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THE POTENTIAL APPLICATION REMOTE SENSING DATA FOR COASTAL STUDY

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ABSTRACT

Coastal is an area that is influent by two processing factors that are marine and land dynamic process. In this area, occurs a complex dynamic process, which caused the relatively quick changes. The use of remote sensing data to study the process that occur in the area will get some helpful information to know the changes that happened, e.g. to study coastline dynamic. The need of this kind information is useful by countries that have long coastline and have so many islands just like Indonesia. This study use Landsat 7 data with ETM+ sensor, supported by Landsat 5 (TM), bathymetric map and tidal data from the study case area of Riau Archipelago especially Batam Island and surrounding. From this study can be summarize that the information on the coastline can be obtain in easy and accurate with combining band ratio of 4/2 and 5/2. The result has to be corrected with visual interpretation of color composite 543 RGB by visual editing to reduce errors from digital processing. The result also has to be corrected with tidal data because the information are obtain from different tidal time, which are usually different with the standard tidal data that are used to determine the coastline.

Preface

Coastal is a very complex, dynamic and delicate environment, because this area is a transition, mixture between land and marine process (Gunawan, 1998). So in this area occur relatively quick changes. For example, from the process those occur in the coastline, abrasion occur in some place and sedimentation occur in another part, or even occur in the same area but in different time periodically. Human activity will increase the complexity and speeding the process that caused the changes.

The use of remote sensing data to study the process that happen to this area are the right equipment and could give a useful information to know the changes that occur, one example are the coastline dynamic study. The need in this information is needed by the country with long coastline and has many of islands like Indonesia.

Remote sensing data that can be uses in the analysis of coastline are various and available in many countries, one example data is Landsat 7 data with Enhanced Thematic Mapper (ETM+) sensor. In this study will be review some method about how to get the coastline information from remote sensing data. The information that will get from applying the method are the coastline information with length, except that using multi temporal data will get the information about the coastline change and the dynamic process that occur along the coast.

Literature

Landsat 7 is a new generation of Landsat satellite that replaces the Landsat 5. Landsat 7 has ETM+ sensor with 8 bands with characteristics as shows on Table 1.

The functions of each band in the sensor to the wavelength like ETM+ are as follows (Lillesand and Kiefer, 1990):

Band 1 (0.45 μm – 0.52 μm), the energy that receive by the band can make a deep penetration to water column and use to support the land use characteristic analysis, soil and vegetation. Band 2 (0.52 μm – 0.60 μm), especially are built to sense the top reflection of vegetation in green spectrum that situated in the two chlorophyll absorption spectral channels. The observation in this band is means to notice the vegetation differences and the fertilization level grading. Band 3 (0.63 μm – 0.69 μm), are an important channel to separate vegetation. The channel is in one part of the chlorophyll absorption and strengthens the visible contras between vegetation and not vegetation, and also to sharpen the contras in vegetation class.

Table 1. The spectral range of the ETM+ is as follows (USGS, 2001)

Spectral Band	Half Amplitude Bandwidth (micro-m)	IFOV Size (micro-r)	Instantaneaous Geometric FOV (m)	Nominal Ground Sample Distance (m)
Panchromatic	0.522-0.90	18.5x21.3	13x15	15
1	0.45-0.52	42.6	30	30
2	0.52-0.60	42.6	30	30
3	0.63-0.69	42.6	30	30
4	0.76-0.90	42.6	30	30
5	1.55-1.75	42.6	30	30
6	10.4-12.5	85.2	30	60

Band 4 (0.75 μm – 0.90 μm), are plan to be perceptive to the amount of vegetation in the study area. This can help to identify plants and can strengthen contras between plant-soil and land-water. Band 5 (1.55 μm – 1.75 μm), are the important channel in identifying plant species, water resistance in plant and the soil humidity condition. Band 6 (10.40 μm – 12.50 μm), are important channel to observed the earth heath surface. Band 7 (2.08 μm – 2.35 μm), are an infrared channel that are known to classify and to analyze vegetation, soil humidity separation and other effect that are involve with heat.

