

Research article

Use of Karst Caves in Malang Regency and the Possible Challenges to Their Existence

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Abstract.

The karst landscape is in the southern part of Malang Regency. In this area, separate phenomena can be seen on the surface (*eksokarst*) and subsurface (*endokarst*). The *eksokarst* landscape is indicated by an arid/dry area; meanwhile the *endokarst* landscape is indicated by the presence of caves. This study aimed to understand the use of the karst caves by the people in Malang Regency, the existing potential inside the cave passages, and the future challenges to their utilization. The study used field observation along the cave sites. Based on the data obtained, the caves in the Malang area are used to obtain clean water from the subterranean rivers, as well as for religious purposes, and as cultural heritage sites for educative tourism. Caves also play an important role in carbon gas absorption. However, many caves have not been optimally utilized by the Malang people. The possible challenges which will be faced in developing cave tourism are as follows: visitor activities in sensitive areas that lead to cave damage; a lack of awareness about the existence of certain high-potential caves, which require skilled researchers to identify; and cave tourist attraction development that raises environmental concerns.

Keywords: karst, caves, utilization, existence

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Published: 12 October 2022

Publishing services provided by Knowledge E

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Selection and Peer-review under the responsibility of the ICGE 2021 Conference Committee.

1. Introduction

Karst landscapes are generally areas constructed of limestone. The characteristics of this landscape are different from other landscapes. The karst landscape is constructed by the dominant process of the dissolution that shapes *eksokarst* and *endokarst* [1]. The *eksokarst* landscape is identically indicated by arid/dry area; but naturally has great potential for *endokarst* related to the existence of caves and subterranean rivers.

Caves have natural spaces that are difficult for humans to access. In general, cave spaces are dark, damp, muddy, steep, and rocky. These conditions cause difficulties in accessing the cave. However, currently there are many caves that have been utilized by the people or institutions. One of the caves utilizations is as a tourism object, for example tourism object attractions of Pindul Cave and Kalisuci Cave in Gunung Kidul Regency, Gong Cave and Tabuhan Cave in Pacitan Regency, Maharani Cave in

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Lamongan Regency, Akbar Cave in Tuban Regency and so on. Beside, caves are also used to meet the needs of clean water, such as the Bribin Cave in Gunung Kidul Regency and as pre-historic dwelling place such as Song Terus Cave in Pacitan Regency.

Malang Regency has the appearance of karst caves in the southern part. This can be seen from the results of an inventory of endokarst features in Malang Regency, which has found 134 caves carried out during 2012-2018 [2]; [3]; [4]; [5]; [6]. The caves are scattered in various sub-districts in the southern part of Malang Regency (Figure 1). The caves in Malang Regency were formed in the past where the results of the formation process can be seen up to now. The existence of caves in Malang Regency has various passages characteristics, such as vertical, horizontal, or a combination of the two passages [6]. In addition, some caves in Malang Regency also have subterranean rivers [7] and interesting cave ornaments [6].

Various potentials that exist in the cave can certainly be utilized by the people. This is because the karst area is an area that is prone to drought, so that caves that have underground potential can be used to meet the needs of clean water for the people. In addition, the cave which has a wide and long hallway accompanied by interesting cave ornaments can be used as a tourist attraction. This of course can improve the regional economy. Thus, the purpose of this study is to identify the use of karst caves in Malang Regency by the surrounding people and analyze the potential that exists in the cave passages in Malang Regency.

2. Method

This research was conducted by doing survey and field observation. Surveys were carried out to measure the length, width, height, and slope of the cave passages and using the cave mapping method [8]; [9]. While observations were made to see the existing conditions in the people related to the use of karst caves in Malang Regency. Based on the results of the field survey, the cave was designed using software to produce a cave mapping. The data analysis used is descriptive qualitative to identify the utilization of the cave by the people and to analyze the potential inside the cave passage in Malang regency.

