Identification of Land Criticism for Land Conservation Actions in the Badeng Watershed with Regulation of Watershed and Protection Forest Management

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Abstract: In 2018 there was a flood in the Badeng Watershed due to landslides on Pendil Mountain. Flooding makes land in the Badeng Watershed critical. This research aims to identify critical lands for conservation actions in the Badeng Watershed. To identify the criticality of land, a geographic information system is used with a scoring method, referring to the Regulation of the Director-General of Watershed and Protection Forest Management Number P.3/PDASHL/SET/KUM.1/7/2018 About Technical Guidelines for Critical Land Spatial Data Preparation. The results showed that the Badeng Watershed has a rather critical area of 10.82 Km^2 (20.65%) in Sumber Asih Hamlet, Mangaran, Sumberarum Village, Songgon District with conservation efforts Lemongrass planting, vetiver grass, reforestation, and rorak. The potential land area has 8.08 Km^2 (14.43%) in Bejong Hamlet, Krajan Sumberarum Village, and Bayu Village Songgon District with efforts to conserve multiple planting systems, forest farming systems, making check dams/gully plugs in grooves, ditches around the slopes, and banks of the Badeng River. The non-critical land area has 33.49 Km^2 (63.93%) in Singojuruh Subdistrict, Alasmalang, Rogojampi, to conserve the planting of rotating cropping systems mulch utilization, mounds, and terracing in agricultural areas.

1 INTRODUCTION

Critical land is land that shows a decrease in environmental quality due to the various uses of land resources that are not wise and not following existing regulations. Such land certainly cannot function optimally following the land designated as a medium for water management and a medium for plant production. Critical land will continuously cause natural disasters.

In 2018, there was a flash flood natural disaster in the Badeng watershed. The flash flood was caused by weathering of material on Mount Pendil, which flowed into the Alas Malang River (Rachmawati, 2018).

One way to prevent flash floods natural disasters is by planting vegetation. The existence of vegetation is very important for the sustainability of land use. Planting vegetation that is following the existing land capacity will be beneficial in the long term. The need to avoid land-use errors is intended so that the decline in land productivity does not occur.

Based on the above problems, identifying critical land in the Badeng watershed is carried out using the Regulation of the Director-General of Watershed Control and Protection Forest Number P.3/PDASHL/SET/KUM.1/7/2018, with the scoring method. Previous research related to the identification of land criticality for land conservation actions, among others, Asmaranto et al., (2012); Erwanto & Lestari (2020); Erwanto & Pratiwi (2020); Erwanto et al., (2020); Hendro et al., (2014); Hidayat & Iswardoyo (2019); Kadir & Badaruddin (2015); Nurhakim (2017); Prasindya et al., (2020), and Ramayanti et al., (2015).

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1.1 Problems

The main thing that wants to be studied in this research is the identification of land criticism for land conservation actions in the Badeng watershed with Regulation of Watershed and Protection Forest Management?

1.2 Research Purpose

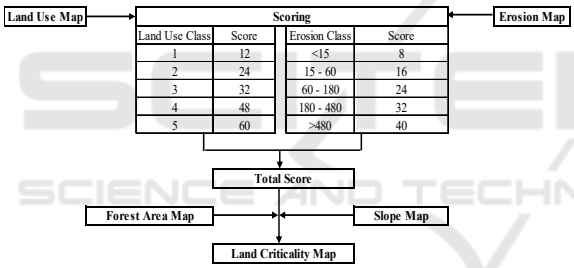
The study aimed to identify the criticality of land for land conservation actions in the Badeng watershed with Regulation of Watershed and Protection Forest Management.

2 THEORY AND METHODS

2.1 Critical Land

Critical land is a land that is very barren and bald with a very low fertility rate, so it cannot be used as agricultural land. This land can still be managed even though its productivity is low. Identification of land criticality is useful for determining conservation policies used on critical land in the Badeng watershed. The identification method used is scoring and the reference used is the Regulation of the Director-General of Watershed Control and Protection Forest Management Number P.3/PDASHL/SET/KUM.1/7/2018.

