ANALYSIS OF CRITICAL LAND IN THE MUSI WATERSHED USING GEOGRAPHIC INFORMATION SYSTEMS

Danang Surya Candra[1]

Abstract. Critical land is a land that is no longer functioning as a regulator of water, agricultural production elements and environmental protection elements. Owing to the fact that the analysis of critical land is usually carried out manually, the probability of errors in processing (human error) is very high. This research utilizes the Geographic Information System (GIS) technology to analyze critical area in protected forest area of Musi Watershed. The application of GIS technology, enables the analysis of critical land according to standard of critical land criteria. The results show that the very critical level area in protected forest area of Musi Watershed is 1.7%. The dominant level is in critical potential area (53.34%).

Keywords: *Critical Land, Watershed, Remote Sensing, GIS, Weighting Method, SPO-4.*

1. Introduction

A watershed is a topographic land area that is bounded by mountain ridges that hold and store rain water, and then distribute it to the sea through the main river. The low carrying capacity of the watersheds in an ecosystem thought to be the main caused of natural disasters related to water such as floods, landslides and droughts. Key components of the ecosystem that supports watersheds are the natural resources (vegetation, soil and water) and human resources.

Declining environmental quality and natural resources was followed by an increase in land use change, particularly from forest to agriculture and from agricultural land to residential. Efforts to improve environmental conditions through a program of RHL will yield better results if the objective information of forest and land conditions can be identified. Providing data and information are indispensable, especially for supporting RHL, which is expected to obtain a reference for allocation of resources to be proportional.

Presently, only attributes data regarding critical land are available at the Indonesia Ministry of Forestry, such that spatial distribution is difficult to know. So the synchronization RHL programs that are multi-sectoral is difficult, because the spatial analysis is one of the main tools in it.

Unavailability of spatial data and information has effect on the assessment of the validity of critical land data. Owing to the fact that the analysis of critical land is usually carried out manually, the probability of errors in processing (human error) is very high. The GIS applications are tools that allow users to create interactive queries (user-created searches), analyze spatial information, edit data, maps, and present the results of all these operations (Clarke, 1986). By utilizing Geographic Information Systems technology (GIS) will facilitate the conduct needs analysis and action to RHL watersheds (DAS), so that the weaknesses in making maps manually can be eliminated, especially those associated with the development of information processing, and map reproduction (Ditjen RLPS, 2003). Another advantage of GIS technology is that it enables quick and precise further map analysis to be carried out. It is helps to improve the decision (policy) making tools associated with forest and land management.

2. Material and Method

2.1. Data

In this research, remote sensing satellite data such as SPOT 2, SPOT 4, and the DEM SRTM data are used. The acquisition date of SPOT-2 and SPOT-4 is in 2009 and 2010. These data are used to determine the condition of land cover. The Regional Physical Planning Program for Transmigration (RePPProT) map is also used. It is used as a guide to determine the system of land that potentially describes a high attrition rate, the presence of rock outcrop (outcrop) and the level of productivity.

2.2. Research Sites

The research sites are in the work area of BPDAS Musi that includes forty sub watershed located in three provinces, namely Prov. South Sumatra, Prov. Jambi and Prov. Bengkulu. The detail of research sites is shown in Figure 1.

[1]Scientist in Remote Sensing Technology and Data Center, Indonesia National Institute of Aeronautics and Space (LAPAN)