2. Results and Discussion

2.1. Cave Conditions in Malang Regency

Caves have spaces that can be identified by doing a cave observation. In addition, caves in Malang Regency were also mapped, based on the physical condition of the

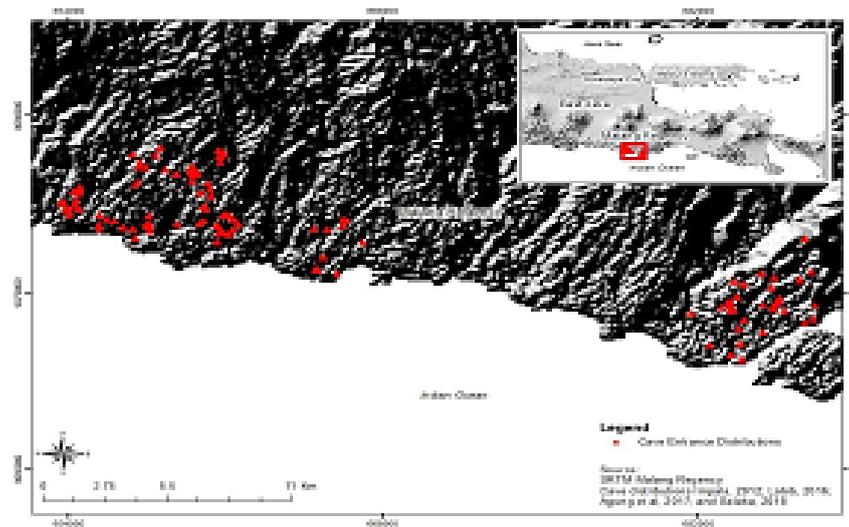


Figure 1: Karst Caves Mapping in Malang Regency.

cave, such as the length, width, height, and slope of the cave passage. The result of the cave mapping (Figure 2) shows the plane view of the physical condition of the cave in Malang Regency. The cave passages in Malang Regency have vertical passages, so it will be difficult to conduct an observation if you do not have the ability to descend the cave. Caves that have long passageways generally have a combination of vertical and horizontal passages such as Bagus-Jebrot Cave, Rampal Cave, Kedung Pitu Cave, Limbah Cave and others. So those who can access the cave are people who able to explore the cave, due to the difficult area. Besides, the results of the observation of caves in Malang regency also show natural spaces consisting of sedimentation of mud or clay, small rocks or boulders, cave ornaments on walls, roofs, and soil, permanent and seasonal subterranean rivers, and habitation of cave flora and fauna.

2.2. Utilization of Caves in Malang Regency

The cave that is formed and exposed to the surface causes an interaction between nature and the local people around the cave. The existence of karst caves has been found in several areas in Malang Regency. Several caves among those which have been found in Malang Regency have been utilized directly by the local people. The utilization of the cave is intended as a source of clean water and a tourist attraction (Figure 3). One of the utilizations of water sources by the local people is taken place at the outlet system of the Bagus-Jebrot Cave, where the water that comes through the entrance of the cave is taken by the local people for daily needs and irrigation.

