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Mapping Potential Locations of Reservoir Development Planning Based on Biogeophysical Conditions in Bulok Watershed of Lampung Province

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ABSTRACT

Floods and droughts are problems that threaten the success of agricultural crops. The reservoir can be used as a water management system that can anticipate these problems. This study aims to examine the potential location of the reservoir development planning based on biogeophysical conditions in the Bulok Watershed of Lampung Province, which uses the overlay method and weighting and scoring techniques developed by Geographic Information System (GIS). The population covers the entire biogeophysical area of the Bulok watershed, with samples of 4 biogeophysical parameters, namely land cover, slope, soil conditions and geological conditions. The results showed that the distribution of land cover types that dominate in the Bulok watershed is mixed dry land agriculture. The most common slopes are flat to wavy slopes. The soil types that dominates are soils with andesite lithology, basalt, diorite, fine-grained tefra, and coarse-grained tefra. The geological formation that dominates is the Hulu Simpang Formation. Based on the 4 biogeophysical parameters selected in the study, there are 69 locations with great potential for planning the construction of reservoirs in the Bulok watershed. 20 points are spread over the administrative area of Tanggamus Regency, 23 points in Pringsewu Regency, and 26 points in Pesawaran Regency. Of the 87.670 ha of Bulok watershed area, 14.192 ha is very potential location area.

1. INTRODUCTION

Watershed can be defined as an area/region that is surrounded and bounded by topography which can be hills or mountains. River is part of the watershed, so watershed include not only the flow of water, but also the landscape around the river. In simple terms, Sinukaban (2004) defines watershed as an area that is naturally bounded by topography, so that any water that falls in the area will flow through the same measurement point. Bulok Watershed is one of the watersheds in Lampung Province, which covers part of the administrative area of Tanggamus Regency, Pringsewu Regency and Pesawaran Regency.

Watershed as a water catchment area has an important role in providing water for humans. Moreover, watersheds play an important role in protecting the environment, including maintaining water quality, preventing flood during the rainy season and drought in the dry season. The important role and function of watersheds for life will further decrease when watershed conditions change to become worse than previous conditions. Some factors that can affect the function of a watershed include land use and environmental physical conditions. Watershed components have a reciprocal relationship (interaction), so changes that occur in one component can change other components (Susetyaningsih, 2012). The large number of changes in forest/shrub land into settlements is often the cause of the decline in watershed functions.

Changes in land cover in the Bulok watershed of Lampung Province that continues to occur from year to year also have an influence on the conditions and water circulation or the hydrological cycle in the Bulok watershed. The magnitude of the maximum discharge that occurs is not only caused by high rainfall in the wet months, it is also influenced by the form of land use. According to Yuwono *et al*., (2011), changes in land use from forest areas to mixed plantations can cause an increasing trend of discharge fluctuations. This can be interpreted that land with annual crops and land with agricultural crops whose land is cultivated continuously will have different abilities to absorb and hold surface water flows.

The Bulok watershed is one of the watersheds that is starting to experience degradation. One of the degradations that occurs in the Bulok watershed is marked by the increasing value of fluctuations in discharge and surface runoff, which then has a negative impact on the downstream part, one of which is frequent flooding in the rainy season and drought in the dry season. Flood events in the Bulok watershed almost always occur every year, so the losses experienced by the community are actually quite a lot, the data on flood events in the Bulok watershed based on the BPBD documentation of Pringsewu Regency shows that from 2015 to 2020 there are always floods in the Bulok watershed every year, with the most flood events in 2019, three events occurred in: 1) South Pardasuka Village and Pardasuka Induk, Pardasuka District, 2) Sidoharjo Village, Pringsewu District in February, 3) Sidoharjo Village, Pringsewu District in March (BPBD Kabupaten Pringsewu, 2020).

Most of the land cover in the Bulok watershed area is mixed dry land agriculture and rice fields whose land is cultivated continuously throughout the year. Agricultural land whose crops are often harvested and constantly changing, making the texture often loose and porous, so the soil cannot hold and store water properly, and when the rainy season arrives, most of the rainwater that falls will become run off which flows directly into rivers so that causing flooding, the inability of the Bulok watershed to store water also causes this area to experience drought/water shortages when the dry season arrives. Therefore, controlling excess water during the rainy season is urgently needed, so that surface water does not just flow and can be used as water reserves during the dry season.

Planning the distribution of water or the provision of water reserves in the dry season can be done in various ways, one of which is by making reservoirs. The purpose of making the reservoir is not only to provide water reserves, especially to anticipate drought in the dry season, it can also function to overcome uncontrolled inundation in the rainy season. High discharge conditions, especially if there is high intensity and relatively long rain, can decrease with the presence of dams/irrigations/reservoirs.

The planning for the construction of the reservoir must be carried out before the construction of the reservoir is carried out. Biogeophysical conditions that will later affect the reservoir building are also taken into account before the construction activity starts. The biogeophysical condition of the Bulok watershed must be well known so that the planning and potential of water resources from the planned reservoir can be well known. The absence of a mapping of the distribution and biogeophysical conditions in the Bulok watershed is one of the reasons behind the importance of this research, which is expected to be useful for estimating the potential of water resources from the planned reservoir, so that it can be used as a solution to overcome the problems of flood and drought in Bulok watershed. Based on these problems, this research was carried out with the aim of taking an inventory of the biogeophysical conditions of the Bulok watershed area, as well as determining and mapping the most potential locations for planning the development of reservoirs in the Bulok watershed area, as one of the efforts to overcome flood and drought in the Bulok watershed.

