technology (remote sensing) is an appropriate alternative is to support the provision of spatial information resources, including coral reefs in the area that is wide enough (Kuchler et al. 1986 in Nurjannah, 1998)

In line with the development of remote sensing technology, currently available satellite ALOS sensor which has 3 principal components: 1) PRISM which can record the visible wave range with spatial resolution of 2.5 meters, 2) AVNIR which can record the range of visible to near infrared waves and have spatial resolution of 10 meters, and 3) which is a sensor PALSAR radar recorder (ALOS / JAXA, 2006). With a sensor carried on PRISM and AVNIR, allowing to identify the basic object of shallow water.

Satellite remote sensing data have the capability and benefits in order to support the availability of data and information on coral reef area. By developing a model method of processing and reviewing the use of remote data Penginderan expected to support the provision of data and updated information is very useful in efforts to manage coral reef area.

Selaru Island is one of the small island at the forefront of the Republic of Indonesia. The island is located approximately 7 miles south sea island of Yamdena or 13 nautical miles southeast of the city of Saumlaki, Selaru also the name of one of Southeast Maluku District in the West, which covers the entire island Selaru, and the small islands around it.

Selaru Island in general topography is relatively flat. Only in some parts of the course there are areas of slightly high, and even then has a height of not more than 100 meters. We have the highest location on Mount Vamith (104 meters). Information and

data related to marine natural resources Selaru Island is still very minimal, whereas selaru Island is potential to develop marine natural resources.

Based on the above, there should be a survey and mapping of marine natural resources especially coral reef mapping, by means of field surveys that can be used as material information to determine the distribution of coral reefs through satellite imagery, and the condition of closure,

The purpose of the survey and mapping are: (1) To map the distribution of coral reef distribution using ALOS satellite imagery AVNIR-2 in waters around the island Selaru, (2) To determine the condition in general, the pros and cons of coral reef ecosystems Selaru Island waters with see closure.

RESEARCH METHOD

Research area will be located in coastal around Selaru Island with the specific location at 08° 10’ 17” South Latitude dan 131° 07’ 31” East Longitude.

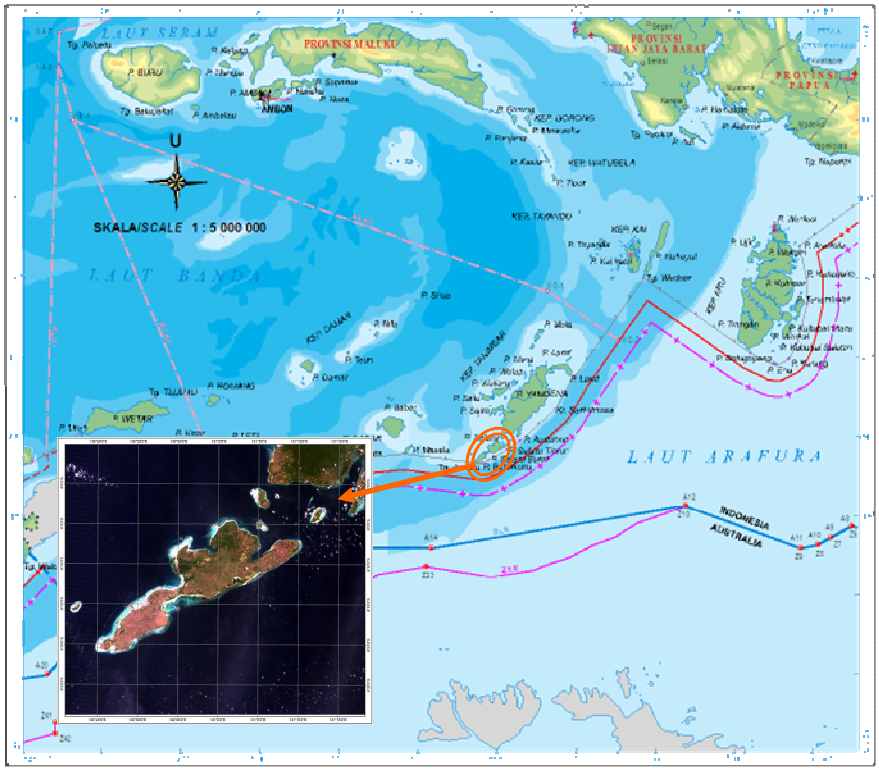

Figure1. Research Locations in Selaru Island (source : Bakosurtanal 2008)