Based on Figure 1, the Erosion Map and Land Use Map are scored. After that, overlay erosion map and land use map. It is generating a first overlay map. The scoring method is, for example, land use map 1 (rice fields, ponds) has a score of 12 multiplied by a land-use weight of 60%, and for example, the erosion that occurs is <15 tons/ha/year has a score of 8 multiplied by the weight erosion by 40%. After that, the multiplication result is totaled between land use and erosion. Then overlay the slope map and forest area function map, resulting in a second overlay map, which is called the critical land map. Classify the criticality of the land on the second overlay map. The example, an area inside a forest area with a slope of 0-8º and has a criticality score of 52-68, on area is classified as Critical Potential (CP). Meanwhile, for areas outside the forest area, if it has a slope of 0-8º and has a criticality score of 68-84, then the area is classified as Somewhat Critical (SC).



Land Use Class	Score
1	12
2	24
3	32
4	48
5	60

Erosion Class	Score
<15	8
15 - 60	16
60 - 180	24
180 - 480	32
>480	40

Description of Land Use Score:

1	Airport, Body of Water, Swamp, Savanna, Settlement / Transmigration, Primary DryLand Forest, Rice Fields, Ponds, Primary Mangrove Forest, Secondary Mangrove Forest, Primary Swamp Forest, Secondary Swamp Forest
2	Plantation Forest, Secondary DryLand Forest
3	Plantation
4	Shrubs, Swamp Shrubs, DryLand Farming, Mixed DryLand Agriculture
5	Open Land, Mining

Scoring System from the Regulation of the Director-General of Watershed and Protection Forest Management Number P.3/PDASHL/SET/KUM.1 /7/2018

LU Class	Weight 60%
1	12
2	24
3	32
4	48
5	60

Erosion Rate	Weight 40%
<15	8
15 - 60	16
60 - 180	24
180 - 480	32
>480	40

Scoring Criticality		
Not Critical	(NC)	0 - 36
Critical Potential	(CP)	36 - 52
Somewhat Critical	(SC)	52 - 68
Critical	(C)	68 - 84
Highly Critical	(HC)	>84

Inside of Forest Area						Outside of Forest Area					
Slope	Critical Score					Slope	Critical Score				
	0 - 36	36 - 52	52 - 68	68 - 84	>84		0 - 36	36 - 52	52 - 68	68 - 84	>84
0 - 8	NC	NC	CP	C	HC	0 - 8	NC	NC	CP	SC	SC
8 - 15	NC	CP	SC	C	HC	8 - 15	NC	CP	SC	SC	SC
15 - 25	CP	SC	SC	C	HC	15 - 25	CP	SC	SC	C	HC
25 - 40	SC	SC	SC	C	HC	25 - 40	SC	SC	SC	C	HC
>40	SC	SC	SC	C	HC	>40	SC	SC	SC	C	HC

Figure 1: Procedure for Determining the Level of Critical Land (Regulation of the Director-General of Watershed Control and Protection Forest Management No.P.3/PDASHL/SET/KUM.1/7/2018, 2018).

2.2 Land Conservation

Land conservation is the control of energy from the effects of raindrops and surface runoff in the process of erosion. The main objective in soil conservation is to obtain a sustainable level of land production by keeping the rate of soil loss below the permissible threshold, which theoretically can be said that the rate of erosion must be less than or equal to soil formation. Since erosion is a natural process that cannot be avoided at all or zero erosion, especially for agricultural land, what can be done is to reduce the rate of erosion to an acceptable level. There are several types of conservation, namely, vegetative conservation by planting in strips, multiple plantings, rotational planting, using mulch, and forest farming systems. Mechanical conservation using land preparation according to contour lines, making mounds, making drain, making waterways, making check dams, making rorak, and making Gully Plugs. In contrast, chemical conservation is conservation by using chemicals.

