



Sustainable Tourism Study on the Role of Ecology in the Karst Area of Kalisuci Cave

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Abstract. Kalisuci Cave has a landscape form in the form of karst areas formed from limestone. Limestone hills in Kalisuci Cave have varying heights formed due to the process of erosion and dissolution of limestone rocks for millions of years. Limestone dissolved by rainwater causes the appearance of unique and beautiful stalactites and stalagmites in the cave. In the cave area there are various biotic and abiotic components that interact with each other. The uniqueness of the cave and underground river flow in Kalisuci Cave makes this area a tourist attraction. The organization of this tourist spot brings economic benefits to the surrounding community and saves the surrounding environment. The popularity of Kalisuci Cave tourism is increasing along with the development of nature tourism in Yogyakarta which makes it one of the main destinations for local and foreign tourists to enjoy unique natural attractions in this area. The purpose of this research is to study the role of ecology in the karst area of Kalisuci Cave towards sustainable tourism. The methods used in this research are field observations, interviews, documentation, and filling out questionnaires..

Keywords: Sustainable Tourism, Ecology, Karst, Kalisuci Cave.

1 Introduction

In Yogyakarta, Gunungkidul is dominated by karst rock landscapes. The landscape in Gunungkidul is called the best in Indonesia because it has a beautiful and unique charm. This area has limestone cliffs caves beaches and underground rivers that are made into famous tourist attractions because of their charming natural panorama. Karst area itself is a geological protected area that has a function as a water storage area. Karst itself acts as a carbon dioxide absorber that occurs due to the dissolution of limestone. According to research the karst area here is the result of the uplift of the seabed that occurred millions of years ago. Judging from the results of the meeting of various fossils of ancient marine animals in the hilly areas of Gunungkidul.

The uplift process that occurred in the area has metamorphosed into organic sedimentary rocks, namely limestone and dolomite rocks. There are not too many groundwater aquifers in the karst area because the soil material in the form of limestone

does not have the ability to store water well, so rainwater will quickly escape to the bottom. This process is unique to the karst area because at the bottom of the karst develops into underground rivers that become a source of groundwater for the local community [5].

One of the famous tourist attractions in the Gunungkidul area is the Kalisuci Cave tour located in Pacarejo Village, Semanu District, Gunungkidul Regency, Yogyakarta. The GPS coordinates of Kalisuci Cave are -8.0038 latitude and 110.6494 longitude. The distance from the city center of Yogyakarta to this area is about 50 km to the southeast. The journey to the location of the cave can be reached by using transportation, such as cars, buses, and motorbikes. The route to this area is from Yogyakarta through the main road to Playen, towards Semanu [1]. The uniqueness of the ecosystem in the cave is an attraction for many people in terms of science and tourism. The karst area in this tour has unique characteristics compared to other areas, because at the time of the formation of morphology under the karst surface occurs during the process of dissolution and karstification. In the Kalisuci Cave area, it is also known as an underground river that is decorated by stalactites and stalagmites that adorn the sides of the cave. The development of tourist caves in Kalisuci Cave is a tourism industry developed in karst areas [14].

The existence of uncontrolled tourism activities can damage the fragile cave ecosystem in the Kalisuci Cave area. To overcome this, it is necessary to have an in-depth understanding of the role of cave ecology to support conservation efforts and sustainable tourism development later. Sustainable tourism in Goa involves efforts to maintain a balance between tourism development and preservation of the surrounding environment [2]. In order for efforts to develop the tourism sector to be successful, it is necessary to involve the local government and also the community around the area. Aspects that can be done in sustainable tourism such as conservation of the environment in maintaining the cleanliness of the cave, educating tourists regarding the importance of protecting the environment, conducting waste management, and establishing rules for managing tourist areas.

2 Research methods

2.1 Type of Research

This research uses a qualitative approach with a description method. Using description research aims to make descriptions systematic factual and accurate descriptions of the facts properties and relationships between the phenomena being investigated. The research was conducted using field observations and literature studies based on theories relevant to the problems found. References obtained can be through books, scientific articles, theses, research reports, and research results. The result of this data collection is the connection to relevant references to strengthen the theoretical basis for research design.

