Changes of Coastlines Caused by Abration using Multitemporal Satellite Images: Case Study - Coastal of Gianyar District, Bali

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Abstract: The beach was a transitional area between land and sea. In Gianyar Regency, Bali stretches the sea along the southern island of Bali which is an area that is directly adjacent to the coastal area. Of course, this is inseparable from the dynamics of changes in the physical coast caused by land erosion by sea water (abrasion) and the presence of sediment transport from the land (accretion) which generally highlight the changes in shoreline. For this reason, research is needed to determine the magnitude of changes have occurred along the coastline in 2002 to 2017 resulting in a map of shoreline changes. This research using the ratio interpretation methods on the SWIR channel and green on Landsat 7 and Landsat 8 imagery plus classification, it can be used to identify the coastline and analyze the magnitude of the changes that occur.

1 INTRODUCTION

Coastline is an area which has several separate ecosystems between one ecosystem and another ecosystem having interconnected and various functions that are sometimes mutually beneficial or harmful. Therefore, the coastal area is an area which has dynamic movement as well as the coastline.

The southeast coast along the coast in Gianyar Regency has a significant change due to impact of these two aspect. Erosion of the beach has an impact to collapse of shores on beach and stalls which become a resting place for recreation to the beaches in Gianyar Regency, Bali.

Classification of coastal areas in Indonesia can be more easily recognized by using remote sensing methods with temporal and spatial processes. Remote sensing technology is very supportive in identification and assessment of resources in coastal areas and coastline changes, because it has the advantage of being able to cover large areas with high spatial resolution, as well as providing many choices of remote sensing satellites which have good accuracy in identifying objects on the surface of the earth.(Hariyanto,2017)

Landsat satellites have the ability to detect coastline changes using band ratio methods (Vreugdenhil, C. B. 1999), therefore this study uses Landsat satellites to determine the coastline changes in 2002 and 2017 in Gianyar Regency, Bali

2 METHODS

The location of this study is located in Gianyar Regency, Bali located between 115o13'29” BT – 115º22’23” BT and 8º18’48 ”LS - 8º38’58 "LS.Administratively, boundaries are as follows:

North Side : Bangli Regency
East Side : Klungkung Regency
South Side : Denpasar City and Badung Strait
West Side : Badung Regency

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Figure 1: Study Area

3 DATA ACQUISITION

The data used in this study are Landsat 7 ETM+ C1 L1TP acquisition date of May 22th 2002, Landsat 8 OLI / TIRS C1 L1TP acquisition date of October 29th 2017, boundary administration of Gianyar regency, boundary administration district in Gianyar regency, ground truth of land cover in Gianyar regency was obtained from measurements to the field, map of Indonesian environment coast of gianyar regency, tidal data in Gianyar regency in 2002 and 2017.

4 DATA PROCESSING

4.1 Band Merging

Combining Landsat 7 and Landsat 8 satellite imagery combine separate bands into one file. Band combined are blue, green, red and SWIR-1 bands. In this case, band combined there are 4 bands, namely band 1, 2, 3 and 5 for Landsat 7 satellite imagery, and band combined there are 4 bands, namely band 2, 3, 4 and 6 for Landsat 8 satellite imagery.

4.2 Sub-setting Image

The case study used is the beach along Gianyar Regency, Bali. Subsetting image uses a subset of vectors from the boundaries of Sukawati sub-district, Blahbatuh sub-district, and Gianyar sub-district.

4.3 Land and Sea Masking

Band Ratio serves to separate the land and sea regions. The formula used to identify coastlines covered by sand and soil is a green band divided by a SWIR-1 band. In this case, the band ratio on Landsat 7 satellite imagery uses a band 2 divided by band 5. Whereas on satellite imagery Landsat 8 uses band 3 divided by band 6.

4.4 Raster Conversion to Vector

Changing the identified image of land and sea into vector shapes (.shp) by using Raster to Polyline and Raster to Polygon tools so that it will produce coastlines from each image.

4.5 Supervised Classification

This classification to see land cover changes around the coast. This classification starts with how to make ROI from the pixels of each class, namely vegetation, settlements, water bodies, and road bodies. Then the classification is done with the supervised classification: maximum likelihood tool, which will form polygons from the classification results of each class.