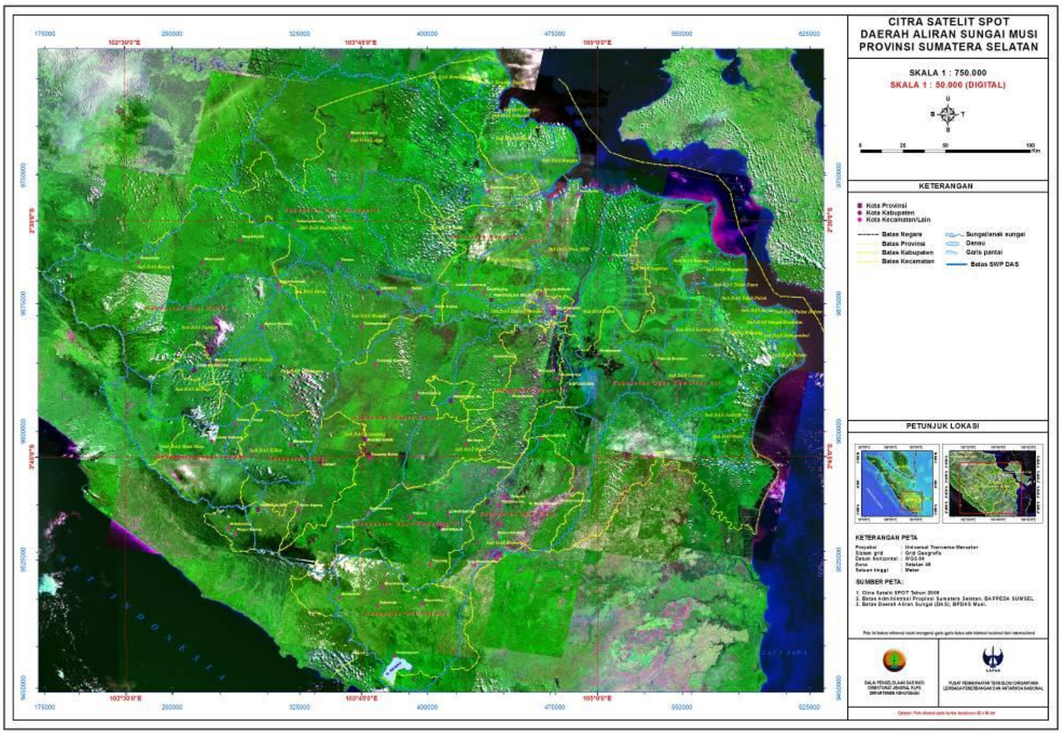

Figure 1. The research sites

2.3. Analysis of Critical Land Level

Critical land is the land (including forests) that have been damaged, resulting in loss or reduction in its function up to specified limits. The purpose of critical land data management is to provide critical land data as the basis for the preparation of forest and land rehabilitation (including soil and water conservation). The other goal is the identification of the location/distribution, wide area and the critical level in whole areas of Musi Watershed.

Until now, there are many research on critical land, i.e: Nugroho and Prayogo (2008), Malczewsk, J (2004) and Sivertun, A and Prage, L (2003). Nugroho and Prayogo (2008) use GIS to produce critical land map in Agam Kuantan Watershed. In the study, by applying technology of GIS, it can be mapped critical land according to standard of critical land criteria. In addition, the constraint of manual map can be reduced, particularly in information processing and map reproduction. In Agam Kuantan Watershed, critical land of forest has extent of 778.704,2 ha, and outside the area is about 496.486,7 ha.

In this paper, weighting method is used to analyze the level of critical land in protected forest areas. The spatial data of critical area is obtained from the analysis of some spatial data that are parameters of critical land. Based on the SK Dirjen RRL no: 041/Kpts/V/1998, the parameters include: slope, land cover, the level of erosion, rock outcrop, productivity and management.

The procedure of determining critical land is described in Figure 2.

Information of land cover is obtained from the SPOT-2 and SPOT-4 interpretation results on scale 1:50.000. Land cover conditions assessed by the percentage of tree canopy cover and classified into five classes. Each land cover classes is scored for the purpose of critical lands determination.

Information of slope is obtained from DEM data. The score of slope is shown in Table 2.

Erosion level is obtained from land system data. Erosion level on land system is classified into six classes, i.e:

1. Eroded land system
2. Extremely severe erosion hazard
3. Very severe erosion hazard
4. Severe erosion hazard
5. Moderately severe erosion hazard
6. Slight erosion hazard

The following table shows the classification of erosion and the determination of critical lands.