2.2 Data Collection

This research uses primary data and secondary data. Primary data is obtained from field observations and explanations from the supervisor, while secondary data in this research is obtained through literature studies such as scientific articles, books, research results and previous research reports that are in accordance with the research concept. In the preparation of this research, the author took the object of research on Kalisuci Cave tourism located in Gunungkidul, Yogyakarta by using the following methods:

a. Field Observation

Observation is a data collection method carried out by directly observing the object under study. By seeing and taking the data needed from the location of the object of research. Observation is carried out at the location of the Kalisuci Cave tourist attraction.

b. Interview

Interview is a data collection technique that is carried out directly face-to-face directly with the source, by asking several questions related to the research topic. Interviews were conducted with the local community and the supervisor.

c. Documentation

Documentation is a data collection technique by looking directly at related research objects. Documentation was conducted at the Kalisuci Cave location by taking photos and videos.

d. Questionnaire

Questionnaire is a data collection technique that is carried out by observing the behavior, conditions, and appearances that are currently taking place at the research location.

3 Results and Discussion

3.1 Characteristics of Karst Area in Kalisuci Cave

Kalisuci Cave is located in Pacarejo Village, Semanu District, Gunungkidul Regency, Yogyakarta Special Region. Topographically, the Kalisuci Cave area has several characteristics. The Kalisuci Cave area is a karst area formed from Neogene-aged limestone. This limestone is easily dissolved by rainwater, forming caves and underground rivers. The dissolution process of this limestone has resulted in a variety of unique topographical forms [6].

The limestone hills around Kalisuci Cave vary in height from 200 to 300 meters above sea level. These hills were formed due to the process of erosion and dissolution of limestone rocks over millions of years. Kalisuci Cave is one of many caves found in the karst area of Gunungkidul. The cave is about 750 meters long, 5 to 10 meters wide, and 5 to 15 meters high. Inside the cave there are various beautiful cave ornaments, such as stalactites, stalagmites and flowstone. The underground river in Kalisuci Cave has clear and fresh water. The river flows through the cave and comes out in several springs, one of which is Kalisuci Cave.

The Kalisuci Cave area has a hilly topography with several valleys around it. These hills were formed due to the process of erosion and dissolution of limestone rocks. The valleys between these hills are usually drained by small rivers. Vegetation in the Kalisuci Cave area is dominated by teak forest (*Tectona grandis*). In addition, there are also several other types of trees such as rubber trees (*Hevea brasiliensis*), coconut trees (*Cocos nucifera*), and bamboo trees (*Bambusa* sp.). These forests play an important role in preserving the environment and water sources in the Kalisuci Cave area. The soil in the Kalisuci Cave area is generally of the limestone type. This soil has a fine texture and is easily eroded. This soil condition needs to be considered in the management of the Kalisuci Cave tourism area to avoid environmental damage.

3.2 Ecosystem Condition of Kalisuci Cave Yogyakarta

Kalisuci Cave has a complex and unique ecosystem. These ecosystems are formed and adapted to the dark, humid, and minimal oxygen conditions of the cave environment. The components of Kalisuci Cave consist of various biotic and abiotic components that interact with each other. In the biotic component, there are several types of plants in the cave that adapt to low light conditions, such as fungi, mosses, and ferns. These plants play an important role in filtering the air and producing oxygen. The fauna in Kalisuci Cave is dominated by nocturnal animals, such as bats, cave shrimp, and cave fish. These animals have special adaptations to live in caves, such as eyes that are sensitive to low light and echolocation abilities in bats [4]. In addition, there are also various types of microorganisms, such as bacteria and fungi. These microorganisms play an important role in the decomposition of organic matter and the recycling of nutrients.

In the abiotic component, limestone is the main component of the cave and is a source of minerals for cave organisms. Water in Kalisuci Cave comes from rainwater that seeps into the ground and comes out in cave springs. This water is a habitat for various types of aquatic organisms. The air in the cave is generally humid and lacks oxygen. This is due to the lack of air ventilation in the cave. The biotic and abiotic components of Kalisuci Cave interact with each other to form a balanced ecosystem.

The ecosystem of Kalisuci Cave Yogyakarta also has threats, such as water and air pollution due to human activities that can damage the balance of the cave ecosystem. Irresponsible visitor activities can disrupt the habitat and balance of the cave ecosystem [12]. As well as climate change that can cause changes in temperature and humidity in the cave, thus affecting cave organisms [8].

