BIOVALENTIA : BIOLOGICAL RESEARCH JOURNAL
***e*-ISSN: 2477-1392**
Vol. 4 No. 1, May 2018

Evaluation of Reclamated Land Use for Settlement Infrastructure Facilities (Case Study Klawas Zone And Suban Zone in Post Coal Mining Air Laya Tanjung Enim)

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Peer review under responsibility of Biology Department Sriwijaya University

Abstract

The research location was conducted in post-mining reclamation field of Air Laya coal mine with an area of approximately ± 3,350 m2 which is planned to be closed (post mining). The number of research sites are 2 observation stations that include Klawas location with the land area ± 277, 8 m2 and the location of Suban with a land area of ± 342 m2. This research is to identify and analyze the biophysical and biological aspects of the environment, potentials and constraints, and then evaluate the post-mining reclamation land use that will be used for Other Use Areas (OUA), the Settlement Infrastructure Facilities. Based on the Mine Closure Plan (MCP) and Regional Regulation of Muara Enim Regency on the utilization of former coal mine land at Air Laya Tanjung Enim, Klawas reclamation land use plan for Resettlement Infrastructure Facilities (zone 2). While the plan to use Suban reclamation land for the area of utilizing Productive Research (zone 8). The analysis in this study is by scoring and map overlays such as analysis of area functions and land suitability analysis based on the physical condition of existing land. The results obtained from this study are the level of land suitability for settlement infrastructure in Klawas, the appropriate land area of 1 % or an area of 2.8 m2 while the non-compliant area is 99 % or an area of 275 m2 of the total area of 277.8 m2. Requirements for land suitability in the Klawas research area include Marginal Match (S3) with a total scoring values of 80. where the climatic conditions support the average air temperature of 24oC and rainfall 23.93 - 27.87 mm/day, the slope of the flat slope is close to the water level rivers 0 – 3 %, complex geological structures have anticlines and faults, Alluvial and Latosol types of soil, many aquifers with shallow depths, geological disasters such as soil / rock mass movements, flooding, erosion and radionuclide radiation exposure medium intensity. The result of land use evaluation for the Klawas reclamation area are more suitable for the area of Freshwater Fisheries Cultivation than for the Settlement Infrastructure Facilities area. The level of suitability of land for settlement infrastructure facilities in Suban, the suitable land is 69.3 % or an area of 237 m2 while the non-suitable land is 30.7 % or an area of 105 m2of the total area of 342 m2. Requirements for land suitability in the research area of Suban are Suitable (S2) with a total scoring values of 130. Climate conditions support with an average air temperature of 24oC and rainfall 23.93 - 27.87 mm/day, slope is quite flat 3 – 8 %, Its geological structure does not contain anticlines or faults, soil types of Andosols and Podsolics, aquifers with shallow to moderate depths, no vulnerability to geological disasters and low intensity radionuclide radiation exposure. The result of the land use evaluation for the Suban reclamation area are more suitable for the Settlement Infrastructure Facilities area than for the Productive Research area.

Keywords: Post Mine, Reclamation, Land Use and Settlement Infrastructure Facilities

Received: 14 January 2018, Accepted: 28 May 2018

1. Introduction

Indonesia has coal reserves of around 64.4 billion tons and around 7.3 billion tons are in the South Sumatra region or around 17 % of Indonesia's coal resources. Coal mining activities in the Tanjung Enim and surrounding areas have been carried out since 1919 using the open pit mining method that has left mining marks in the form of mine openings that have a depth of > 50 meters above sea level (mine void). Land use is a land use and arrangement that is carried out in accordance with existing natural conditions and is in

the interests of all parties. The application of ecological principles to land use planning is the most important application of environmental science [32]. post-mining land use is a term used to describe a land use that will occur after the end of mining operations [28].

The research location was carried out on reclamation land after the Air Laya coal mine with an area of approximately ± 3,350 m^2 which was planned to be closed (post mining). The number of research locations was 2 (two) observation stations, which included Klawas location with ± 277,8 m^2 and the location of Suban with ± 342 m^2 land area has been reclaimed [36].