2. MATERIALS AND METHODS

The research was conducted in the Bulok watershed of Lampung Province. The Bulok watershed has an area of approximately 87.670 hectares with quite diverse physical environmental conditions. Bulok watershed has a temperate climate type based on the Schmidt-Ferguson climate classification. Estimates calculated by Pratama and Yuwono (2016), based on the Schmidt-Ferguson climate classification measured from 2001-2011, Bulok watershed rainfall has an average ratio of dry months (<100 mm/month) of 7 months with wet months (>100 mm/month) of 5 months, thus the Bulok watershed has a temperate climate type. The research was carried out in 2022 using a study of documentation data and field surveys (observations). The research location based on administrative location can be seen in the Figure 1.

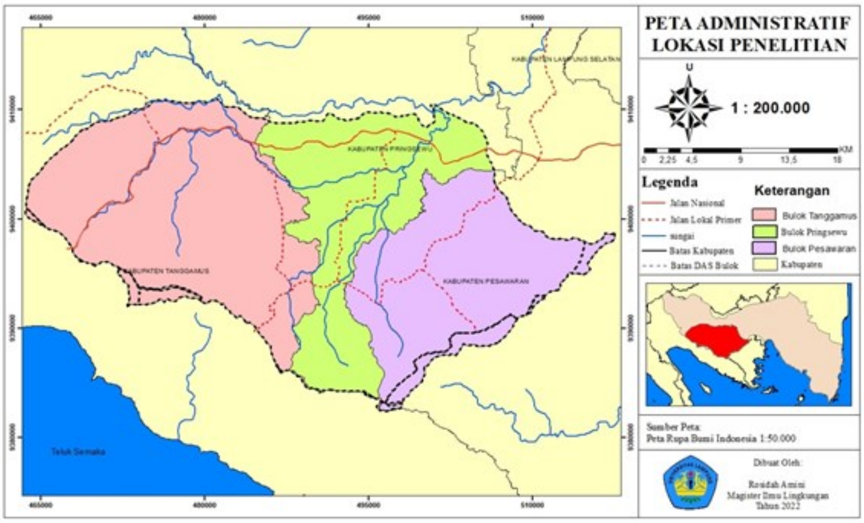

Figure 1. Map of Bulok Watershed administration in Lampung Province

2.1. Research Variables

Research variables are attributes or properties or values of people, objects or activities that have certain variations that are determined by researchers to be studied and then conclusions are drawn (Sugiyono, 2019). The variables of this study consisted of two variables. The first variable is the biogeophysical condition of the Bulok watershed, which includes soil type, land cover, geological conditions, and the slope of the Bulok watershed. The second variable is the determination of the location of the reservoir development planning in the Bulok watershed, which includes locations that are not potential, potential, to very potential for planning the construction of a reservoir.

2.2. Materials and Equipment

The materials used in the research include a map of the research location and a digital map of the biogeophysical condition of the research area. The equipment used includes computers, cellphones, stationery (books, pencils and pens), Google Earth applications, GPS Essentials, ArcGis software, and Microsoft Office.

2.3. Data Analysis Method

The data analysis method uses a GIS (Geographic Information System) techniques overlay to process biogeophysical data in the Bulok watershed, while to determine the most potential locations for planning the construction of reservoirs in the Bulok watershed, weighting and scoring techniques are used as well as overlays also developed by GIS. The weighting method is a simple and effective approach to determine the location of the placement of reservoirs according to certain criteria with the most effective criteria results (Santikayasa *et al*, 2021). The determination of the weights and scores for each biogeophysical parameter used to identify the potential level of a land for planning the development of the reservoir can be seen in the Table 1.

Table 1. Biogeophysical parameters that affect the determination of the potential level of the location for planned construction of the reservoir

No.	Parameters	Parameter Class	Weight	Score	Data Sources
1.	Land Cover*	1. Open ground, Bush 2. Plantation, dry land agriculture, mixed dry land agriculture, rice fields 3. Secondary dryland forest, Settlements	40%	5 3 1	BPKH Wilayah XX
2.	Slope*	1. Wavy (8% - 15%) 2. Choppy (3% - 8%), Small hills (15% - 30%) 3. Flat (0%-3%), Hilly (30% - 45%), Steep/steep hills (>45%)	30%	5 3 1	BPDASHL Way Seputih-Way Sekampung
3.	Soil conditions*	1. Soil class A 2. Soil class B 3. Soil class C	20%	5 3 1	BPDASHL Way Seputih-Way Sekampung
4.	Geological conditions **	1. Formation Group 1 2. Formation Group 2 3. Formation Group 3	10%	5 3 1	BPDASHL Way Seputih-Way Sekampung

Sources: * BP2TPDAS IBB, 2002 and ** Kementerian PUPR RI, 2017

The construction of the reservoir is determined from the total score of all the parameters that affect the determination of the potential location. The value of the potential level is determined using the equation 1.

$$\mathrm{P} = \sum_{i-1}^{n} (\mathrm{Wi} \times \mathrm{Xi}) \quad (1)$$

with P = Value of the potential level of the reservoir construction planning location. Wi = Weight for the i-th parameter. Xi = Class score on the i-th parameter.