4.6 Accuracy Test

Accuracy test uses omission matrix and commission which aims to find out whether the classification process is accurate or not. If the results are above 85% then tolerance has accepted. Accuracy testing is done by making an omission table and a commission that compares the results of the interpretation image with field test results, then generate overall accuracy.

4.7 Spatial Analysis

Analyzing shoreline changes due to the abrasion of Gianyar Regency, Bali in 2002 and 2017.

4.8 Map of Coastlines Change in 2002 to 2017

From the results of the image overlay, then the map lay-outing process is carried out. The resulting map is a map of shoreline changes due to abrasion in the Gianyar Regency region, Bali from 2002 to 2017 which has been corrected with tidal data.

4.9 Calculation of Coastlines Change Area in 2002 to 2017

This area calculation is used to determine how much shorelin**e changes due to abrasion.**

5 RESULT AND DISCUSSION

5.1 Land and Sea Masking

Coastlines change due to abrasion in Gianyar Regency can be known through Landsat 7 and Landsat 8 satellite imagery using band ratio method. Band ratio is used to separate land and sea, so as to produce coastlines from the image. This method uses the value of the surface reflectance on radiometric corrected images.

In this study, the two images used are L1TP levels which has been orthorectified and radiometric corrected using GCP from GLS2000 and DEM data which include SRTM, NED, CDED, DTED, GTOPO 30, and GIMP (USGS, 2017).

The formula used in this method is a green band divided by the SWIR-1 band, this formula can detect sand-covered coastlines and land (Alesheikh, 2007) where in this case study, beach in Gianyar Regency was a beach covered with sand and soil. The formula on Landsat 7 uses band 2 divided by band 5 and Landsat 8 uses band 3 divided by band 6. The following is the result of using the band ratio formula on Landsat 7 and 8 satellite images:

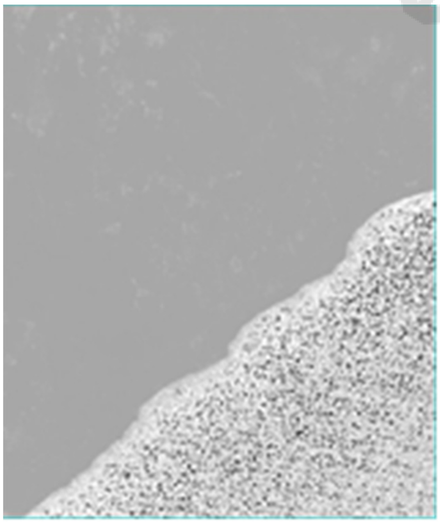

Figure 2. Results of Landsat 7 Image Band Ratio

Figure 3: Results of Landsat 8 Image Band Ratio

Figure 4 tell us that Landsat 7 produces a land area that is in solid gray, and an area of the sea colored in gray dots. Meanwhile, in Figure 5 tell us that Landsat 8 produces a land area that is black and area of the sea colored in white. From this process, a clear coastline can be produced.

5.2 Raster to Vector Conversion

Raster to vector conversion is used to obtain coastlines that can be calculated and overlayed so it will be easier to analyze coastline changes due to abrasion and make a map of coastline changes due to abrasion. Result of raster to vector conversion on Landsat 7 and 8 satellite imagery can be seen in the following figure :