This research is to identify and analyze the biophysical and geological aspects of the environment, potentials and constraints that exist, then evaluate the use of post-mining reclamation land that will be used for Other Use Areas (OUA), namely Infrastructure. Based on the Muara Enim regency Mine Closure Plan (MCP) and Regional Regulation (PERDA) regarding the utilization of ex-coal mine land in Air Laya Tanjung Enim, the plan for the use of Klawas reclamation land for the use of Settlement Facilities and Infrastructure (zone 2). While the plan for the use of Suban reclamation land for the utilization area of Productive Research [7].

The closure of a large mine location such as the location of the former Air Laya coal mine (± 3,350 m^2) has the potential to produce conflicting objectives. One of the options for post-mining land use is to be used for the area of facilities and infrastructure for residential employees and residents of Tanjung Enim and Muara Enim which are separated by the mine area [8]. The main requirements for the use of residential facilities and infrastructure are: the location is in the topography with slopes of 0 – 8 %, does not have high exposure to radionuclide radiation and is not in the geological disaster zone such as; landslides, floods, earthquakes and volcanic tectonic eruptions. The closure and settlement of the mine is carried out in a planned, structured and systematic manner in the context of sustainable development to achieve a safe and successful mine closure and settlement effort [9].

2. Materials and Method

Tools and materials

The tools used in the study are: 1.GPS (Global Positioning System), a tool used to determine the position of coordinates in the field. 2. Soil Sampler, a tool used to take soil samples. 3. Altimeter, a tool used to determine the height of a location. 4. Cameras, tools used to record information and phenomena and activities in the research area. 5. Compass Geology, a tool used to find out the position and direction. 6. Radiation Survey Meter, a tool used to measure exposure to natural radionuclides at the study site.

The materials used in the study are: 1. Plastic, as a container where soil samples are taken from the observation location. 2. Maps used in this study; Map of the Tanjung Enim mining unit coal mine area, TAL zone land use map scale 1: 10,000, Map of the TAL zone post-mining scale of 1: 10,000, TAL zone revegetation map scale 1: 10,000, Map of the TAL zone coal contour scale 1: 10,000, Map of Muara Enim regency structure plan scale 1: 10,000, A slope map of Tanjung Enim district scale 1: 10,000 Map of Muara Enim regency land scale 1: 10,000, Geological map of Muara Enim district scale 1: 10,000, Tofographic map of Muara Enim district scale 1: 10,000, Zoning map of the district's forest estate Muara Enim 1: 10,000 scale

Figure 1. Location of Land Use for Post-Coal Mine Air Laya - Tanjung Enim (Source: Geogle Earth, 2016)

This research is a type of formative evaluation research from a case study using descriptive analytics. Evaluation is part of the decision-making process, which compares an event or plan of activities to the standards and programs that have been set. Evaluation as a research means it will serves to explain the phenomenon. Analytical descriptive where data and information obtained then the results will be presented descriptively at the end of the study and will be analyzed to test the purpose of the research proposed at the beginning of the study. The result of formative evaluation research is to get feedback from an activity in the process [27]. This research was conducted with two methods of data analysis, namely:

Land analysis method after the Tanjung Enim Air Laya coal mine using map overlays at the research site; Klawas (zone 2 ; ± 277.8 m2) and Suban (zone 8 ; ± 342 m2). 2. The method of land suitability analysis after the Air Laya Tanjung Enim coal mine using Scoring methods on parameters that describe natural physical conditions and limitations in the study location for land suitability for settlement infrastructure.

Data Collecting

Data collection techniques using the method of observation/direct observation (field observation) to collect primary data is to describe the actual situation by collecting data and information directly to the object of research in the form of natural phenomena (events that occur in the environment) related to land use in area after the Air Laya Tanjung Enim coal mine. There are two types of data collection, namely primary and secondary data collection. The primary data collection was in the form of laboratory analysis of soil physical properties and data from observations of natural physical factors in the post-Laya mine site. Secondary data collection as a source of supporting data for writing this study is derived from the study of literature and documentation in the field.