2.3 Location of Study

The research location was in the Badeng Watershed, Banyuwangi Regency which has an area of 52.40 km^2 and located at geographic coordinates 8° 6' 12.367" S to 8° 20' 19.109" S, and 114° 6' 34.242" E to 114° 19' 15.679" E [4], as in the Figure 2.

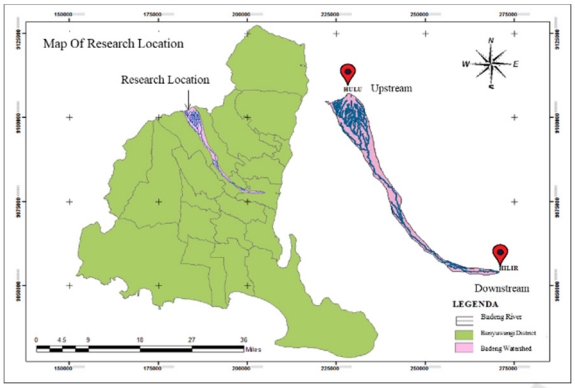


Figure 2: Location of Research in Badeng Watershed of Banyuwangi Regency.

2.4 Data Collection

Primary data in the form of field survey results and coordinates of land criticality areas and secondary data in the form of spatial data are the digital map of Badeng watershed erosion, digital map of the land use of Badeng watershed, digital map of forest area function in Badeng watershed, digital map of the slope of Badeng watershed, digital map administration of the Badeng watershed, and a digital map of the river of the Badeng watershed obtained from the Regional Development Planning Agency of Banyuwangi Regency.

2.5 Step Work

2.5.1 Identification of Land Criticality

Identification of land criticality is carried out to determine areas affected by erosion due to flooding in the Badeng watershed. The identification of land criticality is carried out using the scoring method, referring to the Regulation of the Director-General of Watershed Control and Protection Forest Management Number of P.3/PDASHL/SET/ KUM.1/ 7/ 2018.

2.5.2 The Making of a Land Criticality Map

The making of a land criticality map is carried out using a Geographic Information System by overlaying a base map of land criticality parameters that have been scored based on the criticality level of the land in the Regulation of the Director-General of Watershed Control and Protection Forest Management Number of P.3/PDASHL/SET/ KUM.1/ 7/ 2018.

2.5.3 Study of Critical Land Conservation

Surveying conditions in the field carried out the study of critical land conservation at critical land points resulting from processing map overlay data using Geographic Information Systems. This analysis was carried out for conservation recommendations on critical land in the Badeng watershed, Songgon, Banyuwangi.

3 RESULT AND DISCUSSION

3.1 Land Use

Land use is used to provide an overview of the types of land use in the watershed. Factors such as biophysical, economic, and social conditions become the basis for land planning to preserve the environment and utilize land according to the area's capacity, function, and potential. The percentage and area of land use distribution in the Badeng watershed can be seen in Table 1.

Table 1: Badeng Land Use Scoring.

Land Use	LU	Score	Total Score (Score x 60%)	Area (Km^2)	% Area
Forest	1	12	7.2	32.35	61.76
Garden	4	48	28.8	13.69	26.13
Avalanches	5	60	36	1.92	3.67
Land Waters	1	12	7.2	1.26	2.40
Plantation	3	32	19.2	2.44	4.66
Settlement	1	12	7.2	0.17	0.33
Rice Fields	1	12	7.2	0.56	1.06
Total				52.38	100

Based on Table 1, it can be seen that the land use in the Badeng watershed is dominated by forest, with a percentage of the land area of 61.75% or 32.35 Km^2. The land use map can be seen in Figure 2.