According to Kingma (1991), to determine the width of the interval for each class, it is done by dividing the values obtained by the number of class intervals determined by the equation 2.

$$i = R/n \quad (2)$$

with i = Width of interval. R = Difference of maximum score and minimum score. n = number of classes of potential location for reservoir construction planning.

The location with the most potential for planning the development of the reservoir will have a high total value, and vice versa areas with less to no potential will have a low total value. Table 2 below shows the level of potential locations for reservoir planning based on the sum of the weights and scores of each parameter that affects the determination of potential locations for reservoir construction planning.

Table 2. Potential site level values for reservoir planning

No.	Potential Level of Embung Planning Location	Total Value
1	Very potential	>303
2	Potential	186 – 303
3	Not potential	<186

3. RESULTS AND DISCUSSION

3.1. Biogeophysical Condition of Bulok Watershed Area

3.1.1. Land cover of the Bulok Watershed

Biogeophysical conditions are conditions that describe all the physical characteristics found in the environment, ranging from soil type conditions, geological formations, slopes, land cover, drainage conditions, and others. Biogeophysical conditions are strongly influenced by land cover, where according to Cahyono *et al*., (2019), Land cover is the appearance of physical material on the earth's surface where land cover describes the relationship between natural processes and social processes. The biogeophysical conditions in the Bulok watershed are described by four parameters, namely land cover conditions, slope conditions, soil type conditions and geological conditions in the Bulok watershed. The 4 biogeophysical parameters are considered representative enough to describe the general biogeophysical condition of the Bulok watershed.

The first biogeophysical parameter that influences the determination of a very potential location for reservoir development planning is land cover. Good land cover can be used to reduce surface runoff. According to Novitasari *et al*., (2019), soil conservation with good land cover will protect the soil from raindrops directly. In addition, any plant that covers the soil is a barrier to surface runoff. By inhibiting surface runoff, it can increase the infiltration rate, so that surface runoff can be reduced and flooding is not easy. Several types of land cover in the Bulok watershed can be seen in the Table 3.

Table 3. Types of Land Cover in the Bulok Watershed of Lampung Province

No.	Types of Land Cover	Area (ha)	Sum (%)
1	Secondary dryland forest	1.757	2
2	Mixed dry land farming	52.478	60
3	Shrubs	4	0,005
4	Plantation	1.809	2
5	Settlement	7.647	8
6	open ground	24	0,995
7	Dryland farming	1.134	1
8	Ricefield	22.817	26
	Jumlah Total	87.670	100

Source: BPKH documentation data for Region XX, 2020.

The distribution of land cover types that dominate in the Bulok watershed is mixed dry land agriculture. This shows that most of the people in the Bulok watershed make a living as farmers. The distribution of land cover in the Bulok watershed is shown in the Figure 2.

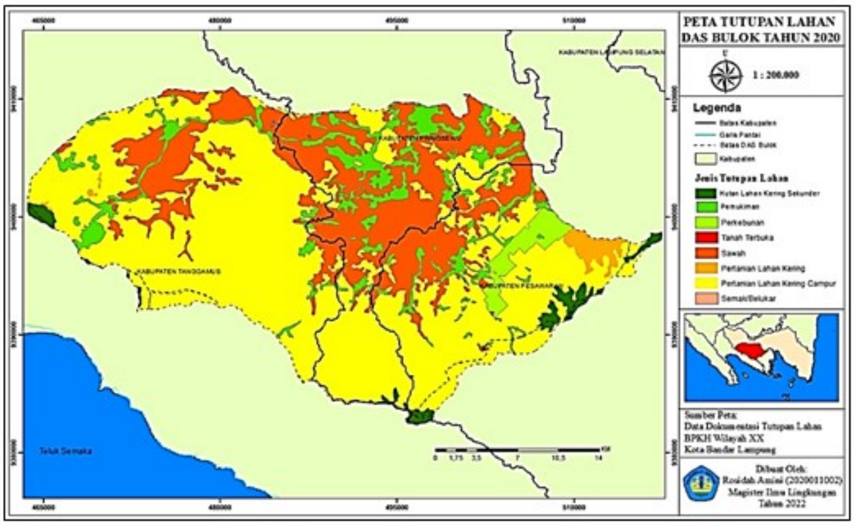

Figure 2. Map of land cover in the Bulok Watershed of Lampung Province, 2020

Mixed dry land agriculture dominates the Bulok watershed area of Lampung Province, because 60% of the Bulok watershed area is mixed dry land agriculture whose distribution almost covers the entire Bulok watershed area, especially the southern to northern areas. After mixed dry land farming, the most widely distributed land cover in the Bulok watershed is rice fields, with a total area of 22.835 hectares. The distribution of rice fields in the Bulok watershed is mostly in the lowlands with gentle/flat to choppy slopes. The large number of mixed dry land and paddy fields in the Bulok watershed can also indicate that the lands in the Bulok watershed are used by farmers throughout the year, by planting crops that are in accordance with the current season. This will affect the ability to hold water by the soil in the Bulok watershed.

Ayu *et al*., (2013), stated that differences in soil surface conditions, organic matter, texture, structure and vegetation are factors that cause differences in water storage capacities. Likewise, changes in soil surface conditions, organic matter, texture, structure and vegetation of the Bulok watershed are changing, due to continuous land use. Most of the soils in the Bulok watershed are loose due to continuous cultivation, so that the ability to hold water in the Bulok watershed decreases, and this is one of the causes of flood and drought in the Bulok watershed.