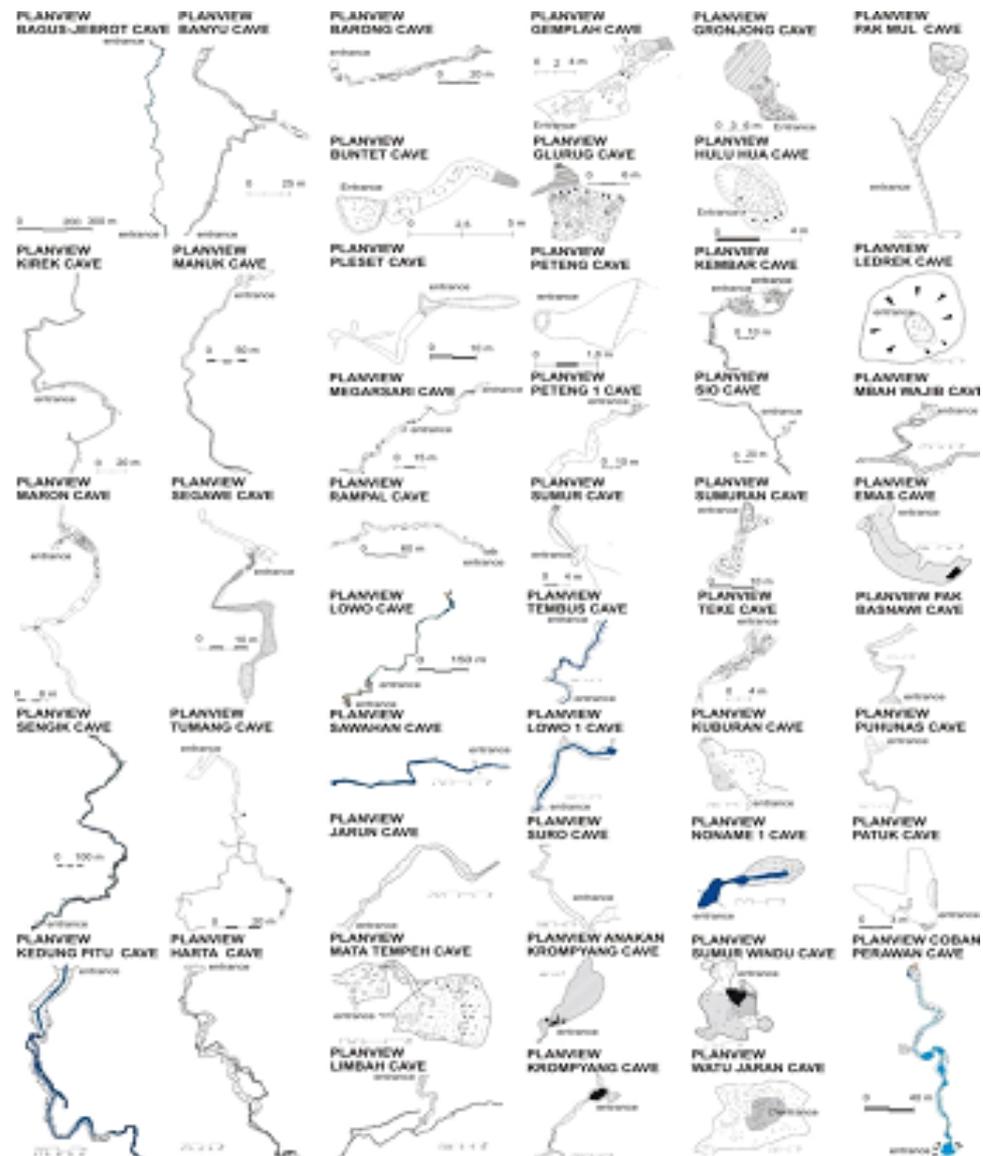


Figure 2: Plane View the Caves in Malang Regency.

The utilization of caves also occurs in the Coban Perawan Cave. During the rainy season the water that comes through the entrance of the Coban Perawan cave will come out to the surface and be used for the local people agricultural irrigation. The utilization of water in the Coban Perawan Cave is carried out by lifting it from an subterranean river. Figure 3b shows a pipe connected to a water reservoir and distributed to the local people. In addition, the use of water by damming subterranean rivers occurs in Sengik Cave. The dammed water is then piped to be channeled to the coastal area of Jonggring Salaka Beach by utilizing the gravity system. Meanwhile, the existence of water sources in the Malang Regency caves and still not being used is very much, such as: Mbah Wajib Cave, Krompyang Cave, Kedung Pitu Cave, Emas Cave, Limbah Cave, Banyu Cave, Kembar Caves, Kirek Cave, Sio Cave , Rampal Caves, Manuk Caves, Gronjong

Caves, Segawe Caves, and Lowo Caves. The caves that have seasonal subterranean rivers include: Harta Cave, No-name 1 Cave, Suro Cave, Jarun Cave, Sawahan Cave, Lowo Cave, and Puhunas Cave; while the Sumur Windhu Cave has salty water because it is close to the sea.



Figure 3: Utilization of Subterranean rivers for People Needs and Tourism Objects.

Some of the karst caves in Malang Regency are also used as tourist attractions, such as the Coban Perawan Cave, Sengik Cave, and Payung Cave. In the coastal area, there are also cave tours such as the Cina Cave located in Sitarjo Village and Patuk Cave located on the coast of Ngliyep. These caves have a horizontal cave characterization. The tours offered in the cave are the existence of interesting cave ornaments such as the Sengik Cave and Payung Cave, as well as the waterfall in the Coban Perawan Cave, and religious tourism in the Cina Cave and Patok Cave.

Coban Perawan Cave is a cave that has been managed to be used as a tourist attraction caves. When entering the Coban Perawan Cave, Personal Protective Equipment such as helmets, buoys, flashlights, and boots are required. When entering this cave, visitors will first swim to get into the cave, considering the water that comes out of the entrance of the cave, is accommodated in the area around the cave entrance. The length of the Coban Perawan Cave is approximately 242 m with the condition of this cave being watery. In addition, there are also water basins in several cave passages. There is a narrow passage of Coban Perawan Cave, but only a few meters. At the end of the Coban Perawan Cave, there is an entrance or avent connected to the surface. Avent is a surface water flow so that if there is surface water flow it will enter the cave