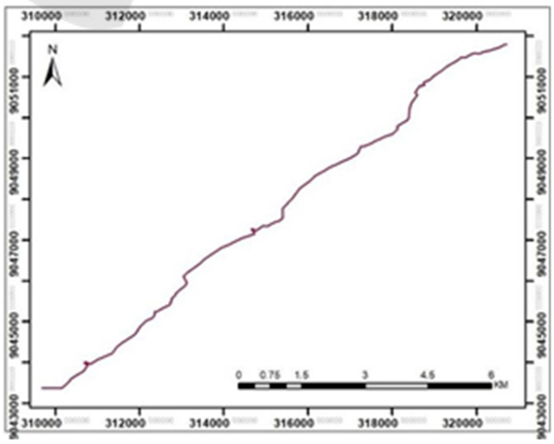

Figure 4: Landsat 7 Coastline Vector in 2002

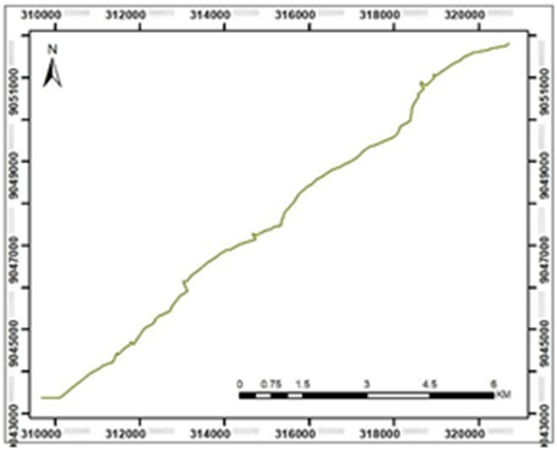

Figure 5: Landsat 8 Coastline Vector in 2017

Figure 6 tell us that coastline vector from Landsat 7 satellite imagery in 2002, and Figure 7 tell us that coastline vector from Landsat 8 satellite imagery in 2017.

5.3 Coastline Changes

Coastline changes due to abrasion in Gianyar regency can be known through Landsat 7 satellite imagery in 2002 and Landsat 8 satellite imagery in 2017 using band ratio method which is converted into a vector, so that extensive abrasion can be known. Image processing results show the abrasion area that occurs on coast of Gianyar Regency which is presented in the following table:

Table 1. Changes in Area Due to Abrasion

District	Sub-District	Village	Abrassion Area (km^2)
Gianyar	Sukawati	Ketewel	0,065
		Sukawati	0,025
		Saba	0,015
	Blahbatuh	Pering	0,006
		Keramas	0,007
		Medahan	0,011
	Gianyar	Lebih	0,026
		Tulikup	0,040
	Total		0,195

The results of processing Landsat 7 satellite imagery in 2002 and Landsat 8 satellite imagery in 2017 show that the abrasion area that occurred quite large from 2002 to 2017 of 0.195 km2. The village that was most affected by abrasion is Ketewel Village of 0.065 km2 Tulikup Village of 0.040 km2, Lebih Village of 0.026 km2, Sukawati Village of 0.025 km2, Saba Village of 0.015 km2, Medahan Village of 0.011 km2, Keramas Village 0.007 km2, and the most slightly exposed to abrasion is Pering Village of 0.006 km2. Coastline changes due to abrasion occur purely due to natural factors, namely the beach located in high seas zone.

Coastline from satellite imagery also takes into account natural factors, one of which is the tide. Map of the coastline changes of Gianyar Regency in 2002-2017 has been corrected from the calculation of the tides. The following is a tidal correction calculation:

Table 2. Tidal calculations

Acquisition Date	Time	HHWL (m)	d (m)	m (m)	η (m)	β (o)	x (m)
22 May 2002	10:12	1,391	11,063	384,208	0,328	1,649	0,199
29 October 2017	10:24	1,476	11,395	412,872	0,081	1,581	0,051

Coastline is carried out by take a point on the coastline which is assumed that the condition of seawater has experienced the same increase, after that it can be calculated the slope of the coast which will result in a distance of coastline shifting from tidal correction (x). Highest High Water Level (HHWL) is obtained from the tidal calculation using the least square method, the depth value (d) is obtained from the contour contained in Gianyar Regency, Beach Environment Map which is corrected with the tidal reading value when recording the image (η) and the HHWL value. Coastline in 2002 obtained from Landsat 7 were drawn ashore in the amount of 0.199 m and coastline in 2017 which is obtained from Landsat 8 is drawn towards the land of 0.051 m.

6 CONCLUSION

Based on results of this study, there are several things can be concluded in this study, Landsat 7 and 8 satellite imagery carried out by band ratio method, a map of the Gianyar Regency coastline changes can be made in 2002-2017. The results of the processing of Landsat 7 and 8 satellite imagery show that the abrasion area that occurred quite large from 2002 to 2017 was 0.195 km2. The village that was most affected by abrasion is Ketewel Village of 0.065 km2 Tulikup Village of 0.040 km2, Lebih Village of 0.026

km2, Sukawati Village of 0.025 km2, Saba Village of 0.015 km2, Medahan Village of 0.011 km2, Keramas Village 0.007 km2, and the most slightly affected abrasion is Pering Village of 0.006 km2.

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