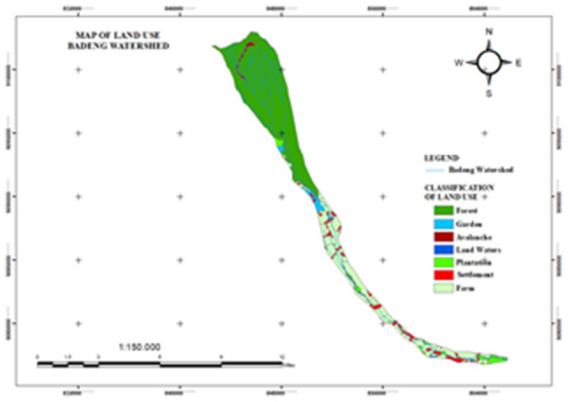


Figure 3: Land Use Map of the Badeng Watershed.

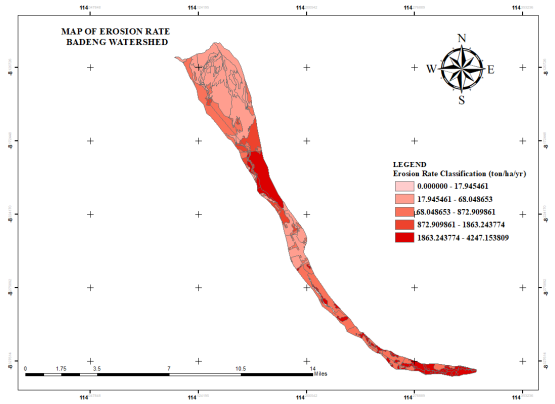


Figure 4: Erosion Map of the Badeng Watershed.

The distribution of land use in Figure 3, shows seven types of land use, namely forest, rice fields, plantations, gardens, settlements, avalanches, and land waters. Land use in the Badeng watershed is dominated by forest, while settlements have the least land use.

3.2 Erosion

Erosion is very influential on the criticality of the land. Part of the soil will be eroded and transported by water or wind and then settles somewhere. This incident resulted in a decrease in land productivity in the Badeng watershed. The erosion score in the Badeng watershed is shown in Table 2.

Table 2: Erosion Scoring of Badeng Watershed.

Erosion Class (Ton/Ha/Yrs)	Score	Total Score (Score x 40%)	Captions
≤15	8	3.2	Excellent
15-60	16	6.4	Good
60-180	24	9.6	Medium
>480	40	16	Very Bad

In Table 2, it is known that the erosion in the Badeng watershed has been classified into 4 classes. The class of ≤15 (Ton/Ha/Yrs) with an area of 98.93% is in the very excellent category. The erosion class 15-60 (Ton/Ha/Yrs) with an area of 1.06% is in a good category, the erosion class 60-180 (Ton/Ha/Yrs) with an area of 0.003% is in the medium category, erosion class >480 (Ton/Ha/Yrs) with an area of 0.011% is in the very bad category. The erosion base map can be seen in Figure 4.

Based on Figure 4, it is known that the erosion rate in the Badeng watershed is 13.037,07 tons/ha/year.

3.3 Slope

The slope base map is used to determine the criticality level of the land. The steeper the slope, the higher the land criticality potential. The slope classification of the Badeng watershed is shown in Table 3.

Table 3: Classification of Slope In The Badeng Watershed.

Slope (%)	Slope Class	Conditions	Area (Km^2)	% Area
0 – 2	I	Flat	2.97	5.68
2 - 8	II	Sloping	23.69	45.24
8 - 15	III	Bit Steep	6.91	13.19
15 - 25	IV	Bit Steep	7.98	15.23
25 - 40	V	Steep	4.11	7.84
> 40	VI	Very Steep	6.71	12.81
Total			52.38	100

Based on Table 3, it is known that the average slope distribution of the Badeng watershed varies from a slope of 0-2%, having an area of 5.68% with flat conditions, a slope of 2-8% having an area of 45.24% with sloping conditions, a slope of 8%-15% having a wide percentage of 13.19% with bit steep conditions, a slope of 15-25% has a percentage of the area of 15.23% with a bit steep condition, a slope of 25-40% has a percentage of 7.84% with a steep condition, a slope of >40% has an area percentage of 12.81% with very steep conditions. The basic map of the slope in the Badeng watershed is shown in Figure 5.