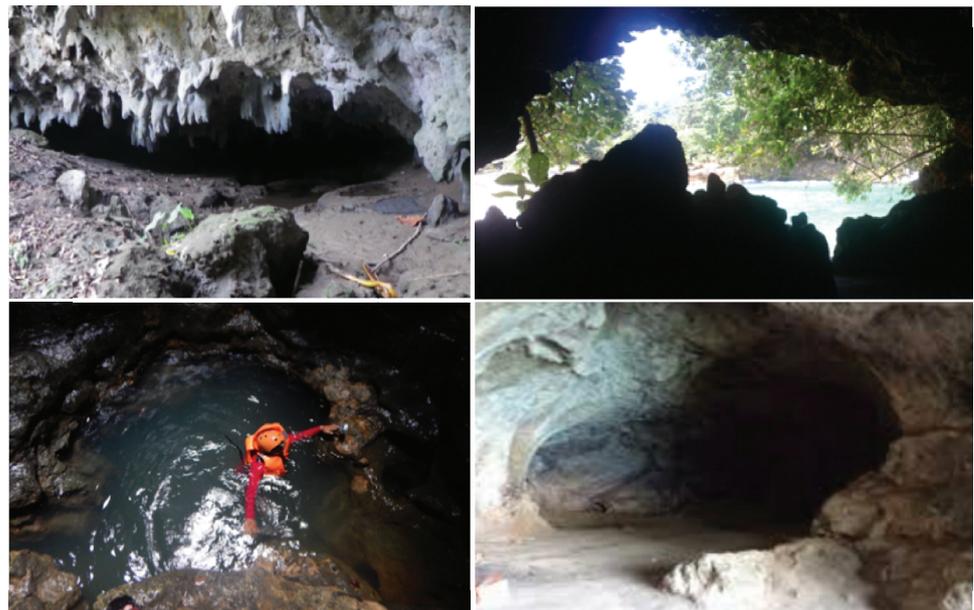


Figure 4: Cave Tourism Objects in Malang Regency.

into a waterfall. The waterfall is an attraction for tourists to visit the Coban Perawan Cave.

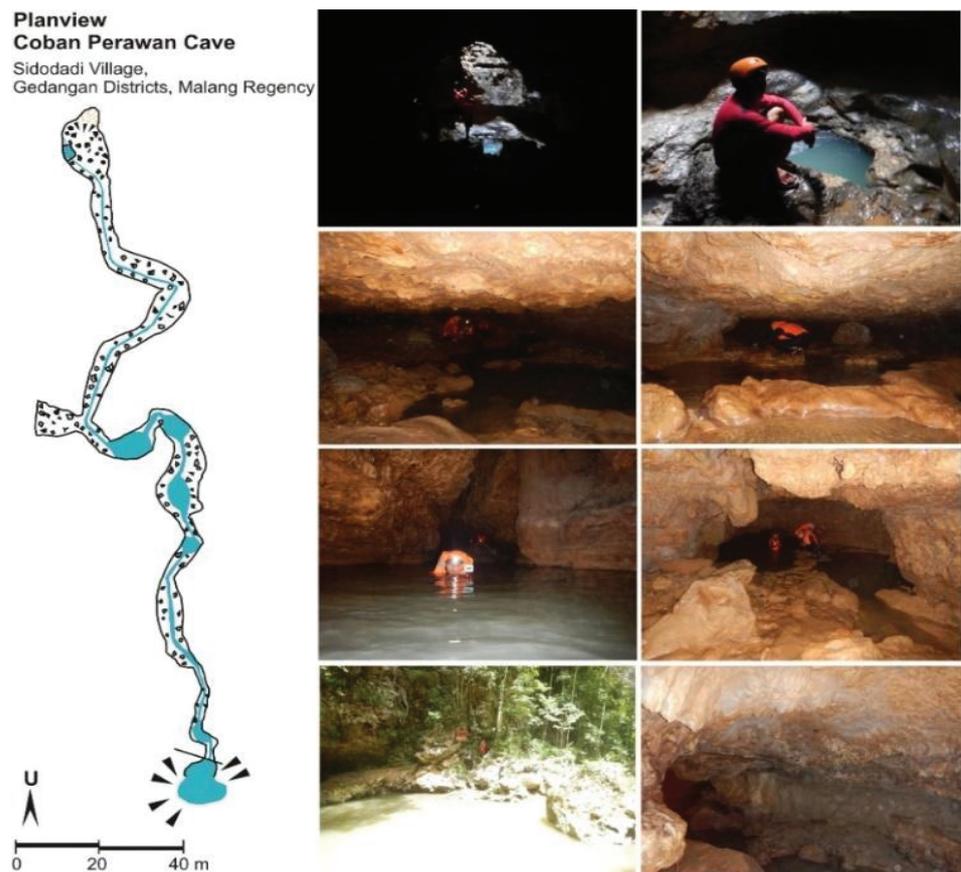


Figure 5: Map and Condition of the Coban Perawan Cave.