3.1.2. Slope of the Bulok Watershed

The slope of the slope is a measure of the size of a land with a relative slope on a flat plane which is expressed in units of degrees or percent (Nisa, 2022). The slope of the Bulok watershed in Lampung Province certainly varies, its distribution can be seen in the Figure 3.

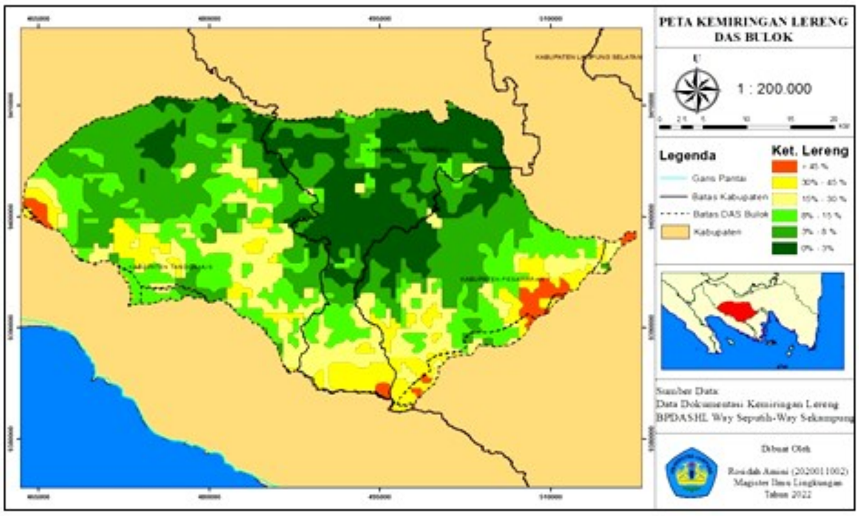

Figure 3. Slope Map of Bulok Watershed, Lampung Province

The slope of the slope is also a physical factor that influences the determination of the potential location of the reservoir in the Bulok watershed. This is in accordance with the study of Tumbo *et al*., (2014), which showed that the slope of the area greatly determines the location for determining the construction of the reservoir and the type of rainwater harvesting technology used. It is not appropriate to build a reservoir on a slope that is too steep, because it will affect the strength of the reservoir structure, and the life of the reservoir can be shortened due to the large amount of erosion that occurs. According to Nuchsin (2011), reservoirs will quickly fill with sedimentation due to erosion if they are built in areas with a slope exceeding 30%.

Analysis of the slope parameters shows that the Bulok watershed has various slopes with dominance by plains with slope classes ranging from 0% – 8%, or between flat to wavy slopes, the percentage of which reaches 53% of the total area of the Bulok watershed. Meanwhile, the distribution of slopes > 45% or land with a steep hilly topography is found on the outskirts of the western, southern and eastern parts of the Bulok watershed. The slope of the slope is between 30% - 45% with hilly topography in the Bulok watershed located after the slope is >45%, this is because hilly land is a continuation of steep hilly land. So it can be concluded that the slope >30% is not suitable if used to construct buildings, whether settlements, reservoirs or others, so it is not surprising that in the hilly to steep hilly topography there are almost no human buildings at all. Details of the slope class and its extent in the Bulok watershed, Lampung Province, can be seen in the Table 4.

Table 4. Slopes Class in Bulok Watershed of Lampung Province

No.	Slopes Class (%)	Topographic Type	Area (ha)	Sum (%)
1	0 - 3	Flat	18.838	22
2	3 – 8	Choppy	27.475	31
3	8 – 15	Wavy	17.209	20
4	15 – 30	Small hills	14.420	16
5	30 – 45	Hilly	8.003	9
6	> 45	Steep/steep hills	1.725	2
	Total number		**87.670**	**100**

Source: BPDASHL documentation data for Way Seputih - Way Sekampung, 2021 (with modifications).

The slope of the slope illustrates the difference in the topography of the Bulok watershed, which also serves as a consideration when constructing a building, this is because according to BP2TPDAS IBB (2002), to construct buildings that are used sustainably, you should avoid building in areas with steep and steep slopes, because The risk of erosion and landslides is quite high. The slope of the slope will be easier to see and understand if it is visualized in the form of a topographic map as shown in the Figure 4.