This research will be carried out for 4 months (February-Mei, 2010). The Alos Image which used is the recorded result of September 18th 2009, with identity scene of ALAV2A194443760 -- A1000234-006, cloude coverage 0-2%. The AVNIR-2 sensor on Alos satellite has 4 band consisted of 3 visible spectral and a near infra red (Table 1).

Table 1. Sensor Description of Alos satellite with AVNIR-2 Sensor

No.Band	Wavelength	Band Position
1	0.42 - 0.50	Blue
2	0.52 – 0.60	Green
3	0.61 – 0.69	Red
5	0.76 – 0.89	Near Infra Red

(Source : JAXA 2005)

The research procedure was grouped into 4 (four) steps are as follows :

1. Data collection
2. Image Processing consisted of :

a). Preliminary step of image processing such as image cropping, geometric correction, atmosphere correction and image masking

b). Lyzenga method application (1981), with the equation :

$$Y = \ln bi - \{ (ki/kj) * \ln bj \},$$

Y : depth invariant index
ln bi : normalized image in band i
ln bj : normalized image in band j
ki/kj : ratio of attenuation coefficient

c). Multispectral Classification

3. Other field data, especially data from the sea, was cross checked with Line Intercept Transec (LIT). The aim of LIT was to check the quality of coral reef directly by SCUBA diving. In the process of data collection, some equipment and materials used are: Transport equipment and navigation of the ship, GPS, and map work, research tools that include SCUBA equipment, roll meters, stationary underwater (uw paper and pencil); The survey team also equipment furnished documentation of a video camera and photo camera housing system to be used under water. At this present time the documentation accompanying the report is very important to provide a visual picture of the activity or object into the study survey.

Data collection of coral reef ecosystems were calculated using line transect offensive or Line Intercept Transect (LIT) developed by Home et al (1994). Data recording is done until the level of coral growth form (lifeform) with accuracy of 1 cm. Although the main object to the extent lifeform but also made the observation and recording profiles coral genus found in the survey area with the general observation techniques.

Figure 2. Method of data retrieval LIT

Technical data retrieval begins with the unfurled roll LIT parallel meters along 100 meters of coastline. Placement of transects conducted at an average depth of the discovery of coral reefs. Furthermore, observers noted categories of coral growth forms at each transition that was touched by the transect line. And so on until the meter to 100.

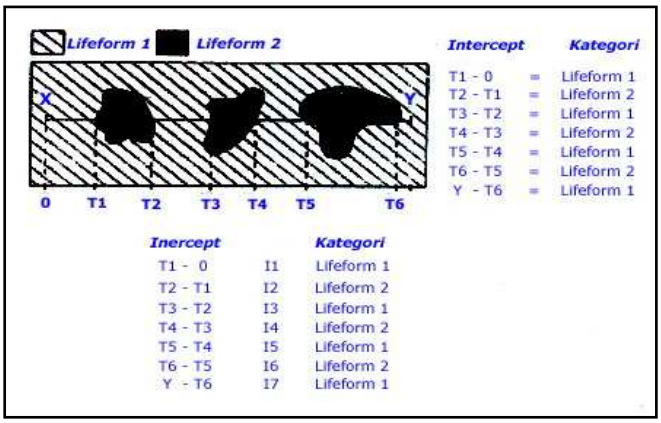

Figure 3. Technique of recording data on the coral lifeform categories pertaining to the transition (Home et al., 1994).

