



# Preliminary Study on the Potential Development of Kulon Progo Geoheritage Based on SWOT Analysis

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## ABSTRACT

Kulon Progo Regency is known to have unique geological conditions. This is proven by the establishment of five geoheritage areas in the region. The five areas are Suroloyo Peak-Kendil, Widosari Structural Remaining Hills, Eocene Nanggulan Formation, Kiskenda Cave, and Kliripan-Karangsari Mangan. This determination is based on the Decree of the Minister of Energy and Mineral Resources 13.K/HK.01/MEM.G/2021 concerning the Determination of the Geological Heritage (Geoheritage) of the Special Region of Yogyakarta. With this determination, the five Geoheritage areas need to be preserved. The sustainability of a site will be well maintained if the site can provide a positive social impact in the form of improving the community's economy and scientific repertoire. This study aims to determine the potential for developing the Geoheritage area in Kulon Progo, especially in terms of tourism prospects. The method used is data collection on general aspects and strategic issues regarding geoheritage governance in Kulon Progo. The analytical method used is the SWOT analysis approach. The results of the study show that the Geoheritage area can be developed into an edutourism and geotourism area. However, it is necessary to develop a systematic and directed program plan. The implication of this research is the development of a Road Map for the Development of the Geoheritage Area in the next 5 years.

**Keywords:** *Geoheritage, SWOT, Potential Development*

## 1. INTRODUCTION

Kulon Progo Regency is an area that has very interesting geological conditions and has great natural resource potential. This is evidenced by the designation of 5 geoheritage areas in the Kulon Progo region based on the Minister of Energy and Mineral Resources Decree Number 13.K/HK.1/MEM.G/2021 concerning the Determination of the Geological Heritage (Geoheritage) of the Special Region of Yogyakarta (Figure 1). The five geoheritage areas are:

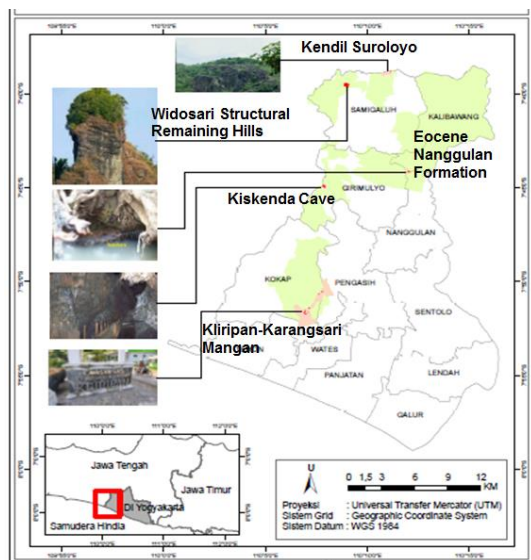
1. Peak of the Kendil – Suroloyo Ancient Caldera Cliff in Gerbosari Village, Kapanewon Samigaluh;
2. the Widosari Structural remaining hill in Ngargosari Village, Kapanewon Samigaluh;
3. Eosen Naggulan Formation in Banjararum Village, Kapanewon Kalibawang;

4. Kiskendo Cave in Jatimulyo Village, Kapanewon Girimulyo;
5. Kliripan – Karangsari Mangan Mining Hargorejo Village, Kapanewon Kokap.

The existence of the five geoheritage locations certainly needs to be protected, preserved and used for education in related fields of science. In order for conservation to work properly, the five geoheritage locations must be utilized by the local community as a source of the economy. This means that the determination of the geoheritage area must be able to have a positive impact on the surrounding community in particular and the district in general.

The term geoheritage was first introduced by Bradbury (1993) which means all aspects of the earth that can tell the history of the formation of the earth. Semeniuk (1998) redefined important geological features including igneous, metamorphic, sedimentary,

structural, geochemical, paleontological, geomorphic, pedological, or hydrological attributes that offer important information or insight into the formation or evolution of continents; or which can be used for research, teaching or reference sites. The Indonesian Ministry of Energy and Mineral Resources in the Minister of Energy and Mineral Resources no. 21 of



**Figure 1.** Geoheritage area in the Kulon Progo Regency area

Therefore, the management of the Geoheritage area must include protection, preservation, education, research and geotourism (Menteri ESDM, 2020). In this regard, it is necessary to conduct an initial study of the potential for development in the framework of preparing a geoheritage management plan in the Kulon Progo area.

