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## **Critical Land Detection Watershed River Bengkulu and Effect of Coastal Area using Geographic Information System**

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### **Abstract**

The specific objective research to detect changes in land for the detection of critical areas and its effect on coastal areas with spatial approach. Determining the change detection of critical areas and coastal areas with Landsat image analysis. The approach used in this study based spatial modeling and then conducted a field survey/matching analysis results with physical characteristics of the land, so that will be obtained data is detection of critical land area and its impact coastal areas. The approach will be analyzed aerial photographs image interpretation and processing of spatial data using geographic information system (GIS). The results of the study are (1) changes in critical land area is 1990 to 240.824 ha or equal 8.384%, in 2005 to 306.202 ha or at 10.661%, in 2015 to 1114.189 ha or by 38.791% and in 2016 with 1211.084 ha or equivalent to 42.164% of the total area of 2872.299 ha. and (2) physical Condition Texture critical land and soil structure to be damaged by coal mining and (3) influence coastal areas their physical shape changes occur in the vast river, meanders and estuaries Bengkulu River watershed are caused by the erosion and deposition rate as a result of coal mining upstream part of the river and waste coal mining activities along the riverbanks.

**Keywords:** Watershed, Landsat, Wasteland, Coastal Region

### **Introduction**

It is undeniable that the environmental conditions in coastal and marine areas can not be released from the condition of a watershed, due to natural coastal and marine areas is an area which is in the downstream segment of the watershed. Hydrological conditions change as a result of efforts to meet the need for uncontrolled land and not pay attention to the rules of the conservation cause problems such as increased erosion and sedimentation, decreased land productivity and acceleration of land degradation (Supriyono, 2015; Hermon, 2017; Hermon *et al.*, 2017)). These changes not only have a real impact in biophysical namely the expansion of critical areas and decrease the carrying capacity of the land, but also social and economic causes decreased ability of trying people in their land. The utilization of land resulted in the destruction of natural resources caused by exploitation without regard to the carrying capacity (Kartodihardjo, 2008; Hermon *et al.*, 2018a). Soil conditions due to the exploitation of land caused largely become critical. In the growing area of land use resulting in critical land (Pratiwi and Murti, 2015; Hermon *et al.*, 2018b)). One of the factors of land use is mining coal. Based on observations and physical assessment, the state of the current landscape in Bengkulu River watershed has experienced the rate of degradation of watershed function significantly due to the pressure of coal mining activities. The existing forest area, some have also been converted into areas of former mine pits. Based on this trend, of course, requires serious attention, given such conditions can be degraded function of hydrological catchment area (catchment area). Therefore Bengkulu River watershed



should receive treatment that can restore the catchment area so that its functions can be restored (Hermon *et al.*, 2018b).

Efforts to improve the condition of degraded land will be able to be as good as the information can be identified objectively condition overall (Tarin, 2012; Gibbs and Salmon, 2015; Sulistiyo, 2015; Hermon, 2014b; Hermon, 2015; Hermon, 2016a; Hermon, 2016b). Provision of data and information is very necessary, especially in supporting the strategy of efficient formula, so it is expected to obtain a reference in the allocation of resources proportionally. That is, to overcome the problem of degraded land required critical level of land distribution map such that it can be seen as a priority area that should be addressed, what actions should be done, and how much funding is needed (Sulistiyo, 2011).

Based on the background described above, the outcome in the research that will be done is to determine and detect changes in critical lands and coastal areas influence the analysis of Landsat images. The approach used in this study based spatial modeling and then conducted a field survey/matching the analyst with the physical characteristics of the field, so that will be obtained from the data area of critical land use change and physical condition of coastal areas. The approach will be analyzed aerial photographs image interpretation and processing of spatial data using geographic information systems (GIS).