Furthermore, recording the results analyzed so that the transition will be obtained percentage of coral cover that can describe the condition of coral reefs in the survey areas. The equation used in the analysis of the percentage of coral cover are as follows:

$$\%\,cover = \frac{li}{L} \times 100\%$$

Where: li = total length of the lifeform to I; L = length of transect lines (100 m). Results of analysis then compared with the percentage of damage to coral reefs standard criteria established by the State Minister of Environment of the Republic of Indonesia No. 4 year 2001.

Table 2. Standard criteria of damage to coral reefs

Standard Criteria		Lifeform (%)
Damaged	Bad	0 - 24.9
	Medium	25 - 49.9
Good	Good	50 - 74.9
	Very Good	75 - 100

RESULTS AND DISCUSSION

The first step pegumpulan basic data as a reference the next step, namely Topographic maps (RBI) from BAKOSURTANAL, this map, contains information on the coastline, rivers, roads, contours, high point, toponymy.
The second step is image processing of the initial process that aims to improve the quality of the image before the application process Lyzenga and classification methods. There are 3 steps in the initial process of cutting the image of image processing (image cropping), geometric correction and separation of land and sea (image masking).

Geometric Correction

Value of Root Mean Square (RMS) shows the accuracy of ground control points (GCP). The average RMSE in this study is 0.031 According to national map accuracy standard United States (U.S. national map standards), the value of RMS for the image must be smaller than half the relevant spatial resolution imagery (Eastman, 1997). Change the position of the image indicates that there is an improvement over the position of the image geometric correction. Because the image geometric correction results will be used for multispectral classification process, the most appropriate method of resampling is nearest neighbor method, where the interpolation method is only taking back the value of nearby pixels that have been shifted into new positions, according to Danoedoro (1996) nearest neighbor algorithm is more appropriate applied to the image of the original channels and also the results of classification.
Geometric correction also gives extensive information about each object class in the area of basic research, not only in pixels but also in units of hectares or acres. So, this process will make extensive calculations of each class in this study becomes much easier.

Water Column Correction (Lyzenga Application Method)

Correction of the water column is the method used to eliminate the influence of the water column. The importance of water column correction is done in this study based on the fact that the multispectral classification using the original image (original data) can not be the most distinguishing characteristics of the object of benthic (benthic object) due to the influence of water depth (water column). Therefore, water column correction is needed before digital classification process to minimize the effect of depth. In this case there are two water column correction techniques are: (1) The equation of radiation transfer, (2) Based on the image approach.

Approach for correction of water column with a simple technique and an acceptable degree of accuracy. This approach is based on the technique of image approach. One of

the water column correction based approach to imagery that is often used for mapping the shallow waters of the basic objects in several regions of the world's territorial Lyzenga method developed by Lyzenga (Lyzenga, 1978).

In this study, water column correction with image approach is application Lyzenga.Metode Lyzenga attenuation model is applied after the initial processing of imagery, this method is used to get a better image of the object bottom waters (benthic object), including coral reefs. Making training area in this study is the first stage transformation method application Lyzenga, in this case the number of training areas created is 30.