However, this can still be done with ecosystem conservation efforts at Kalisuci Cave to maintain natural balance and protect biodiversity. Some things that need to be understood are like visitor management that needs to be done to minimize negative impacts on the cave ecosystem. Increased education and public awareness about the importance of maintaining the cave ecosystem needs to be done. Research on cave ecosystems needs to be carried out to understand more about the interactions between biotic and abiotic components and the impact of various external factors. In addition, law enforcement against activities that can damage cave ecosystems needs to be carried out [7].

3.3 Impact of Tourism in Kalisuci Cave on the Environment

Tourism activities have a significant relationship to environmental quality. Various activities that occur have positive and negative impacts on tourism in the karst area environment which is fragile and difficult to recover. Based on secondary data, there is an identification of impacts caused both positive (beneficial) and negative (detrimental) to the environment in the karst area in Kalisuci Cave. Given that the case study is in Kalisuci Cave, the importance of management related to the environment of the caves in the tourist attraction. This is why it is necessary to examine several cases related to managing cave tourism abroad for tourism purposes. As for Indonesia itself, there are still many that have not been managed in accordance with conservation principles and cave management principles [15].

In developing and managing caves, it can pay attention to the principles of cave management to minimize the negative impact caused to the cave environment in the Kalisuci Cave tourist attraction. As for the guides and infrastructure in supporting the local ecosystem in Kalisuci Cave, it is very important, so it is necessary to increase the supervision function of tourists. In addition, tourists in exploring the cave get the application of the code of ethics from guides and instructors. This reduces the negative impact on the cave environment from tourist activities that can be prevented, making the realization of sustainable tourism management at the Kalisuci Cave tourist attraction.

3.4 Conservation Strategy for Kalisuci Cave

Karst ecosystems have an important contribution in maintaining ecological balance in the surrounding area. Where the ecological balance has a good impact on the local community[13]. In karst areas, the largest mineral resource is carbonate rock, which is usually used as building material, carbide, and decorative stone. Areas in karst areas, especially valley areas, can be planted with dryland annual crops or rain-fed rice fields. This area is also very suitable for planting teak trees and some agricultural commodities. The aquifers in the karst rocks cause water sources in the karst area to be located in underground rivers, springs, doline lakes, and underground river estuaries, where the water can be utilized by the local community. The landscape in the karst area has a very high beauty and uniqueness both on the surface and below the surface of the karst area. To maintain the existing ecological balance, we need to make sustainable conservation efforts implemented by all parties.

One of the factors that determine success in the development of the tourism sector is the involvement of local/village governments, religious leaders, and the surrounding community. The existence of natural tourism will certainly have positive and negative impacts. Therefore, it is necessary for the government, religious leaders, and the community to play a role in it. Developing sustainable village tourism will have a significant impact, such as economic impact on employment and increased community income, social impact on increased competence and expertise possessed by local residents, and environmental impact in increasing the quantity and quality of the

environment for the local community [11]. According to Law No. 5 of 1990, Article 1 point 2, conservation of biological natural resources is the management of biological natural resources whose utilization is carried out wisely to ensure the sustainability of its supply while maintaining and improving the quality of its diversity and value [10].

In general, Kalisuci Cave tourism has an economic impact on the surrounding population and the environment. However, if Kalisuci Cave tourism is not balanced by environmental conservation, it will have a negative impact on the surrounding environment. This is why conservation efforts are needed for the Kalisuci Cave tourism area to continue to protect biodiversity and sustainability of tourist attractions [9]. Some conservation efforts that can be done, including: a) Visitor management, by limiting visitors who enter the cave at the same time is an effort to avoid the formation of excessive crowds and minimize the negative impact on the environment. Visitor management itself can be done by imposing restrictions on ticket purchases in one day. b) Environmental information, providing environmental education programs to increase the sense of awareness of tourism visitors in the importance of maintaining cleanliness and caring for the surrounding nature. This can be done by providing educational tours that convey information about the Kalisuci Cave ecosystem and convey information about the importance of environmental conservation activities. c) Waste management facilities, the tourism sector provides adequate waste management facilities for visitors such as trash bins, waste collection bins, waste recycling programs to reduce the amount of waste that is thrown carelessly at the cave location. d) Water management, both from the local government and from the management of tourist attractions always monitor and maintain the quality of water in the cave and also the rivers that are around and still related to the river in the cave. By routinely testing river water every few months, to prevent water pollution from surrounding industrial or domestic waste, and also to reduce the use of chemicals that can potentially pollute the surrounding water. e) Protecting flora and fauna habitats, the village / local government can issue a policy for the area around cave tourism prohibited from development [3]. This is to maintain the authenticity of the environment and reduce the disturbance of species that live in the location of Kalisuci Cave. This can be done by issuing policies to establish conservation areas, strengthening environmental protection laws, and monitoring the flora and fauna around the location. By implementing the above conservation efforts, it is hoped that it can realize a sustainable tourist environment in Kalisuci Cave so that it remains a beautiful and sustainable tourist destination for generations to come.