## Method

The data used in this study were divided into data and data from Landsat imagery interpretation. Additional data include data on the basis of truth for classes of land cover and land use for the detection of critical areas and changes in area river estuary Bengkulu, Landsat images Landsat research area in 1990, 2005, 2015, and the physical condition of land mines in the renewable in August 6, 2016, with parth/row 125/063, topographical maps and map the watershed scale Bengkulu 150,000 (BPDAS Bengkulu province). Data basic truths in the form of reference data points collected using Geographic Positioning System (GPS) from March 2016 until August 2016 for image analysis, is used for image classification and valuation cation results fi overall accuracy of the classification. Satellite data for 2 years on the other side is composed of multi-spectral data is acquired by Landsat satellites provided by Glovis USGS. Satellite image re-processing prior to the detection of change is immensely needed and has a primary unique objective of establishing a more direct affiliation between the acquired data and biophysical phenomena (Coppin *et al.*, 2004) the geometric correction, determined in advance the type of the composite image that will be used to create a composite color image. The composite image is the incorporation of a combination between channels (bands) which has a spectral resolution of different spatial resolution at which in this case are channels (bands) 1, 2, 3, 4, 5, and 7, each of which has a resolution 30 meter spatial (Lisnawati and Wibowo, 2007; Hermon, 2009; Hermon, 2012a; Hermon, 2012b). A composite image is done by entering into the channels/bands of red, green, and blue (RGB). The goal is to obtain optimal visual display to identify the differences in water surface boundary with the land boundary. By combining Band RGB-543 obtained a detailed interpretation of pixel values in an image merupaan river flow patterns. Composite image by merging band RGB-543 standard is a false color image can be clearly means to do interpretation (Sutanto, 2015). Processing is performed using ENVI Software 4.5. In this study, the combination used is a composite image RGB-543. Asriningrum (2002) in Bogor showed that the composite image RGB-543 is the best result in the model area in Bogor, because the natural color displays with color contrasts most firmly and clearly displays the shape of the earth's surface. The next step is to perform geometric correction-543 RGB composite image of the map subzone Hulu Sungai Bengkulu. Geometric correction is done by identifying Ground Control Points (GCP) in the original image and the map S Bengkulu River watershed upstream. Calculation of Root Mean Square (RMS) indicates the accuracy of GCP. Interpretation of Landsat imagery conducted prior cutting process image (cropping) based on the boundaries of research conducted with the help of ENVI 4.5. The next step of image interpretation, carried out visually directly on a computer monitor (on screen interpretation). The process of interpretation is done by limiting the areas that have the characteristic elements of different interpretations. This shows the type of landscape is a land use which is a tract of mining land be analyzed and made digitization. Withdrawal of the boundary between the results of image interpretation is done directly through the process screen (on screen digitizing). After the digitized image is corrected the next digitized form with Arc tools book select menu Cartografi. The second process is a process carried out with the help of software ArcGIS.10.1



