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Geomorphosite Assessment of Renyok River, Jeli, Kelantan

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Abstract. Renyok River has many unique and interesting geosites. So far there are very few academic publications related to Renyok River so that its potential as a tourist area is not discovered. In order to ensure the Renyok River geosite has the potential to be developed as a tourist attraction, a comprehensive geomorphosite study is carried out along the Renyok river. In this study the data collection was carried out through geomorphological mapping on geosite along the river. Geomorphosite data were obtained and analyzed in reference to the standard values created by Kubalikova. River landform dominated by leucogranite and metasediment where contacts can be found in many locations. The analysis shows that the Renyok River geomorphosite value is quite high in all aspects assessed including Scientific and Intrinsic aspects (75%), educational (87.5%), conservation aspects (62.5%), and value added aspects (75%), but low value only in economy aspects (33%). Overall conclusion is that the Renyok River has a high potential to be developed as a geotourism area with a note that all deficiencies will be improved in the future and subsequently could be beneficial to economic strengthening.

1. Introduction

Renyok River is a river located in the western part of Kelantan state. Topographically as shown in Figure 1, Renyok River crossing a high hilly terrain of the Gunung Basor with unique and interesting geomorphosite. Geomorphosite that can be found in the Sungai Renyok area includes waterfalls, metasediment basements, ponds, and others. Geomorphosites of Renyok River identified as unique landform which potential to be geotourism sites. Geotourism itself is a tourism activity that specifically focuses on the aspects of panorama and geology [1]. The development of certain areas into a geotourism area will certainly have a good impact on people's lives in various aspects of life such as economic, social, cultural, and infrastructure. However, in determining an area as a geotourism area it is necessary to analyse its geosite and geomorphosite. Geosite and Geomorphosite are landscapes that have potential as tourism sites and have value based on human's point of view. This analysis is intended to provide an assessment of certain parameters such as the value of the scientific approach, education, economic, conservation and added value (beauty, culture, geological factors) in certain areas [1]. Lithology of Renyok River is dominated by granite and metasediment which is distributed in the structural landscape morphology.

2. Methodology

This research was done in three stages. The first stage is the literature study on the geological conditions of the research area, the concept of geotourism and the concepts in geosite and geomorphosite analysis. The second stage is the collection of field data as a primary data which



involved the geological field mapping for observation of geotourism potentials, photographic images of some sites, which were captured using digital camera to visualized geological features, landforms, landscapes, rock types, outcrops, sediments, minerals e.t.c., Figure 2 refers to the observation points along Renyok River. Secondary data involved collection of literature materials of topographic maps, satellite images and regional geological maps. The third stage is geosite and geomorphosite analysis based on the quantification method follows Kubalikova [1]. Mapping area in the downstream part of Renyok River is shown in Figure 3.

