Ecotourism Potential of Batu Gelap Cave, Kutai Kartanegara, East Kalimantan

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Abstract. Batu Gelap cave located in Suka Maju Village, Tenggarong Seberang District, Kutai Kartanegara Regency. Batu Gelap Cave is geologically included in Pulau Balang Formation, which is deposited in the transition environment or Back Barrier. Deformation that occurs in the Middle-Miocene of the geological structure of folding and faulting. Geomorphology of the study area can be divided into four kinds of (1) Landform are mountainshomocline or origin (S1), (2) Hilly landforms homocline (S2), (3) Landforms swamp(F1) and, (4) Alluvial landforms (F2). The height of the area between 25 - 125 mdpl, slope 20-40%. The lithology in the area are fossiliferous limestones, packstone - grainstone, crystalline carbonate, and packstone with clay inserts. There are stalactites, stalagmites, and underground rivers with various conditions in the cave. In some parts of Batu Gelap Cave area, there is a historical relic site that has historical past. A good understanding of the geological and historical potential of Batu Gelap Cave area makes this area has a unique appeal in the development of tourism-based area.

1. Introduction

Ecotourism is one of the tourism activities that are environmentally sound by prioritizing aspects of nature conservation, aspects of empowerment of the socio-cultural economy of the local community and aspects of learning and education [1–3].

Kutai Kartanegara which has an area of 27,263.10 Km² or 2,726,310 Ha (12.89%) of the province of East Kalimantan has tourism potential that is suitable for sale to both domestic and foreign tourists. This is supported by a historical review that the Kutai kingdom as the oldest Hindu kingdom in Indonesia in addition to the quantity of tourism that can be offered to tourists [2]. One potential area is the Batu Gelap cave tour which is located in the Tenggarong area opposite Kutai Kartangara, East Kalimantan, precisely located in Sukamaju Village (Figure 1) [1,4,5].

Identification related to Batu Gelap cave tourism potential can be identified through several aspects. These aspects are included in the identification of ecotourism; tightened geodiversity, biodiversity, and heritage in one area[3,6–8].

Geological aspects identify characteristics of rock types arranged in Batu Gelap Hill. Whereas in terms of tourism aspects, it will refer to the Minister of Home Affairs regulation No. 33 of 2009 concerning Guidelines for the Development of Ecotourism in the Regions, stated that the principle of ecotourism is the suitability of the types and characteristics of ecotourism, conservation, economics,
education, satisfaction and experience to visitors, community participation, and accommodate local wisdom[9,10].

Figure 1. Batugelap cave Research Location

2. Data and Method
To obtain the data needed in this study there are several steps that must be carried out, namely the first stage is to conduct a field study. Field study developed to get geological data and historical data of Batu Gelap cave[8] [11]. Geological data needed are geomorphology, lithology and cave interior data [12][13][14]. Which are Geomorphological data to get surface aspects in the form of landscape data. Lithology data is the data obtained to find out the characteristic data of rocks that develop Batu Gelap cave. Interior cave data to get the geometry characters in the cave. The Batu Gelap cave historical heritage can be done by obtaining information to the local community.

3. Result and Discussion

3.1. Geology Data
Geomorphology of Batu Gelap cave area can be discussed by looking at aspects of morphology and morphogenesis. Batu Gelap landform might divide as (1) Landform are mountains homocline or origin (S1), (2) Hilly landforms homocline (S2), (3) Landforms swamp(F1) and, (4) Alluvial landforms (F2). The highest elevation in the area is 80 meters above sea level. The form of hill’s topography that is not continuous can be analyzed that there are differences in lithology (Figure 2). Batu Gelap cave hills have a continuous pattern with a southwest - northeast direction parallel to the surrounding hills.

Figure 2. Morphological landscape of Batu Gelap cave and surrounding
The morphogenesis aspects divided into 2 (two) things, as condition of assistance and geological structure. Rocks composing Batu Gelap Hill is boundstone limestone. Whereas based on the geological structure of the region, Batu Gelap Hill is in the anticline structure of the Separi[8].