## 2. FORMULATION OF THE PROBLEM

In order for protection, preservation, education, research and geotourism to be developed at geoheritage locations, an initial study is needed to determine the conditions of these geoheritage locations. Conditions that need to be understood include: 1) What is the geological condition in general?; 2) What is the condition of the facilities and infrastructure?; 3) What is the social condition of society.

An understanding of these three conditions is needed to design how to arrange the geoheritage area.

## 3. RESEARCH PURPOSES

This research is intended to collect data on conditions and situations around the geoheritage area, including geological conditions, facilities and infrastructure and socio-culture. This study aims to determine the

2020: defines geoheritage as geological diversity (Geodiversity) which has more value as an inheritance because it is a record of what has happened or is happening on earth because of its high scientific value, rare, unique and beautiful, so it can be used for research and education purposes earthly.

potential for developing the Geoheritage area in Kulon Progo, especially in terms of tourism prospects.

## 4. THEORITICAL REVIEW

Research on geoheritage has been carried out by several researchers. Bradbury (1993) conducted preliminary research into the presence of geoheritage sites in Tasmania. One of the results of his research is to propose the term geoheritage and provide a definition of the term. Geoheritage is here taken to mean those aspects of the Earth which are important to our understanding of Earth history. The nature of geoheritage sites which are akin to cultural heritage sites or documents, means that they are non-renewable resources.

The proposal for the meaning of geoheritage was also made by Dixon (1996). Geoheritage is mean components of natural geodiversity which are of significant value to humans for purposes which do not decrease their intrinsic or ecological values; such purposes may include scientific research, education, aesthetics and inspiration, cultural development and contribution to the sense of place experienced by human communities.

Research on geoheritage in Indonesia has begun to be carried out in several places. The Geoheritage proposal in the Yogyakarta area was first presented at an International Seminar in Yogyakarta in 2012 [4]. Propose regarding several locations in the Yogyakarta region that have the potential to be developed as geoheritage. A proposed geoheritage approach with a quantitative method has also been carried out, such as Sahara and Setiawan, (2022). The study was conducted at the Solok location and its surroundings.

## 5. RESEARCH METHODS

The research begins with the literature review method, to collect a number of secondary data and theories that can be used in this research. After the literature review, data collection on general conditions including geology, socio-culture and facilities and infrastructure was carried out. Data collection was carried out through field visits and questionnaires. The results of the data collection were then carried out by a SWOT analysis so that the positive and negative factors in each location were identified. Lastly, a synthesis was carried out to find out the potential that could be developed at geoheritage locations (Figure 2).

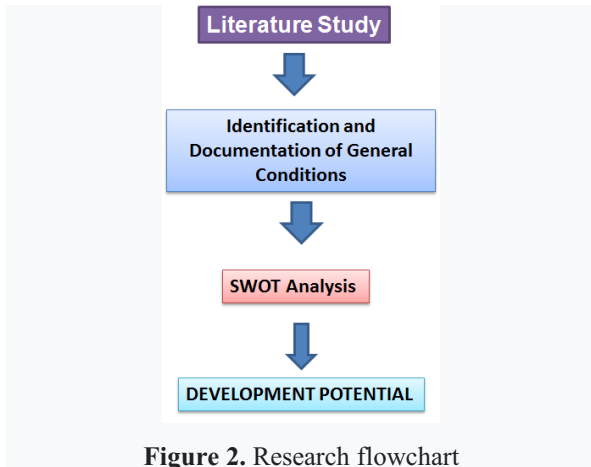


Figure 2. Research flowchart

## 6. RESULTS AND DISCUSSION

### 6.1. General Geology

Kulon Progo district is included in the South Serayu physiographic zone in the Kulon Progo Kubah sub-zone [6]. The Kulon Progo dome is unique because it has a north-south elongated pattern, which is different from the general pattern on the island of Java which extends west-east [7]. This elongated pattern is caused by the formation of ancient volcanic domes that shifted north-south (Figure 3). Starting from the formation of Mount Gajah in the center of the dome, then Mount Ijo in the south of the dome and finally Mount Menoreh in the north (Widagdo, dkk, 2019). Of the three volcanic activities, Gajah Mountain and Ijo Mountain are in Kulon Progo Regency, while Menoreh Mountain the center of the caldera, is in Magelang Regency.

