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Analysis of Coastline Changes Using Satellite Image Data at Tanjung Bunga Makassar, South Sulawesi

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Abstract: One city that has been known as a tourism destination is Makassar, particularly Tanjung Bunga beach. It is known to have various supporting facilities. The purpose of this research is to analyze coastline changes using satellite image data and the cause of its changes. It was conducted from August to October 2012 in Tanjung Bunga using Landsat 5 and 7 satellite data analysed by ER Mapper 7.0 and ArcMap 10 softwares to provide spatial and quantitative information on the coastline changes. Based on digital image processing, results indicated that the coastlines of Tanjung Bunga changes from year to year particularly from erosion and sedimentation. However, it was mapped and recorded that there has been some reclamation projects along the beaches. The largest areal extent changes occurred in 2008 to 2010 amounting to 29,300 m^2 involving 1,907 m strip of coastlines being reclaimed. This study implies that there must be some control in the beach reclaimation and other development projects to conserve and manage Tanjung Bunga for recreational purposes and other intangible benefits.

Key words: Tanjung Bunga · Remote Sensing · Satellite Image · Reclamation

INTRODUCTION

Indonesia is an archipelago with a total of 17,480 islands and long beach shoreline approximately measuring to 95,181 km in length resulting in the coastal areas as the main source of income for the Indonesians [1]. In general, the coastal areas can be defined as the junction between terrestrial ecosystems and marine ecosystems that come together in a fragile balance [2]. Coastal areas of Indonesia have a huge development potential because they are supported with highly productive ecosystems such as coral reefs, mangroves, estuaries, seagrass beds and so forth. Biological resources have high economic value in addition to the wide range of economic development benefits [3].

One method to obtain information on potential natural resources of coastal and ocean is the remote sensing method and geographic information systems (GIS). The usage of this system will retrieve information on the objects contained in a single location on the surface of the earth. Through the recording of data using satellite sensors, many natural resources are detected and of these various types of sensors, one of them is the Landsat image [4].

A city which is already considered as local and foreign tourism destination is the city of Makassar. This is so particularly in Tanjung Bunga beach area as a tourism destination with various supporting facilities. These advantages make remote sensing data to be applied in the conduct of research by analyzing changes in the coastline of Tanjung Bunga Makassar. Based on previous research results, the changes in the coastline of Tanjung Bunga Makassar occurred most in 2005-2006 with an areal extent of 3,097 ha due to factors such as waves, currents, tides and sediment. Therefore, the objective of this study is to analyze the shoreline changes in Tanjung Bunga Makassar using satellite image data.

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MATERIALS AND METHODS

This study was conducted from August to October 2012 which includes literature search, image processing, field data collection, data analysis and writing the final report. This research was held in Tanjung Bunga Makassar, South Sulawesi Province. Tanjung Bunga Beach is one of the tourism destinations that attract local and foreign tourists to the city of Makassar, South Sulawesi. It is administratively located in the district of Tamalate. The boundaries of Tanjung Bunga is north bordering Mariso District and Ujung Pandang District, the South by the River Barombong and Gowa regency, East by Mamajang District and west bordering the Makassar Strait.

The waters of Tanjung Bunga coastal are covered by sand, which mostly comes from the flow of the Jeneberang River. The access from the central region of Makassar to Tanjung Bunga is approximately ±20 minutes. Currently, public transportation to reach Tanjung Bunga is still limited and only those with private transportation can easily reach the beach as one of the recreational areas. The location of the study area as seen from SPOT 7 ETM+ image can be shown in Figure 1.