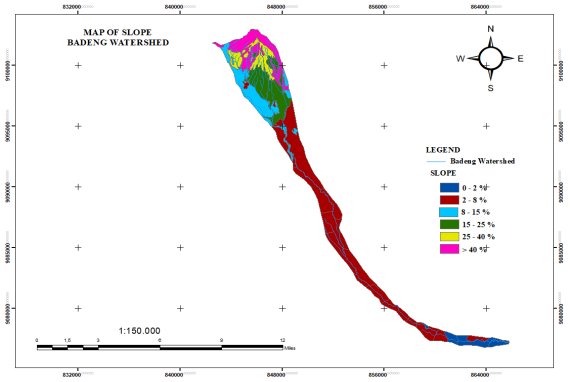


Figure 5: Slope Map of the Badeng Watershed.

Based on Figure 5, it is known that the slope of 0 – 2% has an area of 2.97 Km^2. The slope of 2 – 8% has an area of 23.69 Km^2. the slope of 8 – 15% has an area of 6.91 Km^2. The slope of 15 – 25% has an area of 7.98 Km^2, the slope 25 – 40% has an area of 4.11 Km^2, slopes >40% have an area of 6.71 Km^2.

3.4 Forest Area

Forest area is used to determine the forest area in the Badeng watershed. Forest areas also have a function to regulate water systems, control erosion, and maintain soil fertility. The classification of the Badeng watershed forest area can be seen in Table 4.

Table 4: Classification of Forest Area in Badeng Watershed.

Classification	Area (Km^2)	% Area
Areas Outside the Forest	20.51	39.15
Protected Forest	27.69	52.84
Production Forest	4.19	8.01
Total	52.40	100

Based on Table 4, the forest area in the Badeng watershed is dominated by protection forest with 52.84%, outside forest area of 39.15%, and production forest of 8.01%. The Forest Area Base Map can be seen in Figure 6.

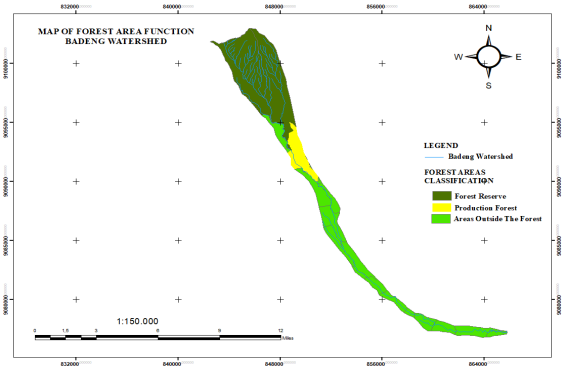


Figure 6: Map of Badeng Watershed Forest Area.

3.5 Land Criticism

Land cannot function properly according to its designation, both as a production medium and water management medium. Land classified as critical can be in the form of bare soil with no vegetation at all, savanna fields, or land overgrown with unproductive shrubs, rocky areas, ravines, or ditches resulting from soil erosion. The following is the classification of critical land in the Badeng watershed, which can be seen in Table 5.

Table 5: Classification of Critical Land In Badeng Watershed.

Classification	Area (Km^2)	% Area
Somewhat/ Rather Critical	10.82	20.65
Critical Potential	8.08	14.43
Not Critical	33.49	63.93
Total	52.38	100

The results of land criticality analysis in the Badeng watershed according to Table 5 based on the Regulation of the Director-General of Watershed Control and Protection Forest Management Number P.3/PDASHL/SET/KUM.1/7/2018 obtained three land criticality classifications with the results of non-critical land zones which is 33.49 km^2 or 63.93%. The critical potential zone is 8.08 Km^2 or 14.43%. While the Somewhat/ rather critical zone is 10.82 km^2 or 20.65%.