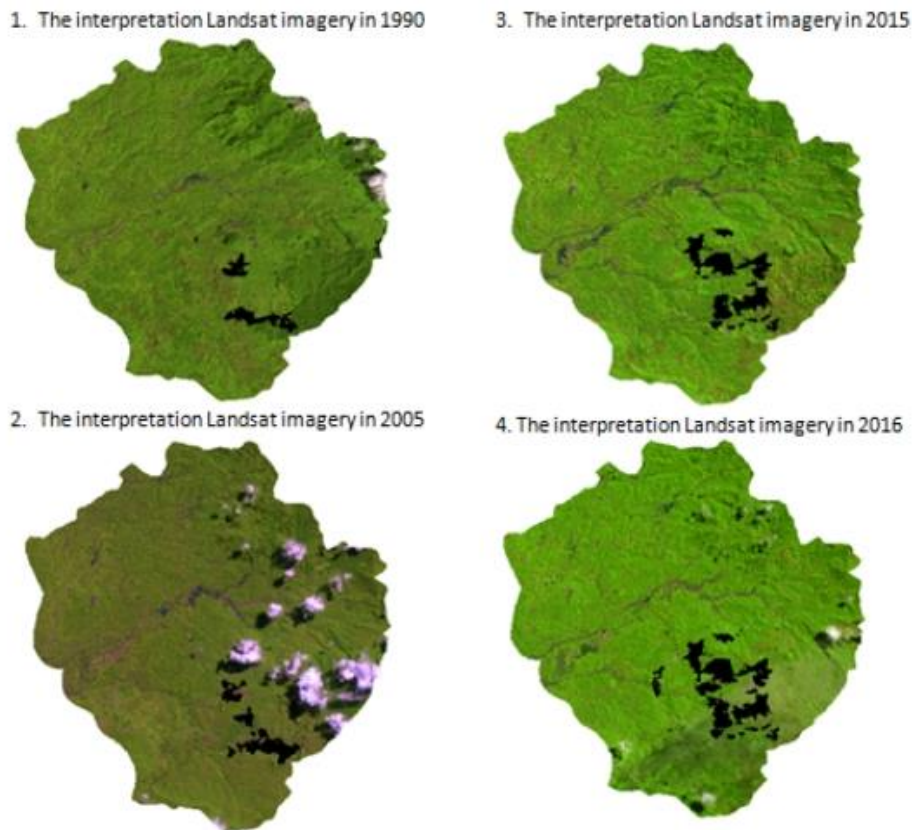
Test accuracy is very important in any research of any kind of remote sensing data. The level of accuracy of data strongly influences the confidence of users against any kind of remote sensing data. Test the accuracy of the analysis for the identification of land cover done in two ways: (1) Accuracy of sampling area (area sampling accuracy) and (2) Accuracy of sampling points / field survey data (point sampling accuracy). Trace Analysis Critical Areas with accuracy Test Sample Area Classification Based Evaluation of accuracy of the image classification results can be made by Matrix ERROR (confusion matrix). Matrix is obtained by comparing the number of pixels results of image classification by the number of pixels in the training area in the classification process are presented data ground truth of the same class as the test pixels. Evaluate the accuracy of mapping includes the number of pixels of samples classified correctly or incorrectly, giving the class name correctly, the percentage of the number of pixels in each class as well as the percentage of total error. Accuracy can be calculated is the accuracy of the sampling area (user's accuracy), the accuracy of the classification process is performed (producer's accuracy) and the accuracy of the pixels corresponding to the result of the classification (overall accuracy). The results are superimposed (overlay) and compared, so that the area and the types of changes in land cover and uses can be identified. Overlay matrix of two image classification results this will produce a change matrix that shows how a change occurs in a certain class of first year to the next. Map changes can be generated by comparing the two images based on the classification results pixels per pixel. Analysis of geographic information system was used to determine the detection of critical areas and changes in coastal areas through spatial data. Then after spatial data obtained, the next step with overlay land use maps and map digitization coastal areas / river estuary. Overlay maps years 1990-2005 and 2016, in order to obtain the detection of critical areas and changes in coastal areas. Overlay is a spatial analysis that combines two thematic input (Prahasta, 2015).

## **Results and Discussion**

### **Detection of Critical Areas**

Based on the results of remote sensing with digital image interpretation techniques gained appearance results coal mines in the Upper River subzone Bengkulu. Visible on Landsat 8 layer on the composite 653 (RGB) are black and light green land vegetation. This is due to a combination of three band 653 is effective for assessing the condition of the land / soil to expose the index and different colors are presented in Figure as follows:

Detection of critical land with image analysis difficult, if not their ground field checks the results of image interpretation. imagery interpretation only to determine the value of the pixels in an image so it can be analyzed visualization of objects on the Earth's surface. Ground field check is to make sure the object is interpreted in accordance with the existing surface of the earth. After then the next is eliminating or editing the attribute table on layer to be adjusted to the physical condition of the study area. The spatial model of critical land which is fully based raster sub Bengkulu River watershed through the integration of Landsat images taken include digital analysis, to all data affecting the occurrence of critical land. Degraded land broadly defined as (Erosion + Slopes + Percentage Header + Management), while the erosion itself is determined by the model USLE defined as  $A = R \times K \times LS \times C \times P$  (Sulistiyo, 2011).