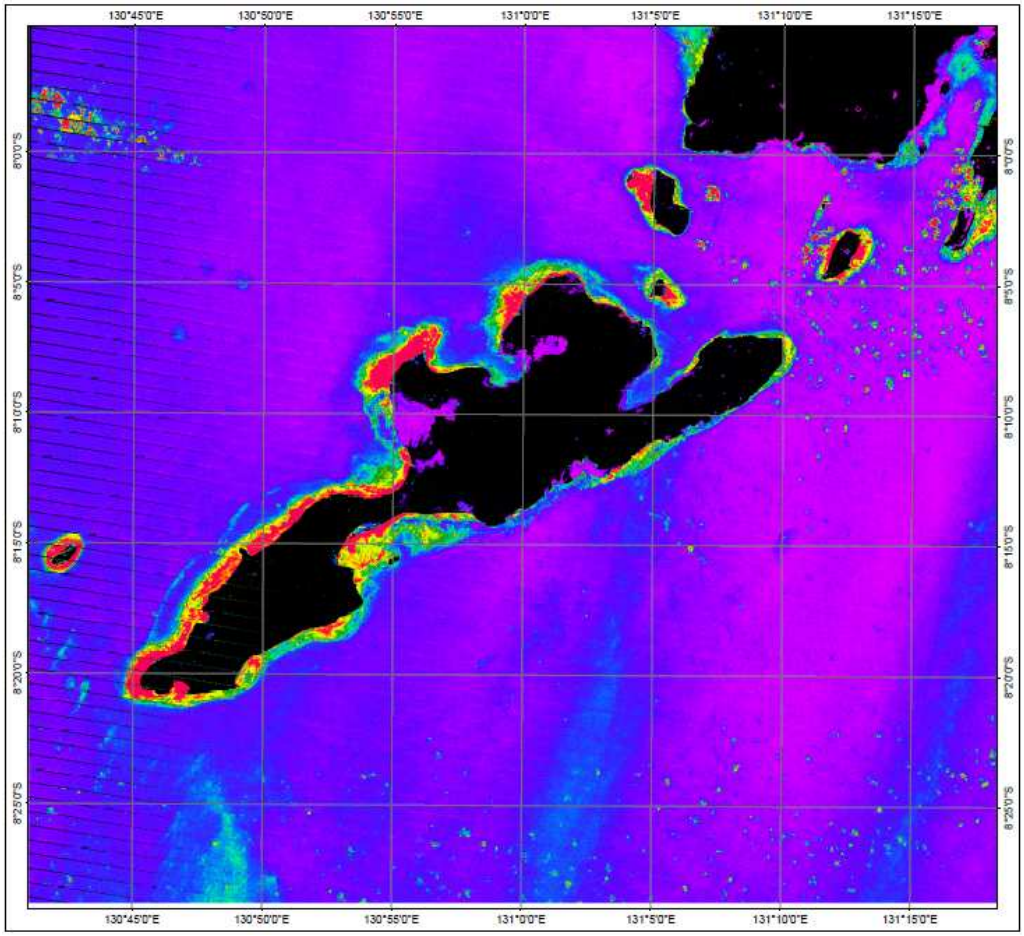

Figure 4. is the display image after Lyzenga algorithm application in pseudocolor layer

Multispectral Classification

Stages of the process of classification is based on object groups that make up benthic bottom waters. Benthic object classes are determined based on data in situ (Land Surveying) in this case consists of 3 (three) classes of coral reef (including rubble), sea grass (including aquatic plants), and sand (including substrate).

Based on the results of multispectral classification of each image obtained 3 (three) basic object class waters.