Methodology

This study use Landsat 7 with ETM+ sensor at date of 15 April 2001 with path/row 125059, supported with Landsat 5 data, thematic map and tidal data from the study area of Riau Archipelago especially Batam Island ad surrounding.

Methods:

1. Single bands that is band 4, 5 and 7.
   With using these single bands is by getting the border value between sea and land, then reclassified the values less than the border value is set to sea and more than the border value is set to land.
2. Band Ratio.
   Band ratio are used band 4 divided with band 2 (b4/b2) and band 5 divided with band 2 (b5/b2). The result values less than one are set to sea and more than one is set to land.
3. RGB Composite
   With combining channel in the RGB composite (543) or others visually, will have a clear border between land and sea.

Discussion

Coastline can be identifying with using single band, which is using band 4, 5 and 7. With using band 4 will set the coastline border with beach covered with vegetation, band 5 and 7 will get coastline covered with soil and rocks. This will cause trouble to beach area with mix land between vegetation and soil/rocks, besides that using single bands can be difficult to find the border value between land and sea. Before doing the process, has to find border value using histogram value in the area straight to the coastline. The difficulties are to find the exact value, because sometimes in the area will be exact but in another area would not get an exact value.

Other method is by using band ratio between band 4 and 2 and between band 5 and 2. With this model can be separate directly between sea and land and the next process will be easier to find the coastline information. But the problem will occur just like in the single band method, in ration b4/b2 will get an exact border in beach covered by vegetation, and in land without vegetation will set to sea. On the contrary using band ration b5/b2 will be exactly in beach with covered by soil. To solve this problem, it can be combined using algorithm:

If (b4/b2) >= 1 then 1 else if (b5/b2) >=1 then 1 else 2….(*ER Mapper formula version*).

With this algorithm can be divide between land and sea become class 1 and 2. And therefore can be classify to land and sea. With this method, the coastline information will be accurate to all land cover along the coastline, but the problem occurs in the beach with muddy substrate that border with mangrove vegetation. In this particular area, the coastline will move backward and the island becomes smaller.

Combining band (composite) RGB also can be used, but it just gives exact coastline visually. So it needs a lot of editing and needs more time. There is another way to find coastline information beside classification that is with digitization above screen. But this is not an effective way for long coastline analysis. As an example to get coastline analysis in Indonesia, will get more time and it is very difficult for the operator. The effective way is to combining composite with band ratio process. But there has to be corrected with visual interpretation from composite RGB 543 to decrease the existing errors. It can get an accurate information in a relatively short time.

The coastline information from remote sensing analysis is a water and land border information when the tidal time is same with the acquisition date of the satellite data, that is around 09.30 west part of Indonesian time (WIB). And the definition of coastline is a border between land and water in the lowest tide. So the information from the remote sensing data are not accurate as it is from the definition. This can be corrected by getting the tidal information from the time satellite acquired and the sea surface level at lowest tide data. From that information we can get the difference of sea surface level and by combining with bathymetric map then it can get the coastline at the desire time.

Conclusion

The conclusion of this study is that the coastline information can be obtain easily and accurate with combining band ration b4/b2 and b5/b2. The result has to be corrected with visual interpretation with composite RGB 543 with visual editing to reduce errors in digital processing. From the result also has to be corrected with tidal data because information form satellite data has different tidal time with the standard tidal data that uses in determine coastline.