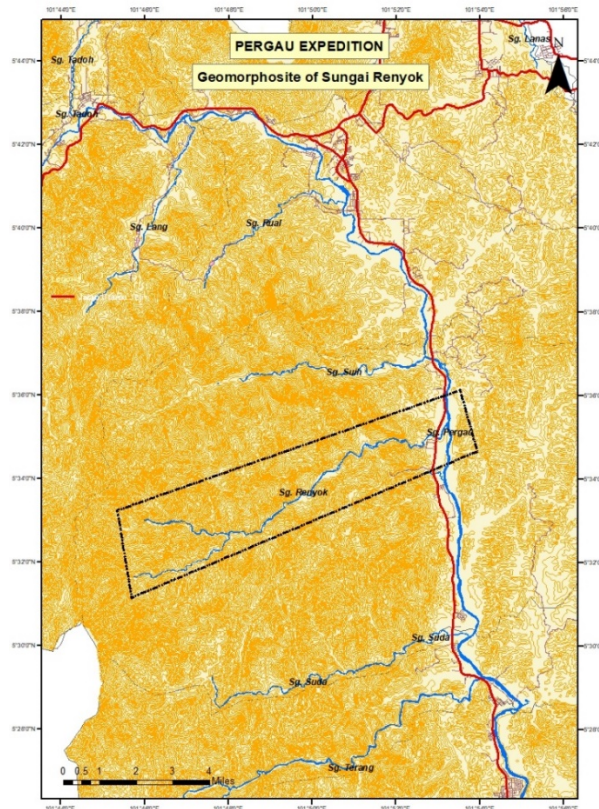


Figure 1. Map of research area

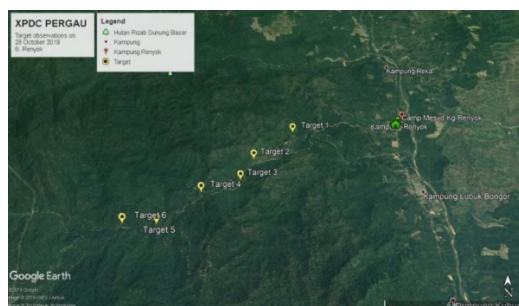


Figure 2. Observation points along Renyok River

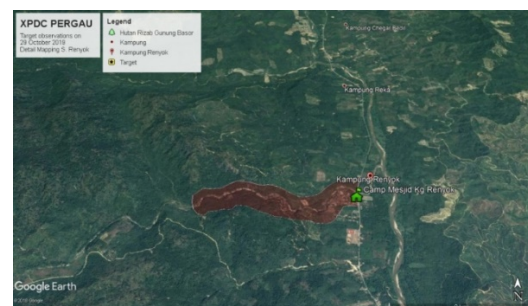


Figure 3. Mapping area in the downstream of Renyok River

Table 1 presents the proposed method for the geosites and geomorphosites assessment for the geotourism purposes. It is based on the geomorphosite concept, analysis of the selected geomorphosite

assessment methods [2,3,4,5] and on the definitions and principles of geotourism Some of the criteria are based on Kubalikova [1].

3. Results and Discussion

3.1 Lata Renyok

Lata Renyok consist of rapids and waterfalls which are close to the river mouth. This area has a slope of between 5-11% while the waterfall as shown in Figure 4 shows up to 27% slope. The rocks found in the Lata Renyok consist of metasedimentary rocks which can be identified with clear foliation characteristics. Geologically the presence of metasediment rocks in this area is quite unique as xenolith from leucogranite intrusion which extends from the Gunung Stong region. The waterfalls and rapids along Renyok River are quite popular because of their beauty, making them one of the mainstay tourist attractions of the Jajahan Jeli. At the bottom of the waterfall there is also a beautiful pool that is often visited by tourists for just swimming.

3.1.1 Metasediment Field

Within a distance of approximately 200 m from Lata Renyok, a stretch of metasediment rock with a width between 30 to 40 m along 300m can be found. This metasedimentary rock looks like a patterned fabric carved with distinctive colors of bright gray, dark gray, white and brown as shown in the Figure 5. On the left side of this metasediment rock or on the banks of the river found contact with leucogranite rock as a thin hornfels rock, this contact zone is the result of intrusion of granite rocks in metasedimentary rocks. Along the rock surface there are many pothole drilling with various sizes with a radius between 20 cm to 50 cm

Table 1. Geomorphosite standard value by Kubalikova [1]

SCIENTIFIC AND INTRINSIC VALUES	
Integrity	0 - totally destroyed site, 0.5 - disturbed site, but with visible abiotic features, 1 - site without any destruction
rarity (number of similar sites)	integrity 0 - totally destroyed site, 0 - more than 5 sites, 0.5 - 2-5 similar sites, 1 - the only site within the area of interest
diversity (number of different partial features and processes within the geosite or geomorphosite)	0 - only one visible feature/processes, 0.5 - 2-4 visible features/processes, 1 - more than 5 visible features/processes
scientific knowledge	0 - unknown site, 0.5 - scientific papers on national level, 1 - high knowledge of the site, monographic studies about
EDUCATIONAL VALUES	
representativeness and visibility/clarity of the features/processes	0 - low representativeness/clarity of the form and process, 0.5 - medium representativeness, especially for scientists, 1 - high representativeness of the form and process, also for
exemplarity, pedagogical use	0 - very low exemplarity and pedagogical use of the form