Digital image processing began with band combinations of 1, 2, 3, 4, 5 and 7 at 30 m spatial resolutions. The images used in this study were Landsat 5 taken from years 2007, 2008, 2009 and Landsat 7 ETM+ from 2006, 2010, 2011 and 2012. Initially, cropping of Landsat 7 ETM+ was performed to focus on the analyzed

Table 1: Equipment and materials used in this study

No.	Equipment and Materials	Usefulness
1. Field Equipment:		
Gobal Positioning System		To determine the coordinates of the point in order to know the position of the station.
		To determine the direction
Compass		Documentation
Camera		Recording measurements and observations.
Stationery		
2. Laboratory equipment:		
	ER Mapper citra processing software version 7.0	Software to analyze the image.
	ArcMap software 10	Used to analyze the map.
	Personal computer (pc)	
	Landsat 5 in 2007, 2008, 2009	Used to analyze and interpret changes in the coastline.
	Landsat 7 ETM + years	
	2006, 2010, 2011, 2012.	
	Administrative map of Makassar	

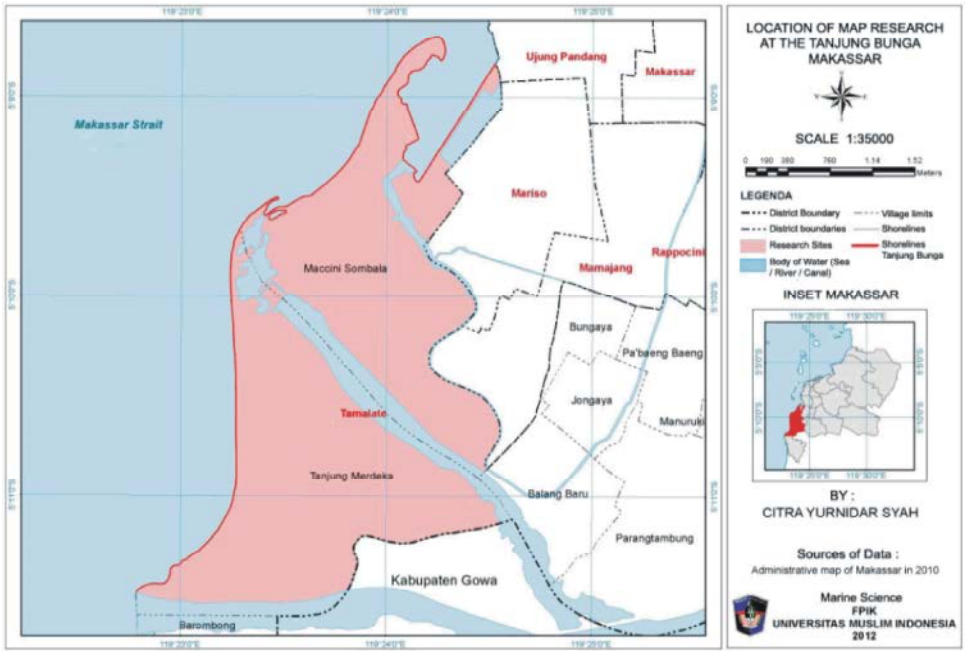

Fig. 1: Map of Tanjung Bunga showing the location of study site

areas of interest (AOI) with the help of a digital map of Makassar administration area. This process was done using ArcMap version 10 by overlaying image of the map with the corrected digital maps administrative boundaries created by AOIs [5]. Then, a FCC was created to obtain the optimum visual land segment identification in order to highlight details from the earth's surface by utilizing a variety of configurations and sharpening of spectral values. A visual interpretation of land forms on a computer monitor was then carried out. A FCC of Landsat 5 using Bands 542 was applied while for Landsat image ETM+ used four bands 7 which were 5428. The projection map functions were then used to find information projection system. Landsat image of map using Landsat 5 and 7 still has a projection NUTM50 [6]. NUTM50 in the northern latitudes was projected to SUTM50 and projected in southern latitudes due to the location of the research that was held in Makassar, South Sulawesi. Digitization process was done automatically using ArcGIS with the ArcMap 10 tools by digitizing objects depicted on the map reproduced in digital format. To produce accurate data, it takes an analog source maps of high quality and for the digitization process, what is required is accuracy and high concentrations of the operator. Later, transformations were used to improve the contrast of color and light in image. This process was done to simplify the process of interpretation and image analysis by changing the histogram line [7]. Next, the overlaying process was performed in a GIS environment to put layers of graphic maps and displays the results on a computer screen. In a nutshell, the overlay displays layers of digital maps with other attributes and produces map that have combination of both attribute information from the two maps leading to shoreline changes classified according to the USGS system development and modification.