Data Analysis

Data from research results are analyzed in stages; 1. Field observation, 2. Data collection, 3. Data processing, 4. Overlay post-mining zone maps and land / tofographic / geological maps according to Muara Enim Regional Spatial Plan (RSP) to produce regional plans in accordance with productive and safe land use in terms of environmental geology after post mining activities, 5. Perform data using Scoring analysis, 6. Conducting land use evaluations is carried out by comparing and matching the characteristics and capabilities of the land with the planned use of land use.

3. Results And Discussion

The results obtained from this study are the level of land suitability for Settlement Infrastructure Facilities in Klawas, suitable land of 1 % or an area of 2.8 m^2 while those that do not match 99 % or an area of 275 m^2 of the total area of 277.8 m^2. Land suitability requirements in the Klawas research area include Marginal Match (S3) with a total score of 80. Where climatic conditions support with an average air temperature of 24^{o}C and rainfall of 23.93 - 27.87 mm/day, the slope of a flat slope approaches the water level rivers 0 – 3 %, complex geological structures there are anticlines in the form of faults and faults, Alluvial and Latosol soil types, there are many aquifers with shallow depths, there are vulnerabilities in geological disasters in the form of soil/rock mass movements, floods, erosion and radionuclide radiation exposure moderate intensity.

The results of the land use evaluation for the Klawas reclamation area are more suitable for the Freshwater Aquaculture area than for the Settlement Infrastructure area. The level of land suitability for Settlement Infrastructure Facilities in Suban, suitable land is 69.3% or an area of 237 m^2 while that which is not suitable is 30.7% or an area of 105 m^2 of the total area of 342 m^2. Land suitability requirements in the Suban research area include Maching (S2) with a total score of 130. The climate conditions support the mean air

Table 1. Land suitability characteristics in the reclamation area of Klawas for Settlement Infrastructure Area

No	Land Characteristics	Land Suitability Terms				Value/Class	
		Very Suitable (S1)	Match (S2)	Marginal Match (S3)	Not Match (N)	Value	Class
1	Temperature average (^{o}C)	-	24 ^{o}C	-	-		
2	Rainfall (mm/hari)	-	23,93 - < 27,87	-	-	30	III
3	Humadity (%)	-	95	-	-		
4	Vegetation	-	-	Less	-		
5	Slope Stability (%)	0 - 3	-	-	-	20	I
6	Erotion Hazards Level (cm)	-	-	-	30		
7	Rock Outcrops (%)	-	10	-	-		
8	Radiatiation Exposure (η s/h)	-	-	-	0,51		
9	Type of Soils	-	-	-	Alluvial & Latosol	30	II
10	Geology Hazards	-	-	-	Potential for Flooding		
11	Road Facilities	-	-	Much Damaged	-		
12	Hidrology	-	-	High density river	-		
13	Hidrogeology	-	5 aquifers	-	-		
14	Geology Structure	-	-	-	Any Faults		
15	Stratigrafy	-	Any Formation	-	-		
16	Tofografy	-	Lowland	-	-		
17	Morfology	-	-	Sedimentation land *Fluvial* Lowland	-		
18	Litology	-	Sedimentary Rocks	-	-		

temperature of 24°C and rainfall of 23.93 - 27.87 mm/day, the slope of the slope is quite flat 3 - 8%, the geological structure does not have anticlines such as faults or faults, Andosol and Podsolic soil types, there are shallow to moderate depth aquifers, no geological disaster vulnerability and low intensity radiation exposure. The results of the land use evaluation for the Suban reclamation area are more suitable for the Settlement Facilities and Infrastructure area than for the Productive Research area.

Land use evaluation is to compare the requirements needed for a particular land use with the characteristics of the land. In the future, a rapid analysis and evaluation of the capability of land in the location of the former Air Laya coal mine in Tanjung Enim is needed as a basis for the preparation of appropriate and sustainable land use policy plans. Utilization of a land in an area is very influential on the physical conditions in the region, especially in the environ

Table 2. Land suitability characteristics in the reclamation area of Suban for Settlement Infrastructure Area