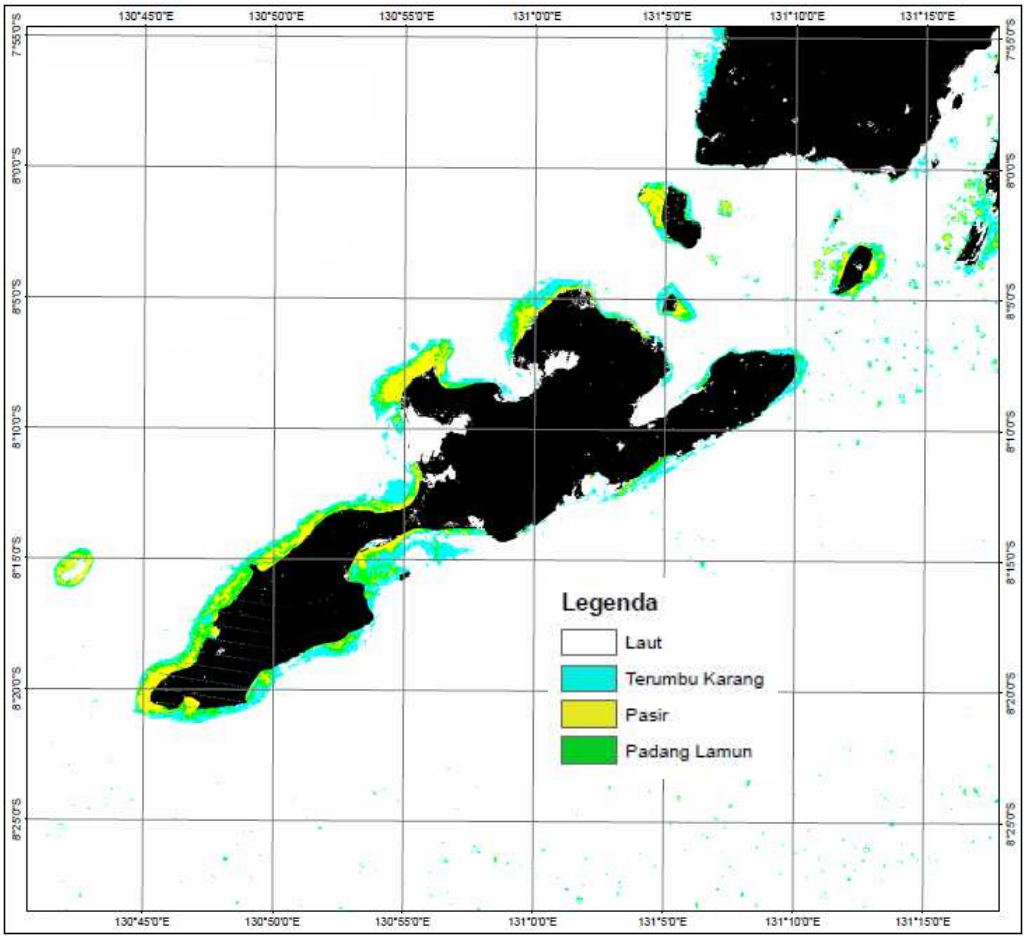

Figure 5. display image after the multispectral classification process

Figure 5 above is the image display after the multispectral classification process for the combination band 1 and band 2, the combination is better to separate the object Benthic after Lyzenga algorithm method, Lyzenga (1981) states, that this method of Lyzenga used to obtain a better visual image for the underwater objects (objects benthic). In this case the object of benthic including coral reefs. Because band 1 band 2 in ALOS/AVNIR-2 sensor is a visible blue ribbon band 1 and band 2 is green. So, for the combination band 1 and band 2 showed better results than the visual object Benthic other combinations, the band featured in the overall accuracy for the combination band 1 and band 2 is 87.59%, while the other band combinations below 75%, by Mumby et al. (2003), that level of detail the default mapping of coral reef ecosystems by interpretation of satellite images that can be received not less in the overall accuracy was 75%. From the classification results in getting an area of 4872.960 hectares of coral reefs, seagrass 2750.400 Ha; and Sand 2839.680 Ha

Distribution point on the Selaru island with LIT surveys method, as presented in figure 5 below, where st1 until st4 representing the west coast of the island selaru, while st5 to represent the east coast of the island st7 selaru.