**Figure 1.** Interpretation Detection of critical

Changes in critical lands in the Upper River subzone Bengkulu to do interpretation image. According to Sutanto (2015) of image interpretation can be done using aerial photographs, satellite images or digital data (air system or satellite system) is displayed in analog form (images and visual). Purwadhi (2006) revealed that the land use of image interpretation is reviewing the image to identify and assess the importance of land use which means objects coal mining activities. Based on the results of digitization and interpretation of the image of the 1990, 2005, 2015 and 2016 obtained the extents of each land cover is detected critical land and its changes on timescales of tens of years and the current condition image recording (August 6, 2016) in the Upper River subzone Bengkulu. Land change detection performed by the spatial approach using image comparison Method classification results (post classification comparison) between the two images that were recorded in two different The results showed changes in land use in the Upper River subzone Bengkulu namely coal mining in the area of Taba Penanjung increased. The area of damaged and become potential critical land caused by the exploitation of mining products increased value of critical land obtained by performing the method overlaying (overlay) (Tampubolon and Yanti, 2015).

**Tabel 1.** Analysis of Critical Land Changes

No	Year	Area Changes (ha)	(%)
1	1990	240,824	8,384
2	2005	306,202	10,661
3	2015	1114,189	38,791
4	2016	1211,084	42,164
	<b>Total</b>	<b>2872,299</b>	<b>100%</b>

Sumber : Resul nterpretation Detection of critical in ENVI 4.5



From the result of extensive analysis of critical land changes from the table above can be seen that the region that has the criteria very quickly changes into a critical land area is 2015 to 1114.189 or at 38.791% and in 2016 amounted to 1211.084 ha or 42.164% of the total area of 2872.299 ha. The relatively rapid changes caused by the exploitation of coal mines in the Upper River subzone Bengkulu. Coal mining operations which continued to surge in the world market demand (Ardiyansayah, 2009). While the changes that occurred in 1990 and 2005 did not increase. Only an increase of approximately 64 ha in change every 15 years. It is interesting to understand that the condition of critical land of the land is still low. The potential of natural resources and coal mining companies are still able to carry out reforestation with the environmental conditions favorable.

### **Physical Characteristics of Critical Land**

The physical characteristics of critical land in Upper River subzone Bengkulu with normal soil profiles were disrupted by dredging, backfilling and compaction of heavy equipment. This resulted in poor water and aeration system that directly affects the phase and root development. Texture and soil structure to be damaged thereby affecting the soil's capacity to hold water and nutrients. Subsoil profile is not perfect, so it will be influential in building conducive to plant growth.

As a result of soil compaction caused in dry soil becomes dense and hard. In this densely textured soils, water absorption into the ground is slow because the pores of the soil is very small, so it will be able to increase the rate of flow of surface water which increased the rate of erosion. Soil conditions are hard and dense very heavy to be processed, which indirectly impact on improving labor needs. Degraded land is a land that soil conditions have undergone or in the process of physical, chemical or biological ultimately endanger hydrological function, agricultural production, housing and social life economy around regional influence To assess critically whether an area can be seen from the ability the land. As for knowing the ability of a farm can be seen from the magnitude of the risk of threats or obstacles in the utilization of the land.