**Figure 3.** Outcrop of (a) mudsupported limestone, (b) sandy limestone, (c) boundstone

Lithology The rock compiler of the study area is a type of non-clastic sedimentary rock, part of limestone intercalation in Pulau Balang formation (Middle Miocene). The main constituent is boundstone limestone with intercalation of fossilized limestone, crystalline limestone, mud supported limestone, dolomitic limestone and sandy limestone. Boundstone occurred as yellowish white limestone with massive structure. The mineral composition is calcium carbonate.

The interior of Batu Gelap caves are different, depends on the surrounding lithology, geological process, humidity, geohydrology, vegetation surroundings. As cave complex, there is lots of mouth-cave with some connected caves. There are 3 interiors in the cave, as stalactites, stalagmites and pillars.

3.2. Cave Accessibility
Batu Gelap Cave is approximately 40 km from Samarinda to north-northwest, passing Samarinda – Sebulu main road. After the main road, the road to location consist of cemented road available for two cars and change to one car passing only near end-road, on approximate 1100 meters distance from main road. The road to cave complex location continued with total 1700 meter soil road track counter clockwise back to parking area. The tracks consist of undulating sandy mudstone hill, limestone hill with occasional flat colluvium surrounding hills.
Tracks might divide into two tracks: “Barat” track and “Timur” track. “Barat” means west, concerning track’s position on west side of the limestone hill. “Barat” track is approximately 810 meter. 5 caves would be seen on this track, with easy to moderate track difficulties, available for family track. “Timur” means east, concerning track’s position on east side of the limestone hill. “Timur” track is approximately 700 meter. 17 caves would be seen on this track, with moderate to advance track difficulties, suitable for outdoor enthusiast. Both “Barat” and “Timur” track would finish the track on the Cliff Corridor, south-part of “Timur” Track. “Timur” track might continue the track by passing “Barat” track on the way back to parking area.

3.2.1. “Barat” Track

“Barat” track would pass 5 caves. From 5 caves, 4 caves are in good conditions and available to be entered with some conditions. 1 corridor exist after fifth cave on “Timur” track, give alternative landscape of tight two-sides limestone cliff along hundred meters with some trees stand on the cliffs. **Cave B01**, Cave located at E 508382, S 9973897. Two connected mouth-caves exist in the area with 6 meter distance. Mouth-cave dimensions are 2.2 meter x 1 meter. Limestone bedding occurred with N 192° E/ 62°. Interested spot in the area is vertical hole inside the cave. **Cave B02**, Cave located at E 508355, S 9973783. Mouth-cave dimensions are 0.50 meter x 0.5 meter and surrounded by vegetation. **Cave B03**, Cave located at E 508357, S 9973760. Two connected mouth-caves exist in the area with 2.2 meter distance. Mouth-cave dimensions are 0.50 meter x 0.6 meter of equal size. **Cave B04**, Cave located at E 508249, S 9973358. Two mouth-caves exist in the area; one with V-shape, wider mouth at cave bottom. The caves acted as water resources as river outflow come out of the cave. The river’s width is 0.5 – 1 meter and recently used for rice-field irrigation around the area. **Cave B05**, Cave located at E 508230, S 9973246. Two caves, connected with approximate length 20 meter and up to 4 meter high. Palm trees planted in front of the cave. 20 meters from the cave, abandoned river exist as Gunam Alam River with approximate width 2 meter. The area told to be civilized in the past as village but none of the remain still exist today. The caves are connected with body of water overlaid the cave floor.
3.2.2. “Timur” Track