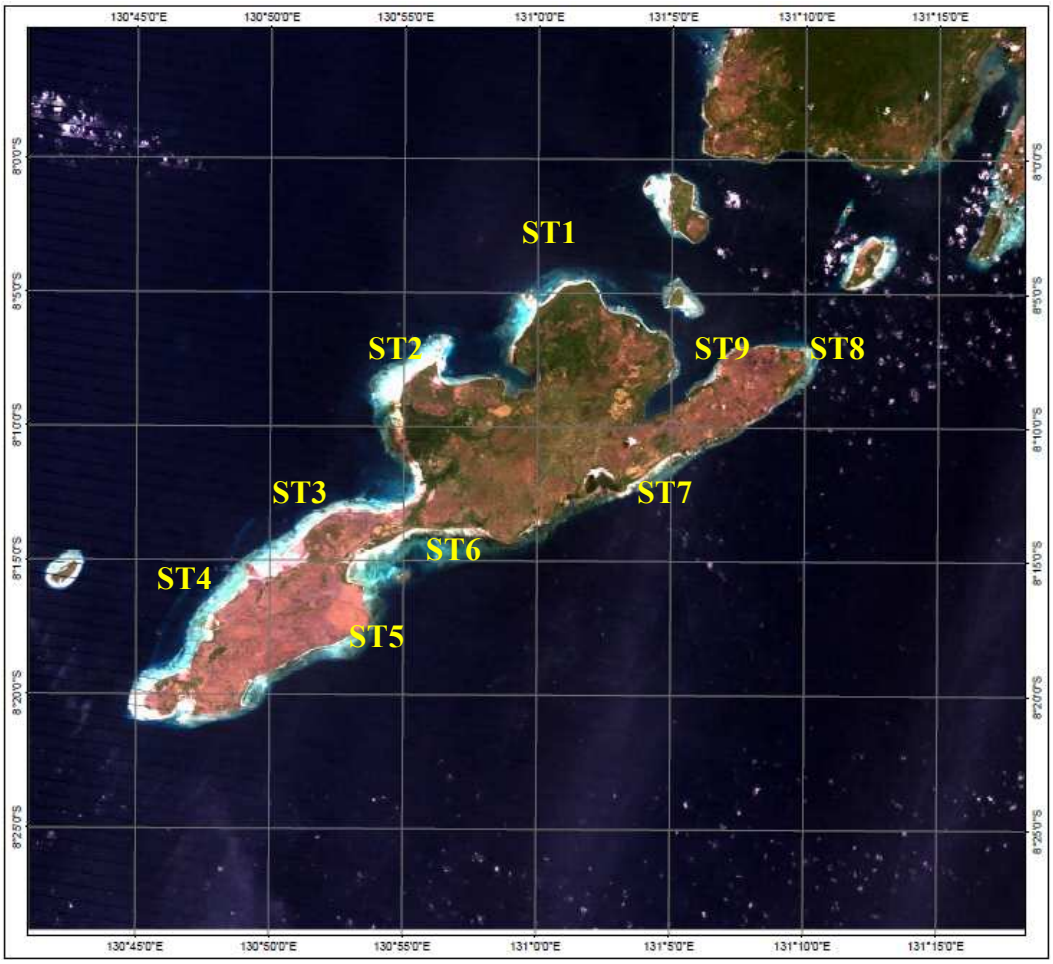

Figure 6. Distribution point survey on the Selaru island

Field Survey Result

Based on the Decree of the Minister of Environment number 04 in 2001, the status of coral reefs is the extent of coral reef condition at a particular location within a specified time based on certain criteria assessed damage to coral reefs by using large percentage of living coral cover. Referring to these criteria, the coral reef ecosystem in the waters surrounding the island Selaru and included in the criteria of bad to good. Of the 9 locations of observation there is only one location that has the bad condition of coral reefs, 4 of which included the criteria are, and 4 locations including the criteria for good coral reefs. Furthermore, the percentage of live coral cover at each observation location can be seen in the graph below (Figure 7).