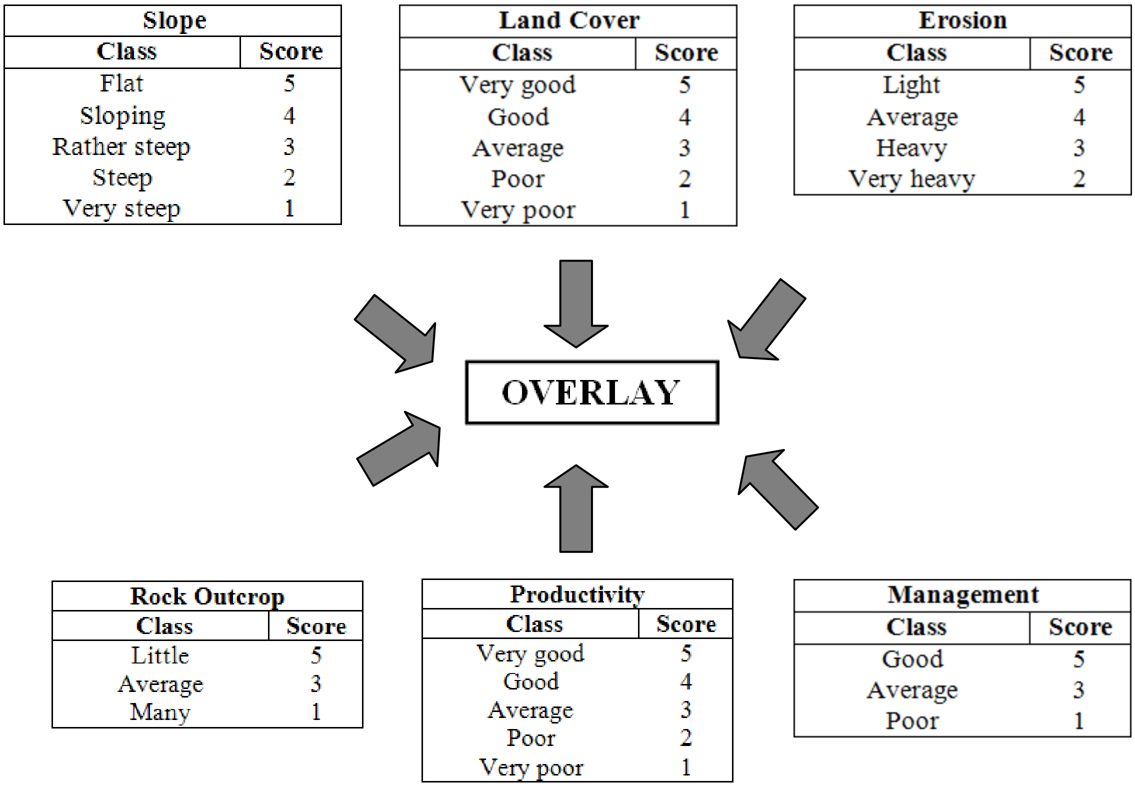

Figure 2. Flow chart for determining critical land level (Nugroho and Prayogo, 2008).

Table 1. The Slope Classification and Its Scoring for Determination of Critical Land

Class	Percentage of Tree Canopy Cover (%)	Score
Very Good	> 80	5
Good	61 - 80	4
Avarage	41 - 60	3
Poor	21 - 40	2
Very Poor	< 20	1

Table 2. Score of Slope for Determination of Critical Land

Class	Slope (%)	Score
Very Good	< 8	5
Good	8 - 15	4
Avarage	16 - 25	3
Poor	26 - 40	2
Very Poor	> 40	1

Table 3. The Erosion Classification and Its Scoring for Determination of Critical Land

Class	Description	Score
Light	Deep soil: <25% topsoil layer loss and/or erosion gully at a distance 20 – 50 m Shallow soil: <25% topsoil layer loss and/or erosion gully at a distance >50 m	5
Avarage	Deep soil: 25 – 75 % topsoil layer loss and/or erosion gully at a distance less than 20	4

	m Shallow soil: 25 – 50 % topsoil layer loss and/or erosion gully at a distance 20 - 50 m	
Heavy	Deep soil: More than 75 % topsoil layer loss and/or erosion gully at a distance 20-50 m Shallow soil: 50 – 75 % topsoil layer loss	3
Very Heavy	Deep soil: All topsoil layer loss >25 % downsoil layer and/or erosion trench depth is at a distance less than 20 m Shallow soil: >75 % topsoil layer loss, partially downsoil layer has eroded	2

Productivity data is one of the criteria used to assess the critical land in the area of agriculture, which is assessed by the ratio of the optimal production of general commodities in traditional management. Land productivity in the determination of critical land divided into 5 classes as shown in Table 4.

Management is one of the criteria used to assess the critical land in protected forest areas, which is assessed based on completeness aspect of management that include the presence of the district boundaries, security surveillance, and counseling. Management criteria for the determination of critical land divided into 3 classes as shown in Table 5.

The weighting of the critical land level in protected forest land is shown in Table 6.

Table 4. Productivity Classification and Its Scoring for Determination of Critical Land

Class	Description	Score
Very Good	Production ratio of optimal general commodities in traditional management: > 80%	5
Good	Production ratio of optimal general commodities in traditional management: 61 – 80%	4
Avarage	Production ratio of optimal general commodities in traditional management: 41 – 60%	3
Poor	Production ratio of optimal general commodities in traditional management: 21 – 40%	2
Very Poor	Production ratio of optimal general commodities in traditional management: < 20%	1

Table 5. Management Classification and Its Scoring for Determination of Critical Land

Class	Description	Score
Good	Complete (presence of the district boundaries, security surveillance, and counseling)	5
Avarage	Not Complete	3
Poor	Not Available	1

Table 6. The Level of The Critical Land

Level of Critical Land	**Total of Weight**
Very critical	120 – 180
Critical	181 - 270
Rather critical	271 – 360
Potential to critical	361 – 450
Not critical	451 - 500

3. Results and Discussion

Based on the results of the identification and interpretation of the image of SPOT-2 and SPOT-4 year 2009/2010 several land cover classes were obtain, namely Airport, Primary Dryland Forest, Secondary Dryland Forest, Secondary Mangrove Forest, Primary Swamp Forest, Secondary Swamp Forest, Plantation Forest, Open Land, Dryland Agriculture Mixed Bushes, Plantation, Settlement, Mining, Dryland Agriculture, Swamp, Savanna, Farm Area, Bush, Shrub Swamp, Pond, Transmigration, and Water Body. The class of Dryland Agriculture Mixed Bushes is the most dominant class in the Musi watershed area. The Level of Critical Land in Musi Watershed is shown in Table 7.

