Detection of Coastal Area Changes Based on Remote Sensing Application

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Abstract— *The research area is located on Pangandaran District, West Java at coordinate 7°39'50" S - 7°42'28 "S and 108°34'13" E - 108°40'0" E. This research aims to identify coastal area changes in the research area based on the remote sensing application. The research was carried out by studio analysis using satellite images in Google Earth and field observation. The data used in this research are satellite images that were taken from 2006, 2015, and 2018. This research uses image comparison method, namely by identifying and analyzing changes that occur on the coastal area. Based on the results, the research area is a coastal plain which has a straight to curved coastline and a low relief-flat area. It shows that there is a fairly clear abrasion during the period of 2006 to 2018. It can be proven from satellite images that show a slight change in coastline of the research area. Moreover, it can be seen that the additional number of residential, education, and tourism areas is quite significant in the last 10 years. Therefore, it is important to maintain the coastal area through supervision and monitoring so that there is no land degradation due to the intensive land use changes.*

Keywords— *Coastal area, land use, satellite images, Google Earth, remote sensing*

I. INTRODUCTION

The research area is located on Pangandaran District, West Java at coordinate 7°39'50" S - 7°42'28 "S and 108°34'13" E - 108°40'0" E. It is a coastal area which is one of the interesting area because of its location as the boundary between land and sea [1]. According to [2], coastal area is very complex and dynamic because it is a transition area between land and marine process. The dynamics are influenced by several factors such as climate, hydro-oceanography, sediment supply, change in sea level, and human activities [3].

In the coastal area, sediment deposits usually accumulate and involve erosion process. Erosional landforms dominate rocky coasts but it can also be found in association with predominantly depositional landforms [4]. According to [5], the coastal abrasion and sedimentation process can occur in different places but can also occur in the same place at different times. These processes can cause changes in the coastline [6].

Coastline is the land margin at normal high spring tide and may be the base of a cliff or the seaward margin of dunes or dry land [7]. The coastline can also indicate changes that occur in the coastal area. The increase in human activities such as beach nourishment, port construction, and tourism area development can change and reshape the coastline [8][9][10]. On the other hand, the coastline change caused by human activities may also coincide with the land use change in the coastal area.

Land use change in the coastal area can be detected and determined properly using remote sensing application [1][11][12]. Therefore, this research will identify coastal area changes based on the remote sensing application. Changes in the coastal area will certainly result in massive land degradation. So that coastal area monitoring is an important thing that needs to be done to protect the environment and maintain sustainable development [1][13].

II. METHOD

The research was carried out by studio analysis using satellite images in Google Earth. The data used in this research are satellite images that were taken from 2006, 2009, and 2018. This research uses image comparison method, namely by identifying and analyzing changes that occur on the coastal area.

The satellite images were used to identify and analyze the land use of the research area. It is the main dataset that can be used in many application of remote sensing. The remote sensing technology is useful and can help to monitor the coastline changes [1][11] and determine the land use characteristics of an area using Google Earth [14][15][16].

Other than that, field observation is needed to find out the actual conditions in the field. Some things that need to be considered in field observation are the similarity of land use between the images and the field, the time of checking, and the potential changes that can occur in the future.

III. RESULT AND DISCUSSION

The research area is a coastal plain which has a straight to curved coastline. It can be seen in Fig. 1-6 that there is no steep slope in the research area. There are also several land use such as residential, plantation, and tourism area that developed by community and local government. In general, land use in the research area does not show any intensive and massive degradation in environment quality.

In the research area (Fig. 1-3), the anastomotic drainage pattern can be identified from its shape. The anastomotic drainage pattern shows a network of interlocking streams in the flood plains and tidal marshes [17][18] which shows that the research area is a low relief and flat area. The erosion and sedimentation processes occur mostly at the point bar. It causes the accumulation of sediment deposits along the river towards the sea. There were differences in 2006, 2015, and

2018, namely the size of the streams and the presence of sediment deposits in the streams. The size of the streams in 2018 becomes slightly larger than in 2006. It can be seen from some parts of the river banks become wider. Moreover, there is increasing accumulation of sediment deposits since 2006 to 2018. It can be determined from the brownish color seen in the river of the research area.

Fig. 1. Coastline near the Padjadjaran University-Pangandaran campus
(Imagery date: 3 September 2006)

Fig. 2. Coastline near the Padjadjaran University-Pangandaran campus
(Imagery date: 10 January 2015)

Fig. 3. Coastline near the Padjadjaran University-Pangandaran campus
(Imagery date: 9 April 2018)

The changes that can be observed through satellite images occur at the coastline. There is a fairly clear abrasion during the period of 2006 to 2018 (Fig. 1-6). It can be proven from satellite images that show a slight change in coastline of the research area. However, the changes in coastline that seen through satellite images do not show significant changes.

Fig. 4. Curved coastline near the Padjadjaran University-Pangandaran campus
(Imagery date: 2 September 2006)

Fig. 5. Curved coastline near the Padjadjaran University-Pangandaran campus
(Imagery date: 10 January 2015)

Fig. 6. Curved coastline near the Padjadjaran University-Pangandaran campus
(Imagery date: 2 June 2018)

It can be seen in Fig. 4, there is not much vegetation near the coastline in 2006. Otherwise, in 2015 and 2018 (Fig. 5 and 6) the amount of vegetation is increasing. It can happen because of the increasing number of land use changes such as the addition of residential, education, and tourism areas is also accompanied by the maintenance of vegetation.