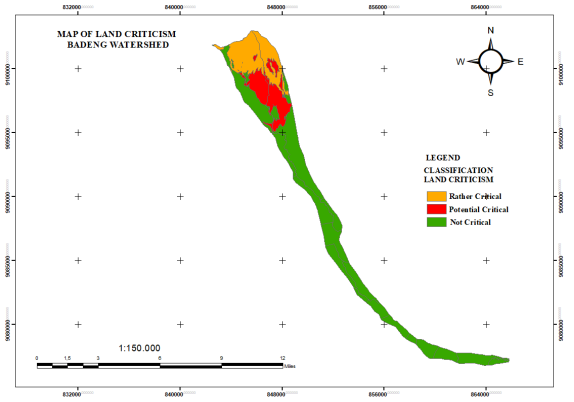


Figure 7: Map of Land Criticality in Badeng Watershed.

Figure 7 is a map of the results of land criticality analysis in the Badeng watershed according to the Regulation of the Director-General of Watershed Control and Protection Forest Management Number P.3/ PDASHL/ SET/ KUM.1/ 7/2018 which can be grouped into three land criticality zones, namely:

a. The somewhat/ rather critical zone of 10.82 km^2 is located in Sumber Asih Hamlet, Mangaran, Sumberarum Village, Bayu Lor Hamlet, Sambungrejo, Bayu Village, Songgon District with a slope of 25-40% and >40%. The types of land use are forest and landslide. The function of the forest area in this zone is a protected forest. The amount of erosion is 9162.10 Ton//Ha/Yrs located at the coordinates of Longitude 114.131832 E, Latitude -8.117319 S.
b. The critical potential zone of 8.08 Km^2 is located in Bejong Hamlet, Krajan Sumberarum Village, Bayurejo Hamlet, Bumisari, Kentangan, Tegalrejo, Bayu Village, Songgon District with a slope of 8-15% and 15-25%. The types of land use are forest and landslide. The function of the forest area in this zone is the area outside the forest and protected forest. The amount of erosion is 34.45 Tons//Ha/Yrs located at the coordinates of Longitude 114.151463 E, Latitude -8.148847 S.
c. The non-critical zone of 33.49 km^2 is located in Sumberbulu Village, Singojuruh, Kampung Anyar Hamlet, Lider, Sumberarum Village, Sumberbaru, Bubuk, Gladag, Benelan Kidul, Songgon, Parangharjo, Kemiri, Bedewang, Cantuk, Alasmalang, Pelantaran Village Bayu Hamlet, Songgon District, Singojuruh, and Rogojampi with a slope of 0 - 2%, 2-8%, and 8-15%. Types of land use are settlements, inland waters, plantations, rice fields, gardens, forests, and forest area functions are outside forest areas, protected forests, and production forests. The amount of erosion is 3840.52 Ton//Ha/yrs at the coordinates of Longitude 114.16574 E, Latitude -8.186919 S.

In Figure 8, the condition of the land area is rather critical at coordinates 8° 6' 37.1124" South Latitude and 114° 8' 6.108" East Longitude. The land use in the area is the forest with no vegetation, and there are former landslides. The potential on slightly critical land can cause high surface runoff if the rainfall intensity is high.

(a) (b)

Figure 8: Zone of Somewhat Critical Area In Sumberarum Village (a) Former Landslide on Mount Pendil (b) Forest on the Slope of Mount Pendil

Mountain areas are synonymous with green, fertile areas, and there are lots of forests, so they are rich in oxygen. However, it turns out that mountainous areas or highlands in the Raung Mountains can also experience land criticality. The cause is soil erosion and landslides with soil types in the form of grumosol and mediteran. In addition, other factors are land conversion, mismanagement of land, and lack of water and soil conservation.