No	Land Characteristics	Land Suitability Terms				Value/Class	
		Very Suitable (S1)	Match (S2)	Marginal Match (S3)	Not Match (N)	Value	Class
1	Temperature average (°C)	-	24 °C	-	-		
2	Rainfall (mm/hari)	-	23,93 - < 27,87	-	-	30	III
3	Humadity (%)	-	95	-	-		
4	Vegetation	-	-	Less	-		
5	Slope Stability (%)	3 - 8	-	-	-	40	II
6	Erotion Hazards Level (cm)	-	10	-	-		
7	Rock Outcrops (%)	5	-	-	-		
8	Radiatiation Exposure (η s/h)	-	-	-	0,17		
9	Type of Soils	-	-	-	Andosol & Podsolik	60	IV
10	Geology Hazards	-	No Potential	-	-		
11	Road Facilities	-	-	Pretty Good	-		
12	Hidrology	-	-	Low Density River	-		
13	Hidrogeology	-	3 Aquifers	-	-		
14	Geology Structure	-	No Faults	-	-		
15	Stratigrafy	-	Any Formation	-	-		
16	Tofografy	-	Lowland	-	-		
17	Morfology	-	Undulating Terrain	-	-		
18	Litology	-	Sedimentary Rocks	-	-		

Table 3. Evaluation of Post-Mining Land Use in Research Sites

No	Land Unit	First Plan Land Use	Performance Land Evaluation
1	Klawas (± 277,8 m^2)	Settlement Facilities and Infrastructure (zone 2)	This area should be used for the Tambak Aquaculture area because this area is type of Alluvial and Latosol soil, very close to the Enim River and Klawas Rivers, so this area has no drought potential because it is close to water sources and has considerable rainfall, but has high vulnerability geological hazards of flooding because they are in areas with flat slopes (0 - 3%) almost the same as sea level and have moderate exposure to radionuclide radiation, average 0.51 η s/h (less safe).
2	Suban (± 342 m^2)	Research Produktive (zone 8)	This area should be used for the Settlement Facilities and Infrastructure area, because it has the appropriate criteria for Andosol and Podsolic soil type settlements, is in a flat attack (3 - 8%), has considerable rainfall and has no potential for geological hazards, although the land in this area is a stockpile of mine excavated land but low radionuclide radiation exposure, the average is 0.17 η s/h (safe).

mental aspects of the geology. Land use in the research area in the Klawas reclamation area (zone 2) was initially designated as land for the use of Settlement Facilities and Infrastructure zones while the Suban reclamation area (zone 8) was initially designated as land for the use of Productive Research zones, but based on observations and data analysis of criteria and characteristics owned by the area so it is necessary to do an evaluation of the suitability of the land use.

The structure of spatial use is the basic framework for the development of a region or city. The plan for the use of the Suban zone 8 space structure is directed at the formation of an integrated spatial structure between the existing regions and the development of new areas both spatially and functionally. The variables that form the spatial structure planned in the plan for the structure of the Suban 8 development zone are as follows: 1. Role and function of 8 Suban zones in local and regional scope. 2. The concept of macro and micro space structures. 3. Population aspects. 4. Service center system or hierarchy and range of service centers to be developed. 5. Transportation network system plan. 6. Plan the flow of goods [35].

Table 4. Scoring Land Use at Research Sites

Topography			Climatology			Type of Land			Scoring Value	Regional Functions	Area
Slope	Class	Scor	Rainfall	Class	Scor	Land Type	Class	Scor			
0 – 3 %	I	20	23,93 – 27,87 mm	III	30	Alluvial and Latosol	I	30	80	Aquaculture	*Klawas*
3 - 8 %	II	40	23,93 – 27,87 mm	III	30	Andosol and Podsolik	IV	60	130	Settlement Facilities & Infrastructure	*Suban*

Table 5. Division of Development Zone of Klawas Zone 2

No	Type of Land Use	Coverage Area	Large of Area (m^2)	Percentage (%)
1	Supporting Infrastructures	Klawas Center	2,8	1
2	Revegetation Area	North Klawas	35	12,6
3	Shrubs & Swamps	Middle Klawas, North & South	173,5	62,5
4	River Border	Enim River Side Border	66,5	23,9
	Total		**277,8**	**100**