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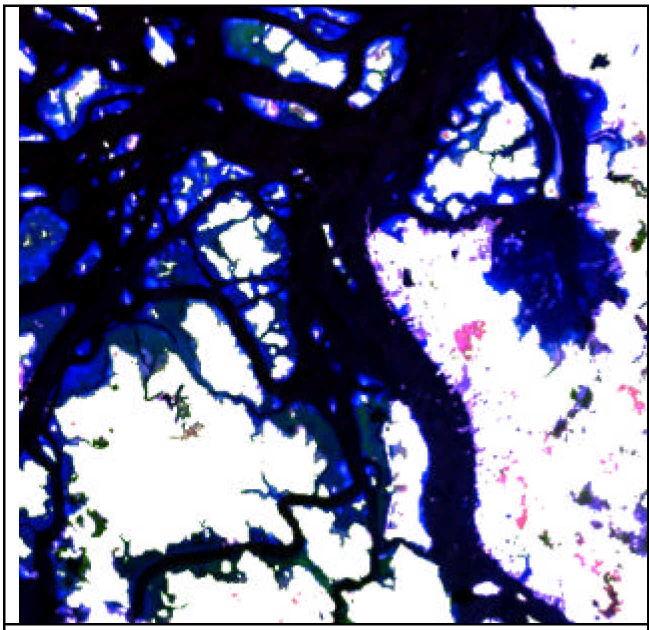


Figure 1. Overlay Image RGB(543) with Land Area by band 4

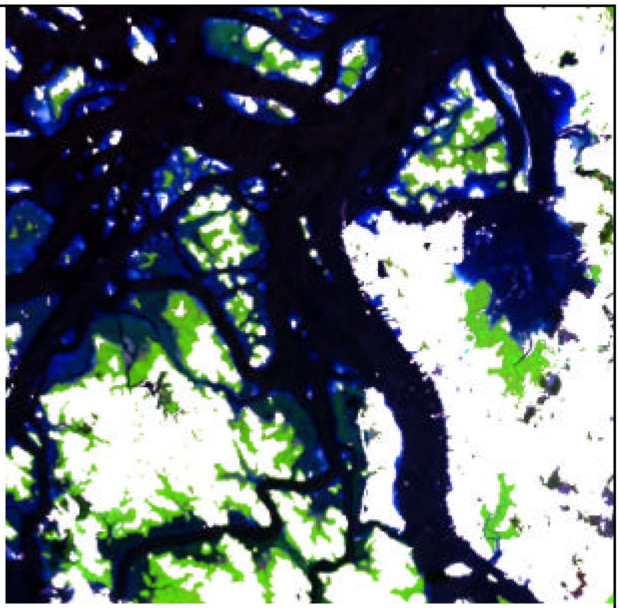
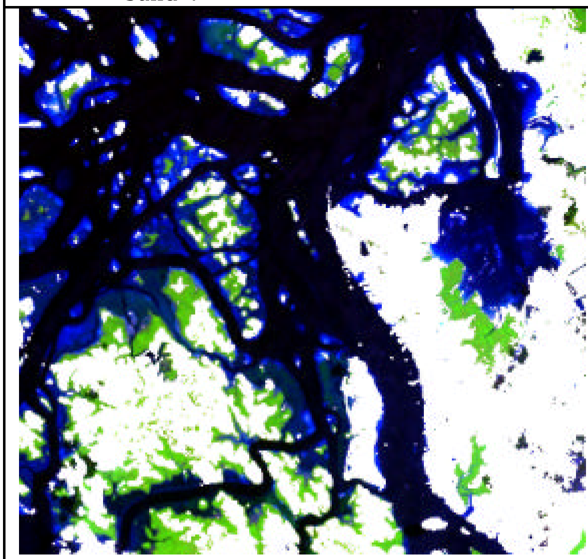
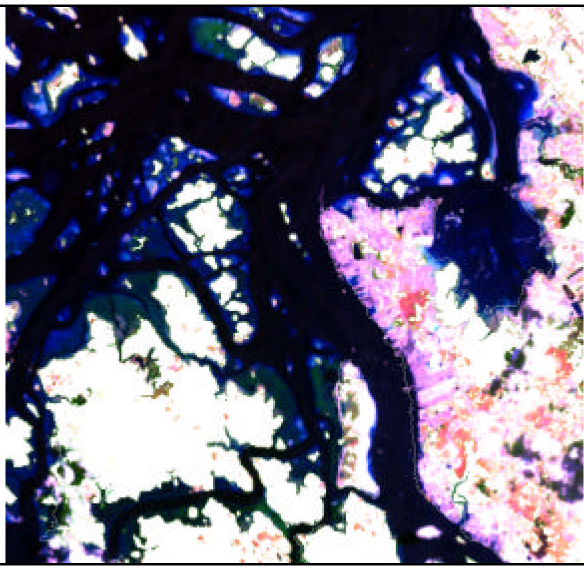