Land use change can occur due to factors of increasing population and economic growth. Based on the field observation results, there are residential, plantation, education, and tourism area in the research area that can trigger changes in land use. These changes are expected to increase economic

growth in the future.

Fig. 7. Plantations as a land use in the research area

Fig. 8. Tourism area in the Pangandaran coastal area

IV. CONCLUSION

The research area is a coastal plain which has a straight to curved coastline. During 2006 to 2018, some land use changes that occurred can be observed through satellite images in Google Earth. The anastomotic drainage pattern can be determined which shows that a low relief and flat research area. It can also be identified that there is a fairly clear abrasion along the coastline. It can be seen that the additional number of residential, education, and tourism areas is quite significant in the last 10 years. Therefore, it is important to maintain the coastal area through supervision and monitoring so that there is no land degradation due to the intensive land use changes.

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REFERENCES

[1] Bioresita, F., Hayati, N. 2016. Coastline Changes Detection Using Sentinel-1 Satellite Imagery in Surabaya, East Java, Indonesia. *Geoid*, Vol.11 (2), 190-198.
[2] Gunawan, I. 1998. Typical Geographic Information System (GIS) Applications for Coastal Resources Management in Indonesia. *Indo. J. Coast. Mar. Res. Manag.*, Vol.1, 1-12.
[3] Solihuddin, Tb. 2006. Karakteristik Pantai dan Potensi Bencana Geologi Pantai Bilungala, Gorontalo. *Segara*, Vol.2 (1), 214-222.
[4] Huggett, R.J. 2011. Fundamentals of Geomorphology. Second Edition. Abingdon, Oxon: Routledge.
[5] Winarso, G., Budhiman, S. 2001. The Potential Application of Remote Sensing Data for Coastal Study. *Proc. of 22nd Asian Conference on Remote Sensing*, Singapore.
[6] Pasaribu, R., Agus, F., Soeprijadi, L. 2019. Spatial Analysis of Coastline Change by Remote Sensing in the North Coast of Karawang Regency. *Jurnal Geografi Lingkungan Tropik*, Vol.3 (2), 50-56.
[7] Bird, E. 2008. Coastal Geomorphology, an Introduction. Second Edition. Chichester: John Wiley & Sons.
[8] Jennings, S. 2004. Coastal Tourism and Shoreline Management. *Ann. Tour. Res.*, 31, 899–922.
[9] Peterson, C.H., Bishop, M.J. 2005. Assessing the Environmental Impacts of Beach Nourishment. *Bioscience*, Vol. 55, 887-896.
[10] Syvitski, J.P.M., Kettner, A.J., Overeem, I., Hutton, E.W.H., Hannon, M.T., Brakenridge, G.R., Day, J., Vörösmarty, C., Saito, Y., Giosan, L., Nicholls, R.J. 2009. Sinking Deltas due to Human Activities. *Nat. Geosci.*, Vol.2, 681–686.
[11] Halim, Halili, Afu, L.O.A. 2016. Studi Perubahan Garis Pantai dengan Pendekatan Penginderaan Jauh di Wilayah Pesisir Kecamatan Soropia. *Jurnal Sapa Laut*, Vol.1 (1), 24-31.
[12] Xu, N. 2017. Detecting Coastline Change with All Available Landsat Data over 1986–2015: A Case Study for the State of Texas, USA. *Atmosphere*, 9, 107; doi:10.3390/atmos9030107.
[13] Bey, A., Díaz, A.S., Maniatis, D., Marchi, G., Mollicone, D., Ricci, S., Bastin, J., Moore, R., Federici, S., Rezende, M., Patriarca, C., Turia, R., Gamoga, G., Abe, H., Kaidong, E., & Miceli, G. 2016. Collect Earth: Land Use and Land Cover Assessment through Augmented Visual Interpretation. *Remote. Sens.*, 8, 807; doi:10.3390/rs8100807.
[14] Jacobson, A., Dhanota, J., Godfrey, J., Jacobson, H., Rossman, Z., Stanish, A., Walker, H., Riggio, J. 2015. A Novel Approach to Mapping Land Conversion using Google Earth with an Application to East Africa. *Environmental Modeling and Software*, Vol.72, 1-9.
[15] Sidhu, N., Pebesma, E., Camara, G. 2018. using Google Earth Engine to Detect Land Cover Change: Singapore as a Use Case. *European Journal of Remote Sensing*, Vol.51 (1), 486-500.
[16] Xie, S., Liu, L., Zhang, X., Yang, J., Chen, X., Gao, Y. 2019. Automatic Land-Cover Mapping using Landsat Time-Series Data based on Google Earth Engine. *Remote Sens.*, 11, 3023; doi:10.3390/rs11243023,
[17] Zernitz, E.R. 1932. Drainage Patterns and Their Significance. *The Journal of Geology*, Vol.40 (6), 498-521.
[18] Howard, D., 1967. Drainage Analysis in Geologic Interpretation: A Summation. American Association Petroleum Geologist: Tulsa USA.