SCIENTIFIC AND INTRINSIC VALUES	
	and process,
	0.5 - existing exemplarity, but with limited pedagogical use,
	1 - high exemplarity and high potential for pedagogical use, goeidactics and geotourism
existing educational products	0 - no products,
	0.5 - leaflets, maps, web pages,
	1 - info panel, information at the site
actual use of a site for educational purposes (excursions, guided tours)	0 - no educative use of the site,
	0.5 - site as a part of specialized excursions (students),
	1 - guided tours for public
ECONOMICAL VALUES	
presence of tourist infrastructure	0 - more than 1000 m from the parking place,
	0.5 - less than 1000 m from the parking place,
	1 - more than 1000 m from the stop of public transport
presence of tourist infrastructure	0 - more than 10 km from the site existing tourist facilities,
	0.5 - 5 – 10 km tourist facilities,
	1 - less than 5 km tourist facilities
local products	0 - no local products related to a site,
	0.5 - some products,
	1 - emblematic site for some local products
CONSERVATION VALUES	
actual threats and risks	0 - high both natural and atrophic risks,
	0.5 - existing risks that can disturb the site,
	1 - low risks and almost no threats
potential threats and risks	0 - high both natural and athrophic risks,
	0.5 - existing risks that can disturb the site,
	1 - low risks and almost no threats
current status of a site	0 - continuing destruction of the site,
	0.5 - the site destroyed, but now with management measures
	for avoid the destruction,
legislative protection	0 - no legislative protection,
	0.5 - existing proposal for legislative protection,
	1 - existing legislative protection (Natural monument, Natural
ADDED VALUES	
cultural values: presence of historical/archaeological/religious aspects related to the site	0 - no cultural features,
	0.5 - existing cultural features but without strong relation to
	abiotic features,
	1 - existing cultural features with the strong relations to
ecological values	0 - not important,
	0.5 - existing influence but not so important,

SCIENTIFIC AND INTRINSIC VALUES

1 - important influence of the geomorphologic feature on the



Figure 4. Lata Renyok

3.1.2 Boundary pond

At the end of the field metasediment there were a small waterfall and a clear pool measuring about 30 m wide and 50 m long with a depth of almost 1.5 m (Figure 6). At the other end there is a boulder leucogranite rock, the majority of which has a volume between 27-1000 m³.

3.1.3 Giant Boulder

The journey to the upper reaches of the Renyok River from the boundary pond is then as if blocked by a sprinkling of boulder leucogranite which is very large along 320 m as indicates in Figure 7. This boulder has a varied volume between 37 to 1000 m³. At the northern edge of the river, contact between leucogranite rock and metasediment rock is shown. Some boulder shows a table-like shape with a flat surface.

3.1.4 Cave Waterfall

Still in the Giant Boulder area (section 3.1.3), on the side lines of the boulder the water flows evenly from the left bank to the right bank of the river to form small rapids that are very beautiful. It was also found that some of the boulder slits were large enough to look like a cave; inside the cave there was flowing water that formed a small waterfall as shown in Figure 8. Waterfalls in a small cave can hold about 5 people, while a large cave can hold up to 12 people.

3.1.5 Granite Pond

In the giant granite area, a pond that is larger than the boundary pond is also found. Figure 9 shows a pond is formed on leucogranite rocks. The study was conducted during the beginning of the rainy season, when it was seen that the pool water looked clear. The depth of water is estimated to be mostly more than 2 m. Some walls of the pond are leucogranite rocks, while others are alluvium which is dominated by large boulder.