Figure 2. Overlay Image RGB(543) with Land Area by band 5



Figur 3. Overlay Image RGB(543) with Land Area by band 7



Figur 4. Overlay Image RGB(543) with Land Area by ratio band 4/2

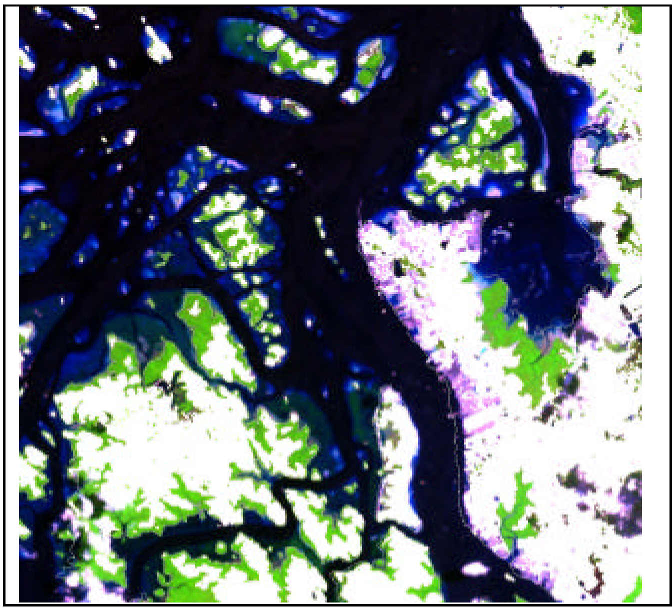


Figure 5. Overlay Image RGB(543) with Land Area by Ratia Band 5/2

Note : White Poligon is Land Area

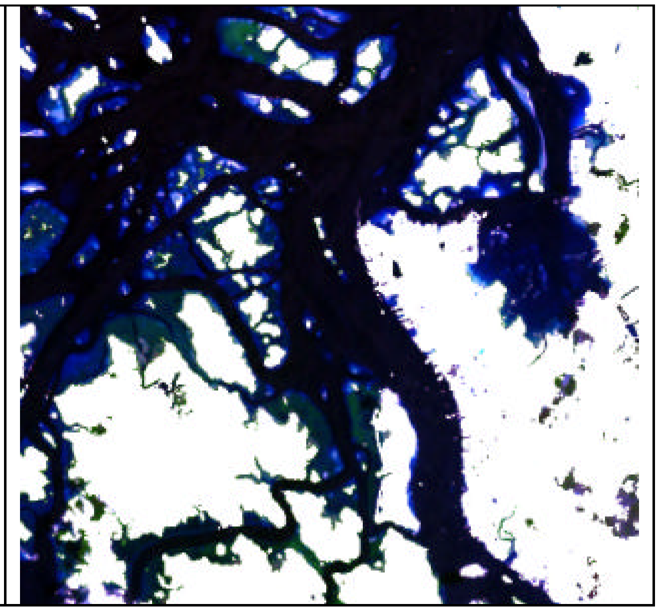


Figure 6. Overlay Image RGB(543) with Land Area by Combained Ratio Band 5/2 and 4/2