Stratigraphic research in the Kulon Progo region has also been widely carried out. Pandita dan Hartono (2019) conduct research on the stratigraphic position of mollusk fossil discovery locations. Pandita et al., (2021), conducted studies on the relationship between volcanic processes and the formation of the Sentolo Formation. The complete stratigraphic sequences of Kulon Progo have been compiled by several researchers, such as Kadar, (1985); Rahardjo, et al., (1995); and van Bemmelen, (1949) are as follows:

The oldest formation in the Kulon Progo Dome is the Nanggulan Formation which is estimated to be Middle Eocene. Unconformably above the Nanggulan Formation, the Old Andesite Formation is deposited, which is a series of volcanic evolution. After the Old Andesite Formation was deposited the Jonggrangan Formation unconformably in the middle of the Kulon Progo Dome. Harmonious and fingering the Sentolo Formation is formed on top of the Jonggrangan Formation. The rock formations were then partially covered unconformably by Quaternary volcanic deposits (Figure 4).

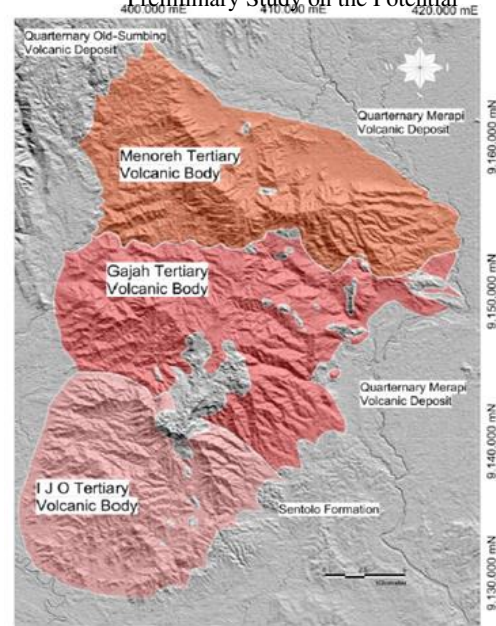


Figure 3. Physiographic map of the Kulon Progo dome (Widagdo, et al, 2019)

MASA / ERA	ZAMAN	KALA	Bemmelen (1949)	Kadar (1985)	Rahardjo, dkk. (1995)	
	KENOZOIKUM	Kwartir		Volkanik Kwartir	Volkanik Kwartir	Volkanik Kwartir
Tersier		Pliosen				
		Miosen		Fm. Sentolo	Fm. Sentolo Angg. Tj. Gunung Angg. Gunung Angg. Karanganyar	Fm. Sentolo
				Fm. Jonggrangan	Fm. Jonggrangan	Fm. Jonggrangan
		Oligosen		Fm. Andesit Tua	Fm. Andesit Tua	Fm. Kebo-Butak
Eosen		Fm. Nanggulan	Angg. Seputih Fm. Nanggulan	Fm. Nanggulan		

Fig 4. Regional Stratigraphy from many author

### 6.2. General Condition of Geoheritage Site

1). The Peak of Kendil-Suroloyo Ancient Caldera is located in the northern part of Kulon Progo district, bordering Magelang regency. Geologically, it is a cliff from the ancient caldera of Mount Menoreh. The incised volcano is thought to have formed approximately 12 million years ago (Widagdo, et al., 2019). The geological uniqueness of this location lies in the natural scenery that can be reached from the top of the cliff. Past volcanic processes are clearly well recorded. In the north of the cliff, the morphology of the dome is clearly visible, so it can be a good learning process (Figure 5).



Fig 5. Natural scenery north of Kendil Peak, it's show the remains of the ancient caldera and the ancient lava dome on the north side.

The condition of facilities and infrastructure at the Kendil Peak location is still very minimal, but at the Suroloyo peak there are several public facilities. The condition of the access road to the location can be passed by mini bus vehicles with a passenger capacity of 15-25 passengers. However, the condition of the road is prone to landslides.