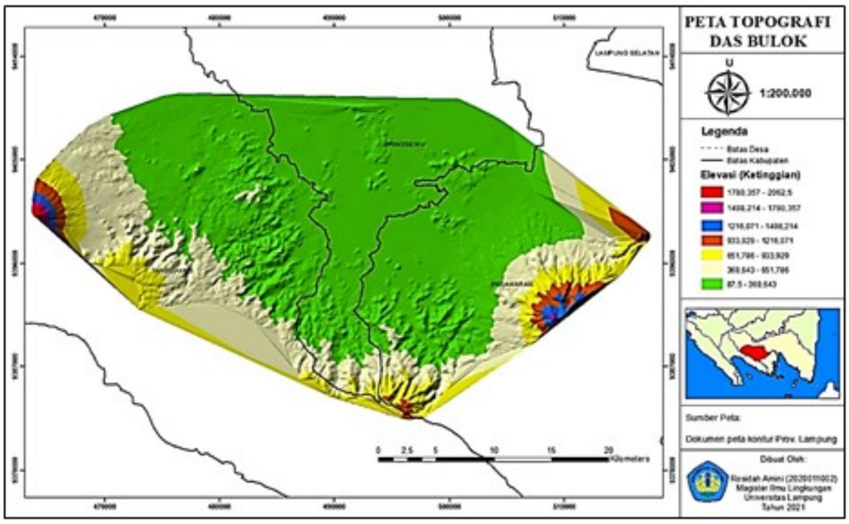

Figure 4. Topographic map of the Bulok watershed in Lampung Province

Figure 4 shows that the morphology of steep hills or highlands in the Bulok watershed is in the south direction, this makes the rivers in the Bulok watershed flow to the north, which then meets the water flow in the main river namely the Sekampung watershed, which will then flow downstream in South Lampung. Areas with high slopes are mostly found in the southern part of the Bulok watershed in the administrative areas of Tanggamus and Pesawaran districts, the further north the Bulok watershed becomes more gentle, although in the middle there is also a hilly and wavy morphology.

The construction of the reservoir should be carried out in a bumpy area, not too steep and not too flat, it would be better if the reservoir is in a basin, this makes the slope and topography one of the factors taken into account in planning the construction of the reservoir.

3.1.3. Soil conditions of the Bulok Watershed

The soil conditions in the Bulok watershed vary, which when viewed from the lithology there are 6 types of soil in the Bulok watershed. The soil lithology referred to in this study is the physical characteristics of the soil that can be seen on the surface, can be held and observed. Its physical characteristics include color, texture, grain size and composition. Details of the soil lithology in the Bulok watershed can be seen in the Table 5.

Table 5. Soil Lithology in the Bulok Watershed of Lampung Province

No.	Types of soil lithology	Area (ha)	Sum (%)
1	Andesit, basalt, diorite, fine-grained tefra, coarse-grained tefra	45.333	52
2	Filit, shale/ Flakes, kwarsit, sandstone, young river alluvium	1.150	1
3	Kwarsit, sekis, filit, Shale, sandstone	2.036	2
4	Basalt, andesit, fine-grained tefra, coarse-grained tefra	21.335	24
5	Fine-grained tefra, Tufit, mudstone, silt, sandstone, river alluvium	1.515	2
6	Young volcanic alluvium, Aluvium, longgokan kipas	16.301	19
	Total number	**87.670**	**100**

Source: Documentation data of BPDASHL Way Seputih - Way Sekampung, 2021.

More than half of the Bulok watershed area or about 52% of the land is of andesite, basalt, diorite, fine-grained tephra, and coarse-grained tephra, which is approximately 45.333 ha. Soil with lithology of andesite, basalt, diorite, fine-grained tephra, and coarse-grained tephra, in the Bulok watershed belongs to soil class N with the main inhibiting factors in the form of landslides and erosion. The nature of the soil is also quite smooth or not too clayey, so there is less potential for planning the construction of a reservoir.

Soil lithology conditions describe the texture and structure as well as soil properties in the Bulok watershed, so it is very important to use it as a parameter that describes the biogeophysical conditions of the Bulok watershed. The construction of reservoirs should be carried out in areas with clay/smooth soil lithology types, which do not easily absorb water, or which often cause puddles. This is in line with the opinion of Hermawan *et al.*, (2020), in their research which states that fine to medium textures are more suitable for water harvesting because they have high storage capabilities.

To simplify the scoring, based on the guidelines from BP2TPDAS IBB (2002), the conditions of soil at the research location were reclassified into 3 groups, namely soil group A, soil group B and soil group C. Classification of soil conditions into three groups based on similarities or differences similarity of soil properties, texture, drainage to soil resistance to various threats such as erosion and landslides. Soil group A is considered to have the most suitable properties and characteristics for building a reservoir, due to its clayy/smooth nature, resulting in imperfect, suitable for reservoirs, besides that the limiting factor in soil group A is also only slightly, and it is still very easy to overcome when soil group A will be used for the purpose of building a reservoir. In contrast to soil group B, the drainage is easy to pass water/ well draine, so the scoring technique is given a lower score than soil group A. Then the last one is soil lithology with soil group C being given the lowest score, because the drainage is getting easier, the passage of water, the limiting factor in soil group C is also very heavy and/or difficult to overcome when the construction of a dam is to be carried out on the soil surface. Details of the regrouping of soil lithological conditions in the Bulok watershed can be seen in the Table 6.

Table 6. Regrouping of soil lithology in the Bulok watershed, Lampung Province

No	Land Group	Soil lithology type group	Area (ha)	Sum (%)
1	Soil group A	• Young volcanic alluvium, Aluvium, longgokan kipas	16.301	19
2	Soil group B	• Fine-grained tefra, Tufit, mudstone, silt, sandstone, river alluvium • Basalt, andesit, fine-grained tefra, coarse-grained tefra	22.851	26
3	Soil group C	• Kwarsit, sekis, filit, Shale, sandstone • Filit, shale/ Flakes, kwarsit, sandstone, young river alluvium • Andesit, basalt, diorite, fine-grained tefra, coarse-grained tefra	48.518	55
		Total number	**87.670**	**100**

The soil group that dominates the Bulok watershed is soil group C, which covers an area of approximately 55% of the total area of the Bulok watershed, or more precisely, approximately 48,518 hectares. This means that most of the soil lithology in the Bulok watershed is actually not suitable for construction of reservoirs. However, these land problems can still be overcome with certain development techniques. The distribution of land groups in the Bulok watershed of Lampung Province can be seen in the Figure 5.