### **Changes in Coastal Areas**

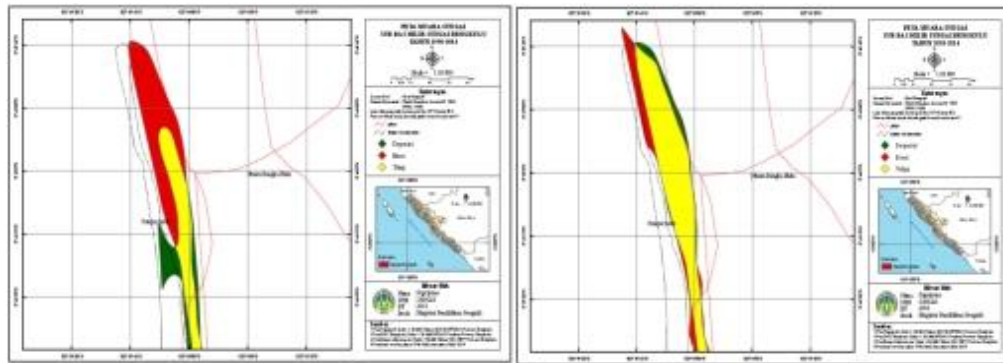
Changes in coastal areas is the result overlay map of two different years are years 1990- 2003 and 2003-2014 years of the obtained picture on the estuary of the river channel downstream subzone Bengkulu River which are the change that advances against North or experiencing deposition. In a period of 10 years (1990-2003 and 2003-2014). The biggest factor affecting changes in the coastal area is changing circulation patterns in the flow of the river estuary that is caused by changes in the structure formation and the depth of the river mouth. Mass mixing layer with low salinity fresh water and sea water masses with high salinity will change permanently. The consequence will lead to a significant change of organisms and plants in the river mouth. This means that no significant changes from the input of fresh water carrying sediment material along the river and the influence of the high seas does not change the structure and formation in the mouth of the river. Extensive erosion and deposition in the estuary of the river can be seen in the following table:

**Table 2.** Erosion and Deposition Broad Estuary

<b>No</b>	<b>Year</b>	<b>Erosion (ha)</b>	<b>Deposition (ha)</b>
1.	1990-2003	10,399	3,106
2.	2003-2014	2,413	1,433

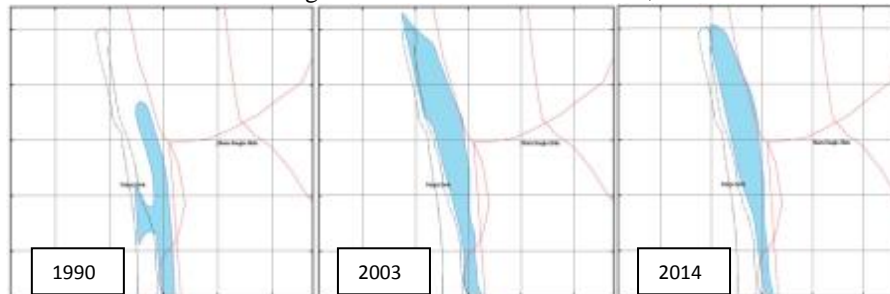
From the table above it can be concluded that the high levels of erosion caused by the deposition in the mouth of the erosion is most prevalent in the period 1990-2003, namely an area of 10.399 ha, followed by sedimentation or deposition rate is 3,106 ha. Then in 2003 through 2014 the erosion process measuring only 2.423 ha with an area of 1,433 ha deposition. The condition can be seen in the following figure:





**Fig 2.** River Estuary Subzone Lower River Bengkulu

For more details see the change from the river mouth in 1990, 2003 and 2014 were as follows:



**Figure 3.** Changes in Coastal Areas Meander River

From the picture above the river mouth can be seen that there is a change in the physical form of the river. The changes are due to the high erosion and siltation / deposition. The big change that occurred between the years 1990-2003. While the changes that occurred in the span of just a river in 2014 have additional extents. In 1990 the river mouth have added advanced towards the North, but the output position of river water into the sea is still in the Southeast.

## Conclusion

Based on the results obtained by employment of GIS applications to achieve the specific research objectives, it is concluded that the results of the study are (1) changes in critical land area is 1990 to 240.824 ha or equal 8.384%, in 2005 to 306.202 ha or at 10.661%, in 2015 to 1114.189 ha or by 38.791% and in 2016 with 1211.084 ha or equivalent to 42.164% of the total area of 2872.299 ha, (2) physical Condition Texture critical land and soil structure to be damaged by coal mining and (3) influence coastal areas their physical shape changes occur in the vast river, meanders and estuaries Bengkulu River watershed are caused by the erosion and deposition rate as a result of coal mining upstream part of the river and waste coal mining activities along the riverbanks

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