“Timur” track would pass 14 caves with various conditions. 1 corridor exist on the end of the track, give alternative landscape of tight two-sides limestone cliff along hundred meters with some trees stand on the cliffs. **Cave T01**, Cave located at E 508387, S 9973774. Interbedded limestone outside the cave available to be seen. The cave have approximate length 2.5 meter with 0.9 meter high. Tight stalactites occurred inside the cave with the 0.20 – 0.60 meter long. **Cave T02**, Cave located at E 508389, S 9973726. Two caves in one location. First mouth-cave is interbedded limestone outside the cave available to be seen. The cave has approximate length 5 meter with 1.2 meter high. Tight stalactites occurred inside the cave with 0.20 – 0.60 meter long. Second mouth-cave has approximate 0.5 m x 2 m mouth-cave. The cave is kind of undercut cliff. **Cave T03**, Cave located at E 508383, S 9973710, with approximate 0.5 m x 1.5 m mouth-cave and 1 m depth. **Cave T04**, Cave located at E 508382, S 9973657, two caves with approximate 0.7 m x 1.5 m mouth-caves. **Cave T05**, Cave located at E 508381, S 9973601, with approximate 2 m x 2 m mouth-cave. **Cave T06**, Cave located at E 508374, S 9973565, with approximate 0.25 m x 0.5 m mouth-cave. Around the cave, local subsidence occurred, of probably cracked-caving zone in subsurface. **Cave T07**, Cave located at E 508345, S 9973551, with approximate 4 m x 4 m mouth-cave and more than 4 meter depth. Occasional stalactites occurred, facing wet muddy cave floor covered with body of water. 

**Figure 5.** Cave B05, (a) mouth-cave with palm tree, (b) connected mouth-cave with water body on the cave floor

**Figure 6.** (a) mouth-cave of T08,(b) mouth-cave of vertical cave T09

**Cave T08**, Cave located at E 508359, S 9973505, with approximate 10 m x 5 m mouth-cave and more than 4 meter depth. Occasional stalactites occurred. Access to the cave need to be managed carefully as still covered with bush and small trees, with elevated topography down to cave-mouth and occasional subsidences. **Cave T09**, Cave located at E 508344, S 9973450, vertical cave, with approximate 0.8 m wide x 10 m long as mouth-cave and more than 4 meter depth. The cave covered with body of water at cave-floor. The bats use the cave as their nest. Occasional strong odor of guano contained H2S gas around mouth-cave should be aware by visitor. **Cave T10**, Cave located at E 508344, S 9973413, vertical cave, with approximate 1.2 m wide x 15 m long as mouth-cave and more than 5 meter depth. The cave used by bats for living. Strong odor of guano contained H2S gas around mouth-cave should be aware by visitor. **Cave T11**, Cave located at E 508335, S 9973398, as passing-cave to connect corridor Cave T09 & T10 with cave T12 at the south-west part. The cave has V-shape with wider part at lower part. The cave has 1.4 m high at eastern part and 1.9 m high at western part with approximate tunnel length 10 m. **Cave T12**, Cave located at E 508326, S 9973374, with...
approximate 1.5 m x 0.5 m mouth-cave and more than 2 meter depth. Cave T13, Cave located E 508306, S 9973349, with approximate 0.5 m wide and more than 2 meter high for mouth-cave. The cave covered with tree roots around the mouth-cave. The cave named “Aula Putri” (Princess Hall) by local people, more than 10 m² room with stalactite-stalagmites ornament inside. Several stalactite-stalagmites already become connected pillars. Cave T14, Cave located E 508302, S 9973316, with two mouth-caves in one location, of approximate 20 meter distance. First cave is approximate 5 m above ground level, available to be entered by stairs. The cave has approximate 1.8 m x 2 m mouth-cave. Second cave has approximate 3.5 m x 1.2 m mouth-cave and 2 meter depth. Limestone boulders occurred inside the cave. Joint occurred as 34 / N 40 E.

![Figure 7](image1)

**Figure 7.** (a) mouth-cave of T13, (b) interior cave T13 with occurrence of stalactites & pillar

![Figure 8](image2)

**Figure 8.** Cliff Corridor (a) snapped tree roots on the cliff, (b) interbedded limestone along the corridor

3.2.3. **Cliff Corridor**

The corridor azimuth is NNE-SSW (N 192° E). The corridor path is on approximate length 116 meter from T14 to the south open space. The corridor width is 220-280 cm with wider area overhead. Approximate cliff height is 12-15 meter. Joint occurred and measured as 40/ N 305 E. The visitor might observe different kind of limestone deposition phase; joints affected the area, and various vegetations along the corridor. Several tree roots snapped on the cliff.