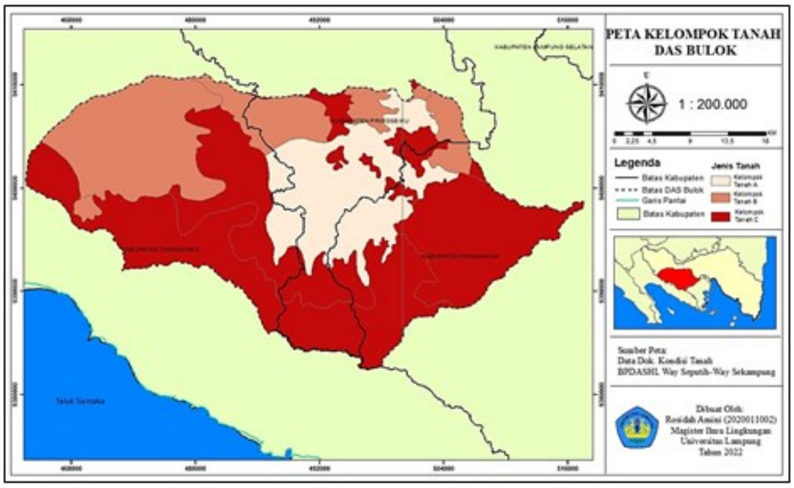

Figure 5. Map of the Bulok watershed land group in Lampung Province

3.1.4. Geological formation of Bulok Watershed

Geological conditions are important to consider in planning the construction of the reservoir because the geological conditions will determine the strength and sustainability of the foundation of the reservoir itself. A map depicting the geological conditions in the Bulok watershed can be seen in the Figure 6.

There are 9 types of geological formations in the Bulok watershed. The formation itself according to Situs Resmi Pemerintah Daerah Kabupaten Pesawaran (2021), is a rock arrangement that has a real uniformity of geological characteristics, either consisting of one type of rock, or a repetition of two or more rock types located on the earth's surface or under surface. Details of the geological formations in the Bulok watershed are presented in the Table 7.

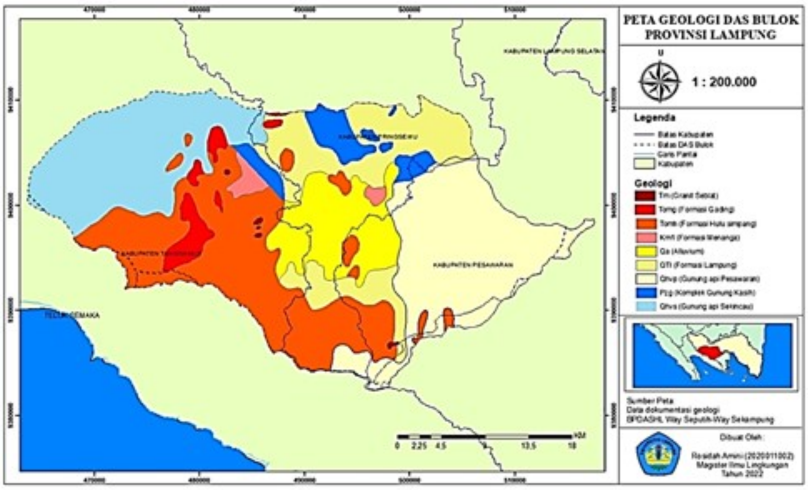

Figure 6. Geological Map of the Bulok Watershed in Lampung Province

Table 7. Geological formations of the Bulok watershed, Lampung Province

No.	Geological formations	Area (ha)	Sum (%)
1	Tm (Granit Seblat)	175	1
2	Tomg (Formasi Gading)	2.523	3
3	Tomh (Formasi Hulu Simpang)	22.190	25
4	Km1 (Formasi Menanga)	1.052	2
5	Qa (Alluvium)	8.702	10
6	QTl (Formasi Lampung)	12.685	14
7	Qhvp (Gunung Api Pesawaran)	19.657	22
8	Pzq (Komplek Gunung Kasih)	3.696	4
9	Qhvs (Gunung Api Sekincau)	16.990	19
	Total number	**87.670**	**100**

Source: Documentation data of BPDASHL Way Seputih - Way Sekampung, 2021.

The most common geological formations in the Bulok watershed are the Sekincau Volcano Formation, the Hulu Simpang Formation, and the Pesawaran Volcano Formation, which are spread over most of the western, southern, and eastern parts of the Bulok watershed.

The Introduction to Reservoir Planning Module made by the Ministry of PUPR (2017), states that geological conditions are considered to assess the condition of rocks and soil types that will be used as the foundation of the reservoir. Geological conditions are often a determinant in determining the type of reservoir that is suitable for the location. The geological and foundation conditions considered include: strength, thickness, direction and slope of the layer, water resistance, joints, cracks and fault structures. (Kementrian PUPR, 2017). So to facilitate the scoring in the Bulok watershed, the geological formations were regrouped, simplified into 3 groups of formations, based on the characteristics of resistance to development and the presence of relatively similar topography and morphology. The distribution of the three geological formation groups can be seen in Figure 7.