The equipment and materials used in this study are presented in Table 1.

The data were then spatially and quantitatively analysed. In the spatial analysis, it is integrated in SIG overlay to quantify the coastline changes. Spatial analysis was done to generate new mapping units used as the unit of analysis [8]. For spatial analysis, a Universal Transverse Mercator (UTM) projection and coordinate system was used. On the other hand, the quantitative analysis used secondary data such as waves, currents and tides for comparison purposes.

RESULTS AND DISCUSSION

Results indicated that reclaimation of coastlines in years 2007-2012 is the main factor that determines the major shoreline change. The other determining factor is the shoreline abrasion as a result of coastal erosion and

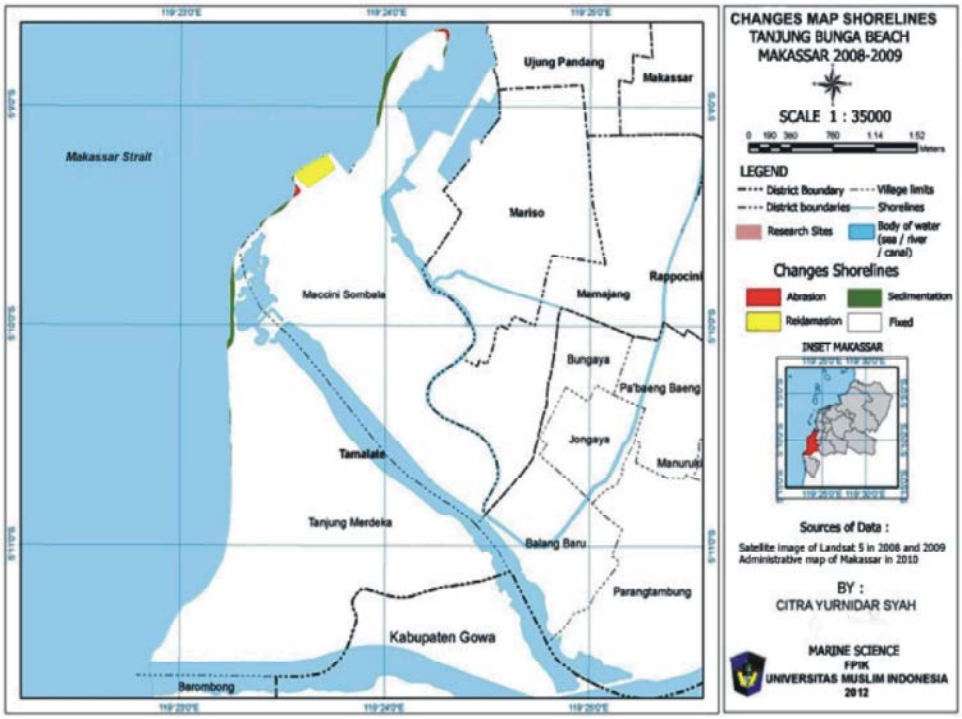

Fig. 2: Coastline Change Map in 2008-2009

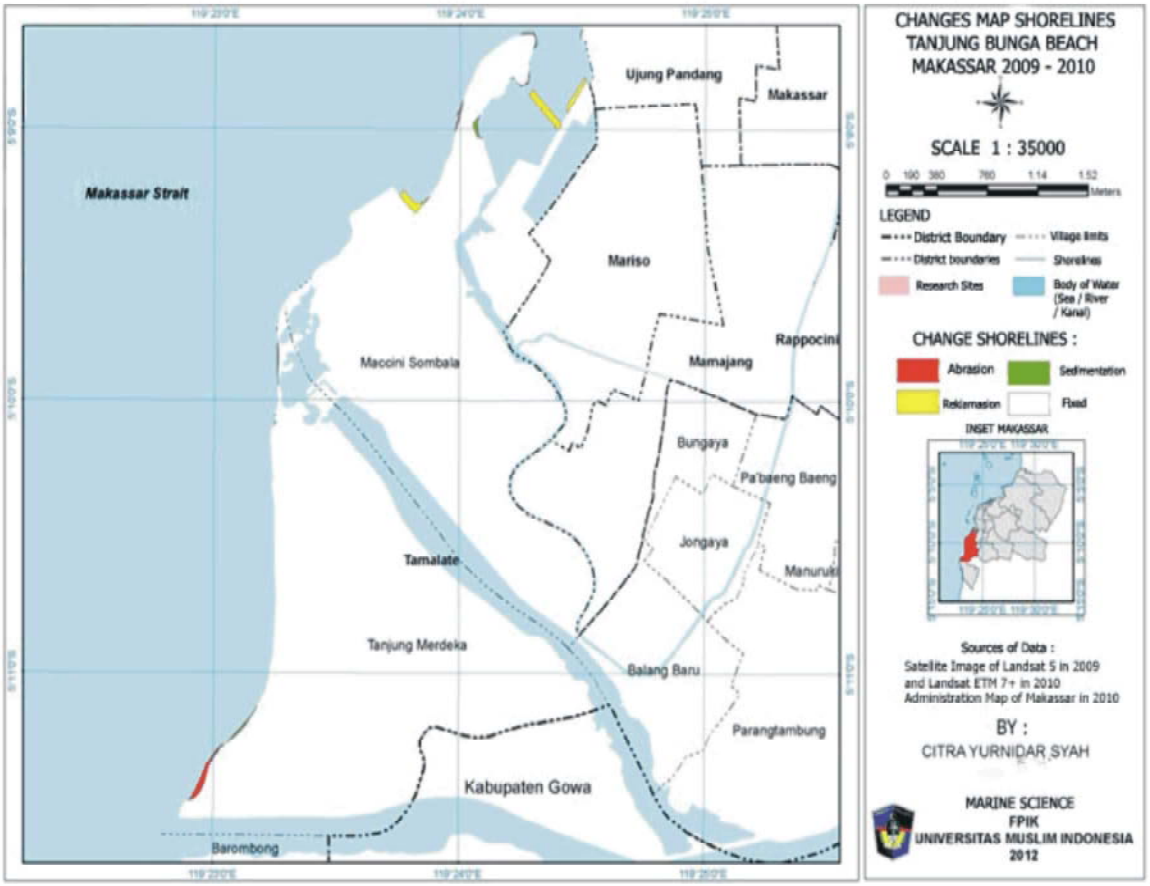

Fig. 3: Shoreline Change Map in 2009–2010

Table 2: Shorelines change at the Tanjung Bunga Beach in 2008–2012

Year	Reclamation (m^2)	Abrasion (m^2)	Sedimentation (m^2)
2008-2009	46,000	16,500	6,9009
2009-2010	29,300	13,900	10,100
2010-2011	-	12,500	3,200
2011-2012	-	11,000	14,900

sedimentation by the damaging sea waves and ocean currents. Shoreline damage due to abrasion is also affected by natural phenomena and uncontrolled human action such as the deforestation of mangrove forest. Figures 2 and 3 and Table 2 illustrated the magnitude of shoreline changes from 2008 to 2010.

Based on the above maps and table of shoreline change in 2008-2012, the most significant reclamation occurred in 2008-2010, with an areal extent of 46,000 m^2 occuring in 2008-2009 while an areal extent of 29,300 m^2 in 2009-2010. Other factors such as abrasion, exploitation of mangroves and sedimentation also change from year to year.

Shoreline change due to the natural phenomena such as abrasion and sedimentation in Tanjung Bunga Makassar from 2007-2012 is more dominant than the human factors especially land reclamation along the shoreline.

CONCLUSION

Landsat images of Tanjung Bunga Beach have proven to be a useful tool in measuring the changes of an additional coastline in 2007-2012 due to the influence of human activities especially beach reclamation. The Tanjung Bunga Beach has the largest shoreline change in 2008-2010 with an areal extent of 46,000 m^2 and in 2009-2010 with areal extent 29,300 m^2. Being Tanjung Bunga coastal area major tourism destinations in Makassar, the local government policy is suggested to restrict future

development activities that may lead to avoid destruction of the sandy beaches and ssustain mangrove forest areas. This research is expected to provide information about the condition of the shoreline changes and to assist in the establishment of sustainable coastal policies.

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