3.1.6 Stepped waterfall

The next area is named the stepped waterfall area (Figure 10), a complex area that presents very beautiful scenery. The entire area is composed of leucogranite rocks. Walking upstream we will first find a clear pool, this pool has a depth of more than 2 m. There are 11 steps of small waterfalls above this pool that flow in the middle of the river. In addition there is another uniqueness in this area, on the rock surface can be found many large pothole drilling between 1m to 2m. At the other end, a pond that is bigger than all the previous ponds can be found.

3.1.7 Waterfall

Elongated shaped waterfall with a height of about 5m is found here where the constituent rocks are leucogranite rocks. On the side of the waterfall there is also a relatively flat plain. The entire waterfall and lara area has a length of about 100 m with a width of about 35 m.

Based on scientific field observations, all geosites described above actually have values between 0.5 and 1 in the geomorphosite score according to Kubalikova. Not all geosite Renyok River is perfect, there are also some sites that have been damaged by human activities including Lata Renyok. However, in general the area of Renyok River has a rare geosite, with its own uniqueness.

For learning in the field of Geology, this area is very good especially with regard to the subject of Geomorphology and Petrology. All geosites are exposed openly with low levels of weathering, so it is very easy to give examples in explaining to students about the shape of rocks and geological processes that occur in the area. During this time the Universiti Malaysia Kelantan (UMK) has done several excursions for geoscience students.

So far, the local government has been working on several facilities for tourists such as parking buildings and information centers. The population around the area is high but it is clear that it is not involved in supporting the existence of this area as a tourist attraction. Based on field observations, there has been no real and serious business effort from the local government in developing economic potential in the tourist area on the Renyok River.

Some part of the Renyok River area is within the Mount Basor Protection Forest. The efforts made by the government in protecting the region from human intervention that can damage the environment of Renyok River are still well guarded. Efforts to expand and develop oil palm and sap fields are still the biggest threat to the Renyok River area. The data and information collected have not indicated the existence of a specific law regarding conservation efforts in relation to the existence of the area.

The Renyok River area certainly has high ecological value. Most of the area is still counted as virgin forest with a variety of biodiversity including some endemic plants which become the environment for wild animals such as elephants, tigers, pangolins, etc. In the social survey conducted, it is known that the local community feels very dependent on Renyok River Based on data analysis that refers to Kubalikova [1], a total score of 75% was obtained. These results indicate that in general the area of Renyok River has high potential to be developed into a tourist area. Inadequate scores can all be refined so that a score of 100% can be achieved (Table 2).

Table 2. Scientific and intrinsic values by Kubalikova (2013)

SCIENTIFIC AND INTRINSIC VALUES		Kubalikova's Score	Sungai Renyok Score (%)
Integrity	totally destroyed site,	0	
	0.5 - disturbed site, but with visible abiotic features,	0.5	0.5
	1 - site without any destruction	1	
rarity (number of similar sites)	0 - more than 5 sites,	0	
	0.5 - 2-5 similar sites,	0.5	
	1 - the only site within the area of interest	1	1
diversity (number of different partial features and processes within the geosite or geomorphosite)	0 - only one visible feature/processes,	0	
	0.5 - 2-4 visible features/processes,	0.5	1
	1 - more than 5 visible features/processes	1	
scientific knowledge	0 - unknown site,	0	
	0.5 - scientific papers on national level,	0.5	0.5
	1 - high knowledge of the site, monographic studies about	1	
		Total Score	75%
EDUCATIONAL VALUES			
representativeness and visibility/clarity of the features/processes	0 - low representativeness/clarity of the form and process,	0	
	0.5 - medium representativeness, especially for scientists,	0.5	1
	1 - high representativeness of the form and process	1	
exemplarity, pedagogical use	0 - very low exemplarity and pedagogical use of the form and process,	0	
	0.5 - existing exemplarity, but with limited pedagogical use,	0.5	1
	1 - high exemplarity and high potential for pedagogical use, geodidactics and geotourism	1	
existing educational products	0 - no products,	0	
	0.5 - leaflets, maps, web pages,	0.5	0
	1 - info panel, information at the site	1	
actual use of a site for educational purposes (excursions, guided tours)	0 - no educative use of the site,	0	
	0.5 - site as a part of specialized excursions (students),	0.5	0.5
	1 - guided tours for public	1	
		Total Score	62.5%
ECONOMICAL VALUES			
presence of tourist infrastructure	0 - more than 1000 m from the parking place,	0	
	0.5 - less than 1000 m from the parking place,	0.5	0.5
	1 - more than 1000 m from the stop of public transport	1	
presence of tourist infrastructure	0 - more than 10 km from the site existing tourist facilities,	0	
	0.5 - 5 – 10 km tourist facilities,	0.5	0.5
	1 - less than 5 km tourist facilities	1	
local products	0 - no local products related to a site,	0	
	0.5 - some products,	0.5	0
	1 - emblematic site for some local products	1	
		Total Score	33%