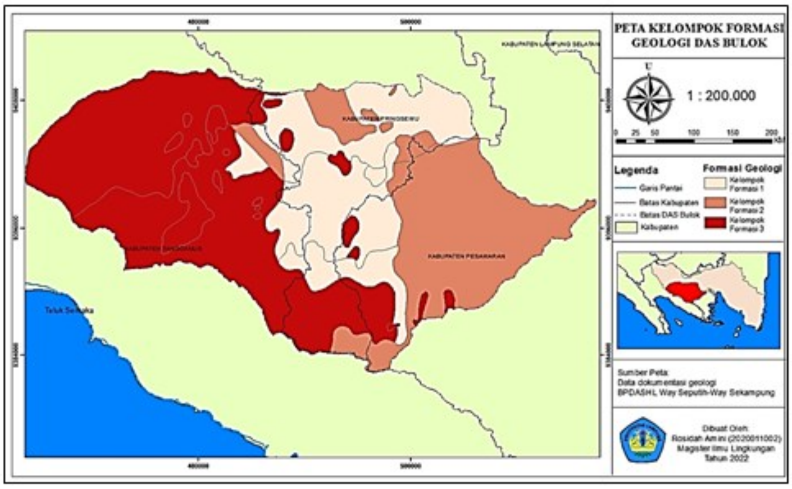

Figure 7. Map of geological formation groups in the Bulok Watershed of Lampung Province after reclassification

The regrouping of geological formations in the Bulok Watershed of Lampung Province resulted in three groups of geological formations, namely formation groups 1, 2 and 3. Details of information on geological formations that have been regrouped can be seen in Table 8.

Table 8. Reclassification of geological formations in the Bulok Watershed, Lampung Province

No.	Geological formation Groups	Details	Area (ha)	Sum (%)
1	Formation Group 1	Alluvium Formation, Lampung Formation, and Menanga Formation.	22.438	26
2	Formation Group 2	Mount Kasih Complex Formation, and Pesawaran Volcano Formation.	23.353	26
3	Formation Group 3	Hulu Simpang Formation, Gading Formation, Granit Seblat Formation, and Sekincau Volcano Formation.	41.879	48
		Total number	**87.670**	**100**

This geological formation shows rock groups that can be used as an indicator of whether or not construction is safe on it. This is in line with Agustin (2016), that in efforts to mitigate and reduce disaster risk, humans should not build settlements, vital and strategic buildings, and other buildings that invite concentration many people in Disaster Prone Areas (DPA). Amri *et al*., (2016), stated that the number of disaster events caused by geological factors was not too significant compared to the number of disasters caused by hydrometeorological factors, but geological disasters, especially earthquakes and tsunamis, in fact caused quite a large impact both in terms of victims and economic losses, so that the construction of any building should be carried out in a place that is far away and safe from the threat of geological disasters.

Formation group 1 is given the highest score in the scoring technique to determine potential points for embankment development, this is because formation group 1 is considered to have the safest geological conditions for construction on it, while Formation group 3 is given the lowest score because it is located in a mountainous area and is closer and often feels the effects of the meeting of the

Eurasian and Indo-Australian tectonic plates in the southern part of Sumatra Island. Geological conditions in the Bulok watershed can be used to estimate detailed morphological and geological conditions that may interfere with the resilience of the reservoir building, for example the presence of faults that are still active or can be reactivated, slope stability against landslide symptoms, and so on.

3.2. Potential Locations for Reservoir Development Planning in the Bulok Watershed

The potential locations for planning the development of reservoirs in the Bulok watershed are the distribution of locations that are considered potential to have the potential for planning for the development of reservoirs. The distribution of these potential locations in the Bulok watershed can be seen in the Figure 8.

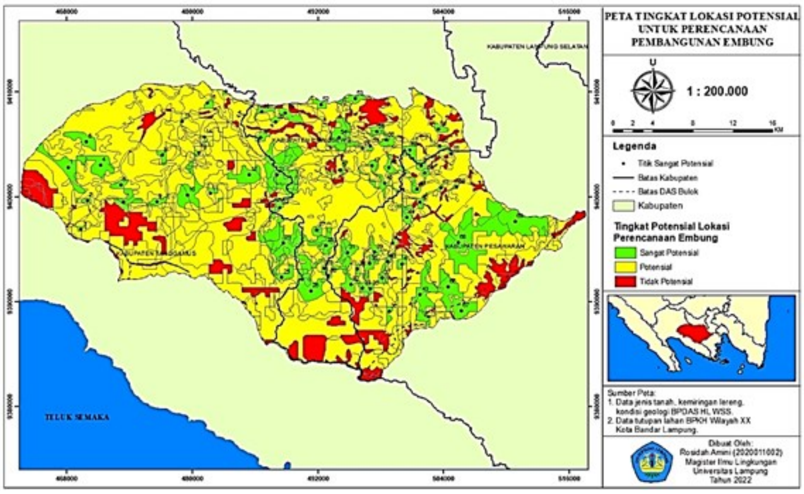

Figure 8. Distribution of potential locations for reservoir development planning in the Bulok Watershed (Research results, 2022)

Determination of potential locations for the planned construction of reservoirs in the Bulok watershed is carried out by processing research data in the form of 4 biogeophysical parameters by weighting and scoring. The results of the data processing resulted in three regional classifications with different potential levels, which can be seen in the Table 9.