In coastal areas, cave tourism is used as a tourist attraction in the form of a niche with a minimal length of cave passage. Ornaments and subterranean river are not as well developed as in the Patuk Cave (Figure 6), and the cave is not connected to other cave systems. Due to the narrow passage, it cannot accommodate many people. The utilization of this cave tourist attraction has also been partially modified. Modifications can be made on the access road to the cave or on the cave passage. In addition, the modification is indicated by the presence of decorations such as lamps and other artificial ornaments, which are placed in the cave to add to the attraction and beauty of the cave passage. Modifications related to access roads to caves such as in Cina Cave and Patuk Cave, while the lighting of the cave passage can be seen in Cina Cave and Payung Cave.

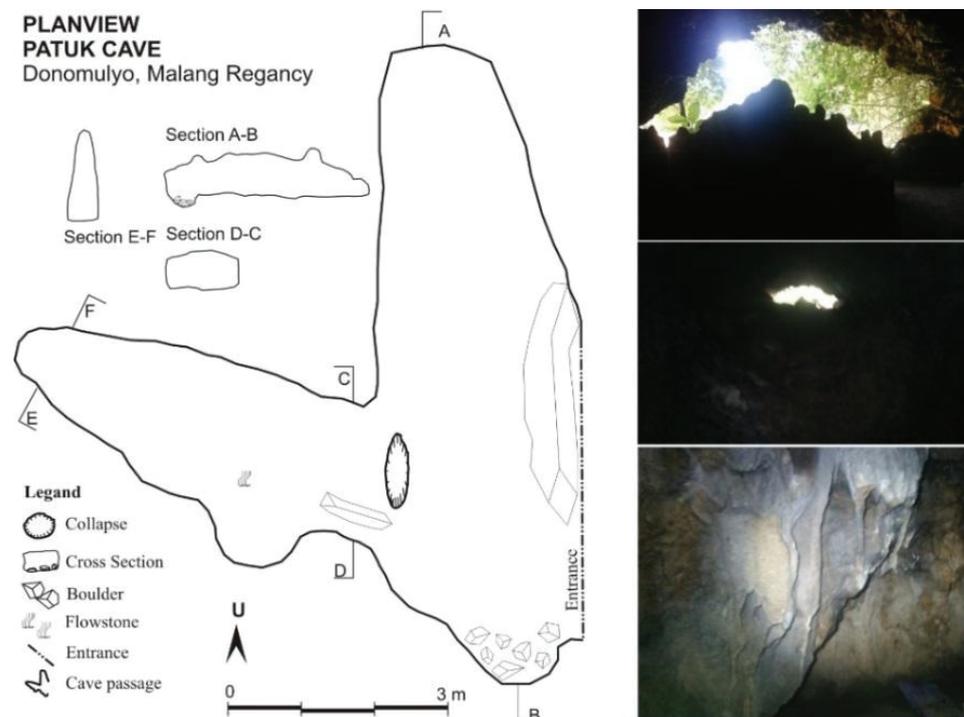


Figure 6: Map and condition of Patuk Cave in the Coastal Area.

Utilization related to cave dwellings in the past has never been seen in Malang Regency. Cave dwellings can be seen in the Song Cave, Song Gupuh, Song Keplek, Braholo Caves which hold history in the past in the Gunung Sewu Karst [10] in the northern part of Java karst there is Kidang Cave in Blora Regency, it was found that there was human habitation with shells found both as artifacts and food scraps, bones and teeth of hunting animals, fireplaces, human skeletons of cave dwellers [11]. The existence of dwelling caves in ancient time, allows this to happen in caves in Malang Regency, but this has not been found.

Other utilization is related to the industry that comes from limestone, which will damage the environment or the condition of the cave. Limestone mining that occurs in Malang Regency is considered to be small mining, but it does not stop the possibility to be the bigger one, based on the fact of the wide distribution of limestone in Malang Regency. Therefore, data collection activities must be carried out quickly so that the caves that have high potential can be protected by the cave ecosystem.