CONSERVATION VALUES		
actual threats and risks	0 - high both natural and atrophic risks,	0
	0.5 - existing risks that can disturb the site,	0.5
	1 - low risks and almost no threats	1
potential threats and risks	0 - high both natural and athrophic risks,	0
	0.5 - existing risks that can disturb the site,	0.5
	1 - low risks and almost no threats	1
current status of a site	0 - continuing destruction of the site,	0
	0.5 - the site destroyed, but now with management measures for avoid the destruction,	0.5
	1 - existing legislative protection (Natural monument)	1
legislative protection	0 - no legislative protection,	0
	0.5 - existing proposal for legislative protection,	0.5
	1 - existing legislative protection (Natural monument)	1
		Total Score
		87.5%
ADDED VALUES		
cultural values: presence of historical/archaeological/religious aspects related to the site	0 - no cultural features,	0
	0.5 - existing cultural features but without strong relation to abiotic features,	0.5
	1 - existing cultural features with the strong relations to	1
ecological values	0 - not important,	0
	0.5 - existing influence but not so important,	0.5
	1 - important influence of the geomorphologic feature on the site	1
		Total Score
		75%



Figure 5. Metasedimentary rock



Figure 7. Giant boulder



Figure 6. Boundary pool



Figure 8. Cave waterfall

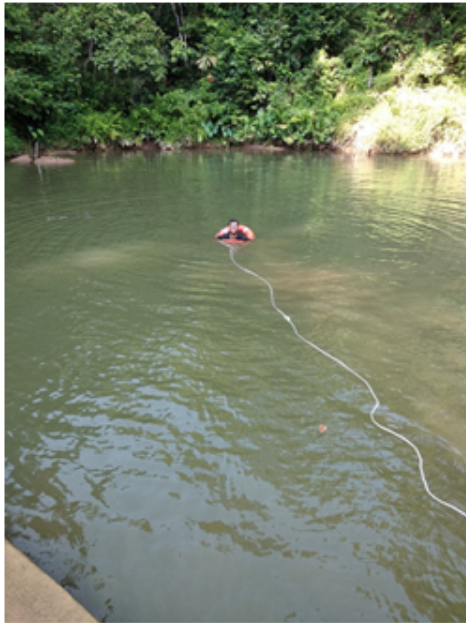


Figure 9. Granite pond



Figure 10. Stepped waterfall



Figure 11. Waterfall

4. Conclusion

Sungai Renyok dominated by leucogranit and metasediment where contact can be found in many places. Significant Landform of Sungai Renyok consist of, waterfalls, rapids, river bedform, big boulders, ponds, meandering rivers, and potholes drillings. The analysis shows that the Renyok River

geomorphosite value is quite high in all aspects assessed including Scientific and Intrinsic aspects (75%), educational (87.5%), conservation aspects (62.5%), and value added aspects (75%), only in economy aspects (33%) the value is low. Based on the results of field data analysis, it can be concluded that the Renyok River which obtained an overall score of 66.6% has sufficient potential to be developed as an object of geotourism.

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