Table 9. Areas of potential locations for reservoir development planning in the Bulok watershed

No.	Potential level of reservoir planning location	Area (ha)	Sum (%)
1	Very potential	14.192	16
2	Potential	64.164	73
3	No potential	9.314	11
	Total number	**87.670**	**100**

The level of potential locations for the construction of reservoirs in the Bulok watershed reaches 16% of the total area of the Bulok watershed, or more precisely, the total area of land that has the potential to be planned for the construction of reservoirs in the Bulok watershed reaches 14.192 hectares.

The planning for the construction of the reservoir at the research location will focus only on locations with high potential. There are 69 locations with great potential for the construction of dams in the Bulok watershed, the details of which can be seen in the Table 10.

Table 10. Distribution of potential locations for reservoir development planning in the Bulok Watershed

No.	The number of very potential location points for planned construction of the reservoir	Administrative layout description
1	20 location points	Tanggamus Regency
2	23 location points	Pringsewu Regency
3	26 location points	Pesawaran Regency

Potential points and very potential locations for reservoir development planning in the Bulok watershed have different definitions, where potential points are considered as areas that do have the potential to be planned the construction of reservoirs with certain additional treatments, while the very potential points which here inafter will also be referred to as potential points only, are considered as the most appropriate location points for planning the construction of the reservoir, with the estimated expenditure of labor and costs lower than the planning construction of reservoirs at potential and non-potential points. Of the 87.670 ha of the Bulok watershed area, 14.192 ha is a very potential location area. Most of these very potential points are in areas with mixed dry land agricultural land cover.

It is also expected that the description of the potential points of the reservoir development planning can provide an overview of the solutions that can be used to overcome the problems of flood and drought that often occur in the Bulok watershed area. This is in line with Zevri's research (2022), which shows that the increase in population with quite extreme seasonal changes in Humbang Hasundutan Regency results in the amount of water availability being uncontrolled and very limited to meet water needs, both irrigation water and raw water needs. One solution is conservation through the construction of a storage pond or reservoir. Krisnayanti *et al*., (2020), in their research also stated that the solution in controlling the availability of water to be able to meet water needs can be done through the conservation of water resources with the construction of reservoirs that utilize rainfall as a water source. The research of Hatmoko *et al*., (2017), also shows that the construction of reservoirs and saving water for all water users is an effort to increase water security and availability.

Reservoir buildings are very beneficial for people's lives, if they are built in the right way and in strategic locations. The potential use of water resources from the planning for the development of reservoirs in the Bulok watershed is not only limited to meeting the water needs of agricultural land, but can also be used for other purposes according to the situation and conditions in the field, for example used for aquaculture and ecotourism. The reservoir with clear green water and the neat and clean arrangement of the location of the reservoir can attract people to come to visit. Purwadi (2020), mentions several benefits of reservoirs, including to accommodate rain water and run off in the surrounding area as well as other possible water sources such as springs, ditches, small rivers and so on. Reservoirs are also useful for providing water sources as irrigation supplements in the dry season for secondary crops, seasonal horticulture, seasonal plantation crops and livestock.

The reservoir development planning is very good because it is in line with some of the Sustainable Development Goals (SDGs). Referring to Peraturan Menteri Desa, Pembangunan Daerah Tertinggal dan Transmigrasi Nomor 13 Tahun 2020 tentang Prioritas Penggunaan Dana Desa Tahun 2021, there are at least 18 development goals and targets through the Village SDGs. The construction of the reservoir is expected to support some of the SDGs goals of the village, including villages without poverty and hunger, healthy and prosperous villages, innovation and village infrastructure, sustainable village settlement areas, and village control and climate change.

The construction of reservoirs is said to be able to support several goals in the Village SDGs because innovation and infrastructure of reservoirs are able to accommodate water that can be used to meet agricultural land water needs, so that villages are no longer too dependent on climate change, agricultural land water needs in villages can always be met as long as year with the presence of a reservoir, so that it can increase the number of harvests of agricultural crops than usual, up to 2-3 times. During the dry season, the community can also use the village reservoir as a source of water. Thus, villages without poverty and hunger, as well as healthy and prosperous villages are expected to be realized soon with the existence of reservoirs which are one of the factors that support the Village SDGs.

4. CONCLUSIONS AND SUGGESTIONS

4.1. Conclusion

The biogeophysical condition of the Bulok watershed area is quite varied, both in terms of land cover parameters, slopes, soil types, and geological formations. The distribution of land cover types that dominate in the Bulok watershed is mixed dry land agriculture, while the most common slopes in the Bulok watershed are slopes of 0-3% and 3-8% or flat to wavy slopes. The most common soil types in the Bulok watershed are andesite, basalt, diorite, fine-grained tephra, and coarse-grained tephra. In terms of geological conditions, the geological formations that dominate the Bulok watershed are the Sekincau Volcano Formation, the Hulu Simpang Formation and the Pesawaran Volcano Formation. There are 69 locations with great potential for planning the construction of reservoirs in the Bulok watershed. 20 points are spread over the administrative area of Tanggamus Regency, 23 points are spread over in Pringsewu Regency, and 26 points are spread out in Pesawaran Regency. Of the 87.670 ha of bulok watershed area, 14.192 ha is a very potential location area.

4.2. Suggestions

The plan for the use of the planned reservoir building in the Bulok watershed should not only be used to meet the water needs of paddy fields, but also can be developed as a medium and place for fish farming, the fulfillment of raw water for residents, and can be used as an ecotourism site. The use of reservoir buildings must be adjusted to the conditions of the Bulok watershed community, the purpose of which is to continue to improve the welfare of the Bulok watershed community.

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