The very critical level area in protected forest area of Musi Watershed is 1.7%. The area is spread in the Komering Sub Watershed, Ogan Sub Watershed, Lematang Sub Watershed, Musi Hulu Sub Watershed, Kikim Sub Watershed, Kelingi Sub Watershed, Rawas Sub Watershed, Macan Sub Watershed, Bungin Sub Watershed, Lalan Sub Watershed, Saleh Sub Watershed, Sugihan Sub Watershed, Pulau Dalem Sub Watershed dan Pidada Sub Watershed. The area of critical land in protected forest are mostly the pond located in Pidada Sub Watershed , Lumpur Sub Watershed and Jeruju Sub Watershed. The dominant level is in critical potential area (53.34%). The Map of Critical Land in Musi Watershed is shown in Figure 3.

Tabel 7. Level of Critical Land in Protected Forest Area

Level of Critical Land	Area (Ha)	Percentage (%)
Very critical	21016.35	1.7
Critical	75897.21	6.15
Rather critical	460447.07	37.29
Potential critical	658602.44	53.34
Not critical	18714.34	1.52

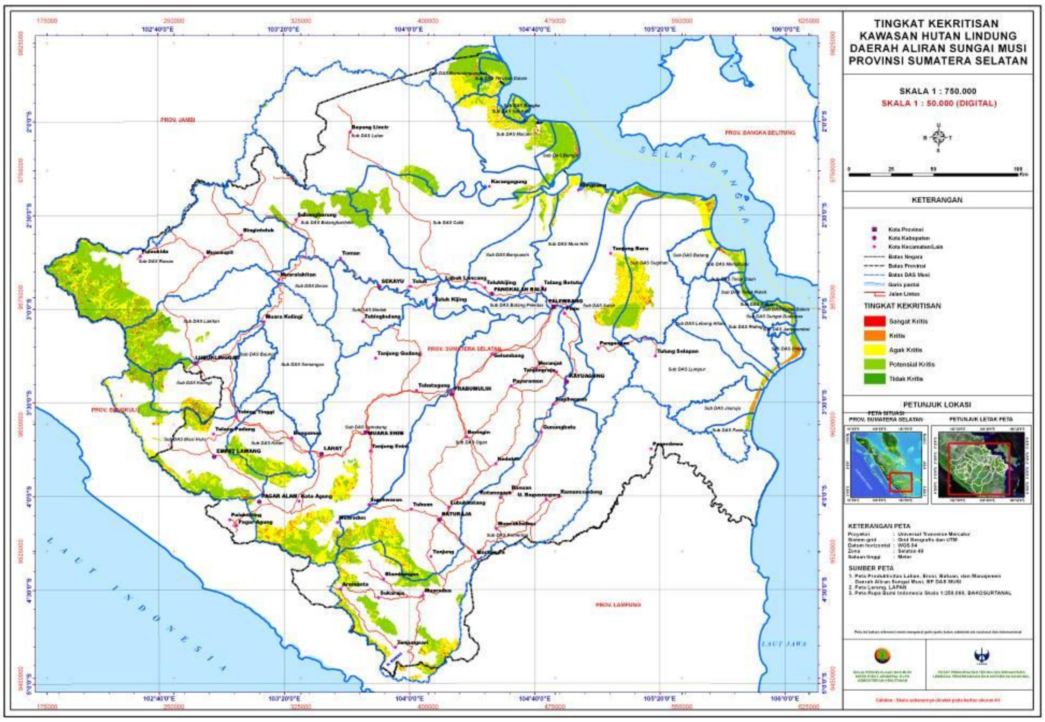

Figure 3. The Map of Critical Land in Musi Watersheet

4. Conclusion

We can analyse critical land according to standard of critical land criteria using GIS technology. In addition, the constraint of manual analysis can be reduced, particularly in information processing and map reproduction. The very critical level area in protected forest area of Musi Watershed is 1.7% (very small area). The dominant level is in critical potential area (53.34%), so it need to be monitored.

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