3.3. **Biodiversity Of Batu Gelap**

The karst ecosystem holds a very high potential for biodiversity, both outside and inside the cave. Several studies in the karst area showed quite interesting findings with many new types and new records found. Until now the caves in Indonesia occupied high biodiversity wealth in the tropics (Deharveng and Bedos 2000).
The karst area contains a lot of interesting and unique flora and fauna wealth. Because of the dry karst environment conditions, some types of flora must be able to adapt to high drought conditions in the dry season besides that, high calcium content also requires all types of flora and fauna to adapt to the karst environment.

Until now the data on karst biodiversity in East Kalimantan is still not well documented. This is a challenge because the rate of damage and destruction of the karst ecosystem in East Kalimantan continues to increase, especially with mining and other exploitation activities, both in karst and around the karst area. One of the karst ecosystems in East Kalimantan and vulnerable to disturbances, one of which is the Batu Gelap Cave in Kutai Kartanegara Regency. In addition to storing high biodiversity potential, Batu Gelap is also a reservoir of water used by the surrounding population to meet their daily needs.

In general, biodiversity in the Batu Gelap area has similarities to cave ecosystems elsewhere in Kalimantan. Some types of flora such as orchids, ferns, palms and pandanus are common types that grow on the outer karst cliffs. Some of them are endemic species found only in Kalimantan. Banyan trees (Ficus sp.) Grow in the upper part of the karst with a long root system that penetrates the cracks of the karst rock to reach the source of water and nutrients. In addition to banyan trees, the most common species around the Batu Gelap Cave include: Gliricida sepium (reside), Mangifera sp. (mangga-manggaan), Pterospermum javanicum (bayur), Cananga odorata (kenanga), Nephelium sp. (rambutan hutan), Octomeles sumatrana (binuang male), Alstonia scholaris (pulai), Neonauclea sp., Mallotus sp., Dillenia excelsa (simpur), Peronema canescens (sungkai), Vitex pubescens (laban) and Dracontomelon dao (sengkuang). In this area also found some Ulin trees (Eusideroxylon zwageri) which have been cut down by the community to use the wood.

From the observations in the field, the fauna that lives in the Batu Gelap Cave area include: bats, several species of birds, snakes, various kinds of insects, snails and according to local residents there are also long-tailed monkeys. Fauna from arthropod groups, book animals, dominate the environment in the cave. Fauna in the karst region have important ecological functions. Therefore if it is disturbed it will have an impact on other ecosystems. Insectivorous bats have a role to control pest insects that have the potential to harm agriculture. Whereas fruit-eating bats have the role of spreading seeds as well as helping pollinate various types of plants with high economic value.

![Figure 9. Several biodiversity around Batu Gelap (a) Mallotus miquelianus, (b) Octomeles sumatrana (binuang laki)](image)

3.4. Heritage Of Batu Gelap

Batu Gelap area was villages but have been left by the communities. The water supported from river existed around the caves. One abandoned river, Gunam Alam river, already covered with bushes, located around cave B05. Some artifacts in the form of jars said to be occurred in the caves but none still remain inside the caves. Local legend exists in the area, as Gunam, citizen of old villages, receive God’s anger as using wrong accessories, stingray’s tail, while doing ceremony Erau Benua. The villages cursed to be stones, become Batu Gelap Cave area.

4. Conclusions

With accessibility that is close to the community, the existence of the Batu Gelap Cave karst ecosystem is currently very threatened. Some of these threats include: Limestone and Guano mining.
Forest changes in the karst area become agricultural and plantation land. Pollution of water sources by community agricultural and plantation activities. Tourism activities that is less friendly to the karst and cave environment. Protection and preservation of the karst cave area in Batu Gelap Cave has several strategic values, in the form of: Economic value, related to agriculture, forestry, mining, water management and tourism. Scientific value, related to geology, biology, archeology and paleontology. The value of humanity, relating to beauty, recreation, education, spiritual and religious elements or beliefs.

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