The easier access to the cave in the southern part of Malang Regency leads to the growth and extending of new lands. The caves will be exposed to the surface either through dredging or illegal logging. People will utilize the resources around them. In addition, the caves which located in the southern part of Malang Regency which is known as a coastal tourism area, will probably be opened in order to make a new path that connect the caves and the coast. For example, Coban Perawan Cave and the Cina Cave which are the main marine tourism in Malang Regency. Indeed, the increasing of cave tourism services must be balanced with the knowledge and abilities of the surrounding people in the future.

These uses are of course due to the interaction between human and the environment around the cave. However, in the cave passages also provide services for human such as an important role in absorbing carbon dioxide through the karst process [12]. Caves have the value and ecosystem role as subsurface biodiversity, culture, and subterranean rivers [13]. The diversity of cave fauna can help pollination carried out by several animals, while in a humid cave entrance environment will grow various kinds of plants that can be used by the people. The cultural role of the cave as a dwelling in the past, besides that the cave is used as an *edu-tourism* that provides various aesthetics and knowledge in the cave. Caves offer water source that flow through cave passages that can be used to fulfill human needs.

2.3. The Possible Challenges of the Caves Existence

The utilization of karst caves is currently still relatively low. The caves that have been used for tourism are as follows Cina Cave, Payung Cave, Coban Cave, while other caves can be categorized as special attraction tourism objects. The current potential of the cave is related to the interesting decoration of the cave passage in the form of cave ornaments. Caves in Malang Regency that have interesting cave ornaments but have not been used as tourist objects are Harta Caves and Lowo Caves. Harta Cave is located in Sumbermanjing Wetan District, and Lowo Cave is located in Donomulyo District. Of

course, the utilization of cave tourism must concern to the conditions and environment of the cave. This is because the cave has an environment that is vulnerable to damage.

Tourist activities that can cause cave damage include the opening of entrance to the passage, surface erosion due to the use of ladders and ropes, sediment compaction, vandalism and graffiti, entry of other energy sources from food residues, entry of human waste that causes water pollution [14]. In addition, the activities of the people around the cave can also cause damage to the cave. The following is one of the impact of human activities around the caves; the damage caused by the disposal of garbage and household waste around the cave entrance or in the cave passage. It causes water pollution in the cave [6]; [7]. This is certainly a threat as well as a challenge for the people and tourism managers in utilizing the cave as a tourist attraction. Tourism managers need to arrange a regulation to limit the cave visitors' activities in order to maintain the conditions and environment of the cave.

Public awareness about the existence of caves that have high potential should be increased. Many potential caves are damaged either by ornament damage or water pollution (Figure 7). Both tourists and the people should be aware of the importance of keeping the environment around the caves to be as it should be because the lack of awareness will lead to the massive and more serious problems. This is a challenge for the Ministry of Tourism and Creative Economy of Indonesia, for the tourism agent and managers, the surrounding people, and also tourists by utilizing the potential of caves around Malang Regency by paying attention to the principles of sustainability.



Figure 7: Vandalism, Garbage, and Pollution in Several Caves.

Another challenge is the need of special skills in tourism managing. Those special skills include the skill of tracing caves, knot-tying, operating the special equipment needed. Besides, the tourism management who develop the tourism object should pay attention to the environment and ensure the continuity; for example, providing the high efficiency lighting around the caves, tidying the cables in order to make it invisible so as not to damage the caves, and make temporary path made of solid plastic or stainless steel instead of permanent materials [15]. The interpretation of cave tourism should be more focus on education than entertainment. This is because caves have potential in the increase of the science literacy as well as the relation between human activities and caves.

3. Conclusions

Some of the caves in Malang Regency have been used to meet water needs of the people and as a tourism attraction, both religious tourism and special attraction tourism objects. However, there are still many caves in Malang Regency that have potential and have not been used optimally. The awareness of the surrounding people about the existence of high potential caves also needs to be increased, because the cave has an environment that is vulnerable to damage. This is a challenge and responsibility of the government, tourism managers, and the surrounding people who utilize caves to meet their water needs in daily life and irrigation as well as a tourism attraction, both religious tourism and special attraction tourism objects. Industrial activities in the form of mining, pollution, landfills, and vandalism by humans are things that will damage the cave ecosystem, considering that caves have an important role in carbon sequestration, as cultural heritage, as a source of water, and help pollination through fauna that live in the cave.

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