Table 6. Division of Development Zone of Suban Zone 2

No	Type of Land Use	Coverage Area	Large of Area (m^2)	Percentage (%)
1	Supporting Infrastructures	Suban Center	237	69,3
2	Revegetation Area	East Suban & South Suban	90,6	26,5
3	Retention Reservoir	Water retention reservoir area	14,4	4,2,
	Total		**342**	**100**

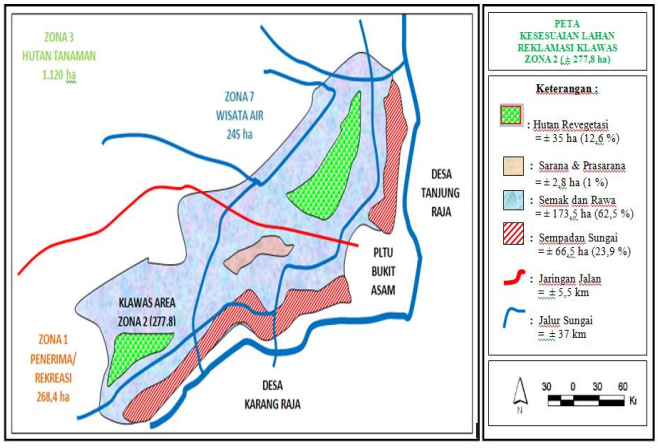

Figure 2. Suitability Map for Klawas Reclamation Land

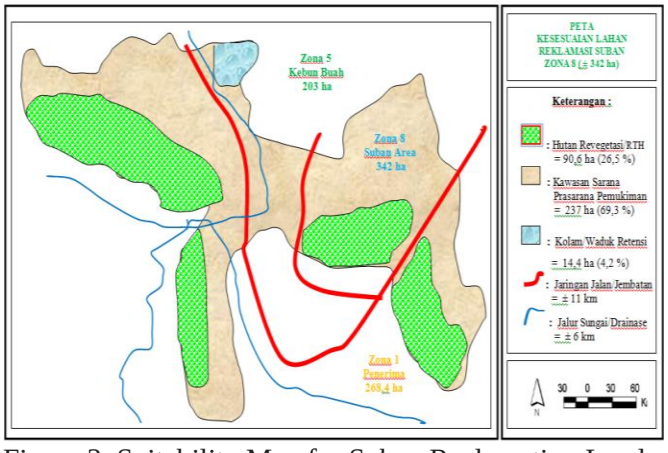

Figure 3. Suitability Map for Suban Reclamation Land

Based on the results of post-mining land use scoring at the Klawas and Suban research locations from Table 1. it shows that the Klawas region has a total score of 80 while the Suban region has a total score of 130 which states that the Klawas area is less suitable for residential infrastructure facilities while Suban region is suitable for residential infrastructure facilities.

4. Conclusion

1. The results of the analysis relating to the biophysical and environmental geological aspects based on existing land conditions state that the Klawas research area is ± 277.8 m^2 (zone 2), previously designated as a zone of Settlement Facilities and Infrastructure, indicating that the area is in accordance with Marginal Match (S3) because of many inhibiting factors and constraints. Whereas Suban has an area of ± 342 m^2 (zone 8), previously it has been designated as a productive research area zone indicating that the area is Maching (S2) because there are many carrying capacity factors and potential land for settlement facilities and infrastructures.
2. Results of evaluation of land suitability based on carrying capacity, potential and constraints associated with Regional Spatial Planning (RSP), namely; the level of suitability of land for Settlement Infrastructure Facilities in Klawas, suitable land of 1 % or an area of 2.8 m^2 while those that do not match 99 % or an area of 275 m^2 of the total area of 277.8 m^2. Land suitability requirements in the Klawas research area with a total score of 80. The level of land suitability for Settlement Infrastructure Facilities in Suban, the corresponding land is 69.3 % or an area of 237 m^2 while the inappropriate land is 30.7 % or an area of 105 m^2 of total total area of 342 m^2. Land suitability requirements in the Suban research area with a total score of 130.

3. The evaluation results of the land use plan in the study area produced output in the form of land use guidelines which stated that the Klawas zone 2 reclamation area was not suitable to be developed into residential infrastructure facilities while the Suban zone 8 reclamation area was suitable to be developed into residential infrastructure facilities.

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