The socio-cultural conditions around Kendil-Suroloyo Peak are closely related to the name Suroloyo itself. The name Suroloyo is related to the palace where the gods live in wayang mythology. This place has also been used by the community for religious rituals, because there are offerings placed in one of the viewing posts. The placement of the Punokawan statues draws closer to the cultural meaning of wayang for this Puncak Kendil-Suroloyo site.

2) *Widosari Structural Remaining Hills* is an isolated hill that is higher than its surroundings. This hill is bounded by vertical cliffs resulting from erosion of joint areas and faults (Figure 6). The Widosari Hills are the remnants of the rocks from the Menoreh ancient volcano. It is composed of closed packed breccia with intercalated tuff of gravel and layered sandstone. The upper part of the Widosari hill is composed of breccia and gravel tuff. Estimated rock position  $N325^{\circ}E/25^{\circ}$ . Regionally, this rock is included in the Old Andesite Formation group. Based on the variation of the rock that developed, it is possible that it is the proximal-medial part of the Menoreh ancient volcano, this is based on the slope of the rock which tends to the southwest.

Conditions of facilities and infrastructure are available, but still minimal. Parking lots and access roads are still through private land owned by residents. The location can only be reached by private vehicle, because the road width is not sufficient + 3m.



Fig 6. Widosari Structural Remaining Hills

The location of Widosari Hill is close to the Nglinggo tea plantation which has become a tourist destination, as well as other tourist locations. The viewing post facility on Widosari Hill offers quite a beautiful view, with cool air. The peak name Widosari has no special meaning. Located near the Widosari Peak location is the village of Widosari which has various traditions. These traditions include dance, shadow puppets and the traditional arts of Bangilan and Lengger Tapeng. In addition, there are still Kenduri and Merti Desa traditions. Widosari villagers also have the ability in culinary offerings in the form of Widosari Roasted Tea, Coffee, Enting-enting Ginger, Geblek, Palm Sugar. In addition, there are handicrafts in the form of written batik, stamped batik, gradation batik, sandals made of corn chips, carved kentongan, wooden masks, and leather puppets. Near the Widosari Peak location, there are tea plantations.

3) *Eocene Nanggulan Formation* is one of four Eocene outcrops on the island of Java [6]. So the Nanggulan Formation which is located in the Kalibawang area is worthy of being a Geoheritage location. The Nanggulan Formation is composed of quartz sand, claystone, silt and coal (Figure 7A). This location is also one of the biostratigraphic Mollusk levels [6].

The location is along the Kali Songgo river, with surrounding morphology in the form of rice fields. The river is frequently flooded and has a high erosion rate. Access to see the outcrop is still very limited, it can only be traversed on foot. Public facilities are not specifically available. Near the location is ITNY's field campus, and it has often been the place for field lectures from various universities (Figure 7B).



Fig. 7: A) Ones of Eocene Nanggulan outcrop at Kalisonggo river's; B) Field Camp of ITNY at Banjararum Village, near Eocene Nanggulan outcrop

4) *Kiskenda Cave* is a natural cave formed in a Karst landscape. This karst landscape results from the karstification process in the Jonggrangan Formation. The location of Jonggrangan Village and its surroundings is in a young karst stage, which is characterized by the formation of underground caves and rivers. The phenomenon of geological natural disasters that occur around the cave is an avalanche on the north side of the cave. The occurrence of this landslide indicates the potential for sink holes which are common in karst areas.

The facilities available at this geoheritage location are quite complete, because they have been developed since 2005. Several facilities such as parking lots can accommodate small buses (15-25 passengers). In addition, there is an amphitheater which is used for Sugriwa-Subali ballet performances (8A). The stairs and entrance to the cave have been repaired (B). The road to the location is adequate, although large buses (> 40 passengers) cannot pass due to the many uphill bends.



Fig. 8: Facilities in Kiskenda Cave: A) Revitalization of the amphitheater; B) Stairs into Cave.

5) *Mangan Kliripan-Karangsari* is a former manganese mining location, in the form of underground mining. Based on the regional geological map, the former mining location is in the Sentolo Formation, which is in the form of clastic limestones. The presence of manganese in this formation is the result of a sedimentation process, and is found in the form of nodules and layers [13]. The rock conditions found are layered limestone with moderately weathered conditions on the surface (Figure 9). The Sentolo Formation at this location has an unconformity overlying with the Old Andesite Formation.