(a) (b)

Figure 9: (a) Location of Somewhat Critical Zone in the Pendil Mountains, Sumberarum Village, Songgon District; (b) Critical Potential Zone in Sumberarum Village, Songgon District.

Figure 9 is a somewhat critical zone in the mountainous area of Pendil, Sumberarum Village, Songgon District. The Land Use in this zone is a landslide, having a slope of >40%. The conditions of critical potential areas located in Sumberarum

Village, Songgon District at coordinates 8° 11' 1.40" South Latitude, and 114° 8' 51.2328" East Longitude. The type of land use in this area is a forest area in the form of a savanna. Therefore, the critical potential zone in Sumberarum Village, Songgon District. The land use in this zone is forest, with a slope of 8-15%.

The condition of the rice fields around the banks of the Badeng River located in Kemiri Village, Songgon District at coordinates 8° 17' 35.394" South Latitude, 114° 12' 58.464" East Longitude, where in the area is not a critical zone but still contributes to land erosion and flood zones.

3.6 Land Conservation Study

Efforts that can be made to prevent or minimize the adverse impacts of land criticality are by conducting conservation in the Badeng watershed. The following are conservation recommendations in the Badeng watershed:

a. Somewhat Critical Zone

Conservation recommendations for the somewhat/ rather critical zone are vegetative conservation in the form of planting citronella and vetiver grass for critical land management and anticipation of landslides and reforestation in the Raung mountain forest area. For plantation areas, coffee and cloves are planted with mechanical conservation to make rorak.

b. Critical Potential Zone

Conservation recommendations for potential critical zones are vegetative conservation by planting teak, pine, and mahogany trees with multiple cropping systems or agroforestry systems, meanwhile, for mechanical conservation in the form of making check dams and gully plugs in grooves, ditches, or ravines around the slopes and banks of the Badeng River.

c. Non-critical Zone

Conservation recommendations for non-critical zones are vegetative conservation by planting rotational cropping systems and mulch in agricultural areas. Meanwhile, for mechanical conservation in making mounds and making terraces in highland agricultural areas.

4 CONCLUSIONS

The identification of land criticism for land conservation actions in the Badeng watershed with Regulation of Watershed and Protection Forest Management can be concluded as follows:

a. Slightly critical land of 20.65% with 10.82 Km^2 is located in Sumber Asih Hamlet, Mangaran, Sumberarum Village, Bayu Lor Hamlet, Sambungrejo, Bayu Village, Songgon District. Recommendations for vegetative conservation in the form of planting citronella and vetiver grass for critical land management and anticipation of landslides and reforestation in the Raung mountain forest area. For plantation areas, coffee and cloves are planted with mechanical conservation in the form of making rorak.
b. Critical potential land is 14.43% with 8.08 Km^2 in Bejong Hamlet, Krajan Sumberarum Village, Bayurejo Hamlet, Bumisari, Kentangan, Tegalrejo, Bayu Village, Songgon District. Recommendations for vegetative conservation by planting teak, pine, and mahogany trees with multiple cropping systems or agroforestry systems, meanwhile, for mechanical conservation in the form of making check dams and gully plugs in grooves, ditches, or ravines around the slopes and banks of the Badeng River.
c. Non-critical land is 63.93% of 33.49 km^2 located in Sumberbulu village, Singojuruh, Kampung Anyar hamlet, Lider, Sumberarum Village, Sumberbaru, Bubuk, Gladag, Benelan Kidul, Songgon, Parangharjo, Kemiri, Bedewang, Cantuk, Alasmalang, Pelantaran Hamlet Bayu Village, Songgon District, Singojuruh, Rogojampi. Recommendations for vegetative conservation by planting rotational cropping systems and using mulch in agricultural areas. For mechanical conservation in the form of making mounds and making terraces in highland agricultural areas.

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