4 Conclusion

The Kalisuci Cave area is a karst area formed from limestone rocks dissolved by rainwater. This cave has a complex and unique ecosystem, but the cave ecosystem has several threats such as water and air pollution due to human activities and irresponsible visitor activities such as littering. If these threats are left unchecked, they will disrupt

the habitat and balance of the cave ecosystem. Therefore, it is necessary to take action from these threats to be minimized by striving to preserve the ecosystem, such as visitor management, increasing education, and socialization activities for the local community on the importance of maintaining environmental balance. Kalisuci Cave holds valuable ecological wealth that plays a role in maintaining the balance and sustainability of the cave ecosystem. As a natural water reservoir that can be utilized by the surrounding community during the dry season.

References

1. Diahwahyuningtyas, A. (2022, June 9). Cave Tubing in Kalisuci Cave: Routes, Location, Prices, and Vacation Tips. *IDN Times Jogja*.
2. Jauhari, A. (2016, August). Strategic Value of Karst as an Area that Needs to be Protected.
3. Lesmana, T., & Sulandjari, K. (2023). Empowering Local Communities in Environmental Conservation: A Review of Collaborative Projects, Sustainability, and Decision Making. *Jurnal Multidisiplin West Science*, 2(09), 808–818.
4. Maknun, D. (2017). Ecology: Population, Community, Ecosystem, Realizing a Green, Natural, Islamic and Scientific Campus.
5. Permatasari, A. Z. (2018). Potential and Conservation of Groundwater Resources in Karst Areas in Gunungkidul Regency, Yogyakarta Special Region.
6. Pratiwi, I. M. (2021). Geoconservation in the Function of Protection and Utilization of Karst Ecosystem of Mount Sewu. *Jurnal Rekayasa Lingkungan*, 21(1).
7. Purmadi, R. M., Santika, D. M. J., & Wulandari, A. S. (2020). The Importance of Conservation Education to Preserve the Environment (Case Study in Cidahu Village, Kuningan Regency). *Jurnal Pusat Inovasi Masyarakat Juni*, 2(4), 602–606.
8. Purnomo & Heri, D. S. (2016). Resort and Training Adventure at Kalisuci Cave Tourism Geosite Ecological Architecture Concept by Responding to Site and Local Materials.
9. Purwanto, P., Haryanti, N., & Raharja, S. A. S. (2020). Marketing Mix and Visitor Behavior of Special Interest Tourism at Kali Suci Caving and Tubing Tourism Objects. *Jurnal Ilmu Lingkungan*, 18(3), 467–475.
10. Samed. (2021). Biodiversity Conservation in Indonesia: Recommendations for Improving the Conservation Law. *Jurnal Hukum Lingkungan Indonesia*, 2(2), 1–28.
11. Sukaris, S., Kurniawan, A., & Kurniawan, Moh. D. (2023). Sustainable Village Tourism Development Strategy. *Jurnal Manajerial*, 10(01), 17.
12. Suprayogi, S., Cahyadi, A., & Agniy, R. F. (2016). Urgency of Karst Area Management of Pindul Cave, Karangmojo District, Gunungkidul. In *Hidrologi*

- dan Kepariwisataaan Kawasan Karst Goa Pindul Kabupaten Gunungkidul (pp. 1–9). OSF.
13. Tyas, D. N., Vitdiawati, R., & Nusantari, R. (2016). Conservation and sustainable utilization of Gunung Sewu karst area as part of geopark to maintain ecological function. *Symbion (Symposium on Biology Education): Proceeding, Departemen of Biology Universitas Ahmad Dahlan*, 311–324.
 14. Wijaya, A. P. (n.d.). Urgency of Karst Hydrological Characteristics Analysis in Geotourism Development in Kalisuci, Gunungkidul. *Departemen Geografi Lingkungan Fakultas Geografi Universitas Gadjah Mada*.
 15. Willyanto, M. I. (2012). Partnership in the Management of KaliSuci Karst Special Interest Tourism Object (Study on Sustainable Development of Karst Areas). 1–231.

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