The facilities available at this geoheritage location are complete, but currently several renovations have been carried out. The access road to several holes is still a dirt road that can be passed by private cars. Some of the remaining mining buildings can be reached by private vehicles, located near the main road.



Figure 9. A) Location of the mining cave entrance being renovated; B) The outcrop condition of the Sentolo Formation is strongly weathered.

### 6.3. SWOT Analysis

Analysis was carried out on the results of identification of geological conditions and general conditions. The method used in the analysis of general conditions and strategic issues is SWOT analysis, namely: Strengths, Weaknesses, Opportunities and Threats.

1) *Strengths*. The five geoheritage locations each have different geological characteristics. Some of the strengths that can be relied upon in the development of geoheritage areas can be described as follows.

1. Three geoheritage locations, namely Kendil-Suralaya Peak, Widosari Structural Remaining hills and Kiskenda Cave have very good views and are liked by tourists. Nice scenery accompanied by its geological meaning is a good combination to be sold as a natural and educational tourism object.
2. Two locations is good for learning about mining-geology there are Eocene Nanggulan and Kliripan-Karangsari Mangan .
3. The Kulon Progo region has a variety of indigenous cultures and also handicraft products, some of which have been exported overseas.

2) *Weakness*. The five geoheritage locations each have different problems for their development. Weaknesses recorded from field survey data are as follows

1. The access road to the location is one of the deficiencies in the four locations.
2. Four locations, except Kiskenda Cave, do not yet have adequate facilities, such as food kafe, toilets, parking lots and playing place.
3. Kiskenda Cave and Puncak Kendil-Suroloyo are directly adjacent to other districts, it needs cooperation between local governments for their development.

3) *Opportunity*. Even though they have a number of weaknesses, the five geoheritage locations still have opportunities to be further developed. Some of the opportunities that can be developed are as follows.

1. The five locations have the same opportunities to become geotourism locations, both in terms of educational tourism or to enjoy the beauty of nature. In general, compared to one of the other geoheritage locations in DIY, such as the Breksi Cliff, the Kendil-Suralaya Peak, Kiskenda and Widosari Caves have

more charm of natural beauty and also knowledge of geology.

2. The Kulon Progo area has become an interesting location for learning the evolution of volcanoes and also field lectures. This condition allows geoheritage in Kulon Progo to be further developed into a natural laboratory or geopark.
  - 4) *Threat*. As a Geoheritage area, the main goal is to conserve the area. Threats to this conservation process are more in natural conditions and also in society
1. Natural disaster conditions such as landslides can occur at the five geoheritage locations.
2. The threat of conflict of interest within the community, given the status of land ownership. So that the status of land ownership needs to be resolved before planning the development of the area is carried out.

#### 6.4. Discussion

The five geoheritage locations in Kulon Progo have a number of feasible potentials to be developed into geoparks in the future. Starting from the oldest rocks which are rare because they are Eocene old for Java, the evolution of ancient volcanoes, karst natural phenomena and underground mines. However, the five locations have several obstacles ranging from locations that are difficult to visit, access that still passes through private land, and the threat of natural disasters.

Based on the SWOT analysis, it appears that there is a lot of added value that can be utilized by the existence of the Geoheritage site in Kulon Progo. As the main purpose of establishing a geoheritage area is to make the area protected, it is necessary to have a well-planned management. Currently, governance still overlaps between the Department of Tourism and the Office of Education and Culture.

Governance conditions that do not involve the community can be a separate obstacle. Therefore, it is necessary to realize community participation in the management of the Geoheritage area. This needs to be done because most of the land around the geoheritage area is owned by individuals and used as their livelihood. Locations such as in Widosari where the entrance is through the residents' yard shows the need for cooperation between managers and residents. Until the FGD was held there was no agreement on the use of the land, this is a separate problem that must also be resolved.

#### CONCLUSION

The five geoheritages locations have great opportunities to be developed as educational tourism and geo-tourism areas. This is because of the uniqueness and beautiful natural scenery, which has attracted a number of tourists to visit.

The growth of local culture, such as naming places in wayang legends, will attract cultural tourists to visit these locations.

The development of the geoheritage location into a tourist area will be able to help improve the economic conditions of the local community. Conservation programs will be able to run in harmony with the economic benefits of geoheritage sites.

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