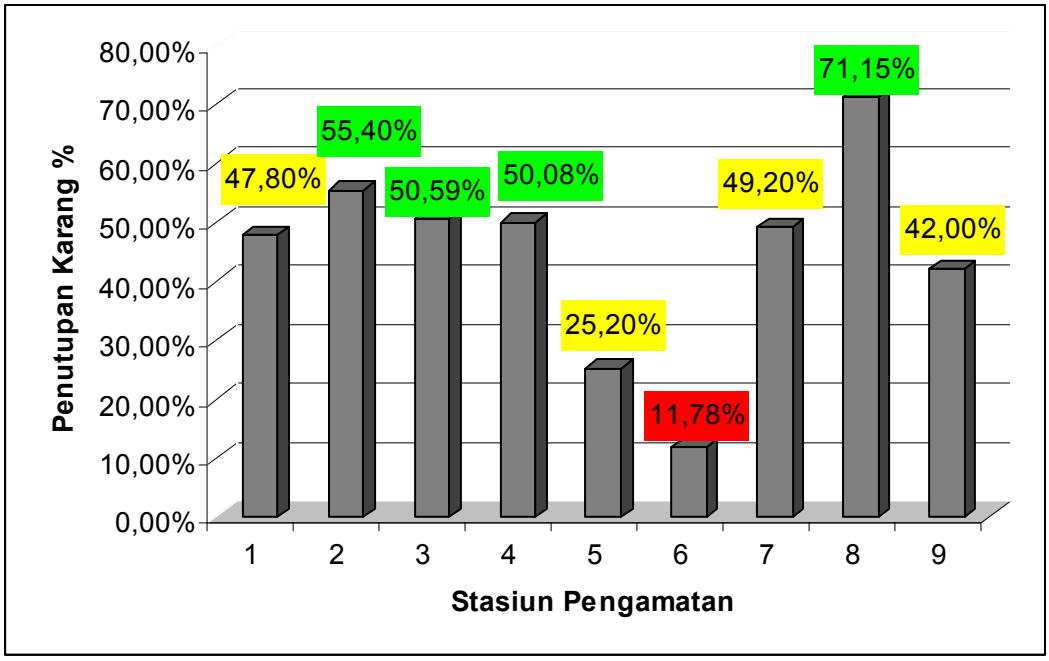

Figure 7. Cover lifeform coral reef each stasion

Based on the above chart, the percentage of stations with the highest live coral cover was found at the site ST8. While the percentage of observation stations with the lowest live coral cover was found at the site ST6. At the station ST6 coral reef ecosystems, including bad criteria. Closing substrate highest recorded from abiotic components or fracture-dominated coral rubble to reach 65.60% in ST5. Furthermore, dead coral which consists of DC and DCA recorded with the closing of 41.80% in ST4. High rates of coral mortality at this location is probably due to mechanical effects due to reduced anchor. Another impact is no less a major contribution is the coral predator Acanthaster plancii.

CONCLUSION

1. To Sensor AVNIR-2, combination band 1 and band 2 is the best combination for detecting the distribution of coral reefs by using transformation method Lyzenga.
2. The results of image interpretation shows that the distribution of coral reefs in the waters around Selaru estimated at 4872.960 hectares (AVNIR-2 acquisition September 18th, 2009).
3. The survey results show That the condition of coral reefs on the east coast of the island Selaru Better Than the coral reefs on the west coast.

REFERENCES

Bakosurtanal. 2008. Island Marore and Kawio: North gate Nusantara. Cibinong: Center Sea Natural Resources Survey Bakosurtanal.

Diskanlut NTB. 2006. Rencana Zonasi Wilayah Pesisir dan Laut Provinsi Nusa Tenggara Barat Tahun 2006-2020. PT Komperji Nusaraya, Bogor

JAXA. 2006. Advanced Land Observing Satellite (ALOS). [online]. Available from: http://www.eorc.jaxa.jp/ALOS/cd alos/eng/alos2.htm.

Lillesand, T.M. dan R.W. Kiefer, 1990. Remote Sensing and image Interpretation. Gajah Mada University Press, Yogyakarta.

Lyzenga, D. R. 1978. Passive Remote Sensing Techniques for Mapping Water Depth and Bottom Features. Applied Optics, (17) : 379-383.

Lyzenga, D. R. 1981. Remote Sensing of Bottom Reflectance and Water Attenuation Parameters in Shallow Water Using Aircraft and Landsat Data. International Journal of Remote Sensing, (2) : 71-82.

Mumby, PJ., W. Skirving, A.E. Strong, J.T. Hardy, E. LeDrew, E.J. Hochberg, R.P. Stumpf and L.T. David. 2003. Remote Sensing of Coral Reefs and Their Physical Environment. Marine Pollution Bulletin, 2003 edition.

Suharsono, 1996, Jenis-Jenis karang yang Umum Dijumpai di Perairan Indonesia. Proyek Penelitian dan Pengembangan Daerah Pantai P30-LPI, Jakarta