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Research Article

Disaster Management for Geopark-Based Tourism in Yogyakarta, Indonesia

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Abstract.
Yogyakarta in Indonesia is on the south flank of the Merapi Volcano and is bordered by the Southern Mountain, West Progo Mountain, and the Indian Ocean. Many geological and archaeological phenomena are found here, making geological and cultural diversity part of the wealth of Yogyakarta. One of these was Hindu-Buddhis temples developed during the 8th-10th century that were buried by volcanic materials dated between 1910 y BP and 2010 AD and resulted in cracks, wavy paleosols, liquefactions, and bumpy buildings. The catastrophe eruption of 4 VEI in October 2010 and the earthquake with 6,2R on May 27th, 2006, took thousands of lives. Apart from the disastrous effects, the natural disasters built unique geodiversity with education and utilization potentials. Using the values of education, conservation, early warning, utilization, uniqueness, and the improvements of the economic community developments, 15 geoheritages have been appointed, to be an Aspiring Jogja Geopark. This paper aimed to assess qualitatively and quantitatively whether the geological, biological, and cultural diversities can be prepared. The method used was questionnaires filled by visitors, local people, academicians, local tourist managers, small and medium enterprises (UMK), and micro small and medium enterprises (UMKM). The data was processed using RapidMiner software for clustering. The results discovered that people around the 15 destinations did not know about the Aspiring Jogja Geopark, but the academicians, local governments, POKDARWIS (local tourist managers), and the UMK and UMKM knew. Because of their limited knowledge, the local people were unaware of the park. However, they were surprised and enthusiastic about the geopark. Visitors very happy and proud of it. The community had been waiting for a geopark. It is a symbol of the unity of Yogyakarta's people and the ruler, an embodiment of the slogan of "life in harmony with disasters", and the optimisation of the geoheritage's utilization to improve the local economy.

Keywords: disaster management, geopark tourism, Yogyakarta

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1. Introduction

A total of 20 geoheritage sites have been determined by the Ministry of Energy and Mineral Resources of the Republic of Indonesia in the Yogyakarta Special Region (DIY) during 2020-2021; 5 of them have already been included in the Gunung Sewu Global Geopark. This was followed by the regulation of the Governor of DIY No. 40 of 2021 regarding its management. Furthermore, the 15 sites will be proposed as pioneers for the Jogja geopark. Those sites are in the Regencies of Sleman, Bantul, and Kulonprogo. Referring to the Governor of DIY Regulation No. 40 of 2021, the Aspiring Jogja Geopark includes (1) the Peak of the Cliffs of the Ancient Kendil-Suroloyo Caldera, the Geological Structural Origin of Widosari's Hills, Eocene Nanggulan Formation, Kiskendo Cave, and Kliripan-Karangsari Manganese are in the area of Kulonprogo Regency; (2) the Godean Intrusion Hills Complex, Turgo-Plawangan Old Merapi Rock Complex, Bakalan Pyroclastic Flow of Merapi, Ancient Pyroclastic Breccia Cliffs of Sambirejo, Ngelepen Land Termite, Berbah Pillow Lava, and Eocene Limestone are in the area of Sleman Regency; and (3) the Bukit Mengger of Opak Fault, Ancient Mangunan Lava, and Parangtritis Sand Dunes are in the area of Bantul Regency (Figure 1). Based on the geological conditions that can be determined throughout the geoheritages, it is known that the uniqueness is related to (1) the remnants of the disaster impacted by the eruptions of Merapi Volcano that have occurred before, (2) the remnants of the disasters caused by the 27 May 2006 earthquake in the Districts of Pleret and Imogiri (Bantul Regency) and zones prone to landslides and other mass movements in Kulonprogo Regency, and (3) the cultural heritage of the Dutch Mangaan mine in Kulonprogo. To optimize efforts to protect, conserve, and utilize all these geoheritages, a Geopark is developed, which is synergized with efforts to realize the preservation of Biodiversity and Culture-diversity. Aspiring Jogja Geopark is also intended for educational efforts, early warning (disasters), and improving the economy of local communities.

Some scientists determined geoheritage is a union of geological science with the recognition and importance of geology in human society [1]. Geoheritage is geological diversity that has more value, a legacy of records of high scientific value, rare, unique, and beautiful, it can be used for research and earth education purposes [2–5]. Geoheritage is identified as part of geodiversity that needs to conserve by its importance values and its education values [6–8]. Geodiversity is a description of the uniqueness of geological components such as minerals, rocks, fossils, geological structures, and landscapes [9] that are the essential wealth of an area as well as their presence, distribution, and conditions that can represent the geological evolution

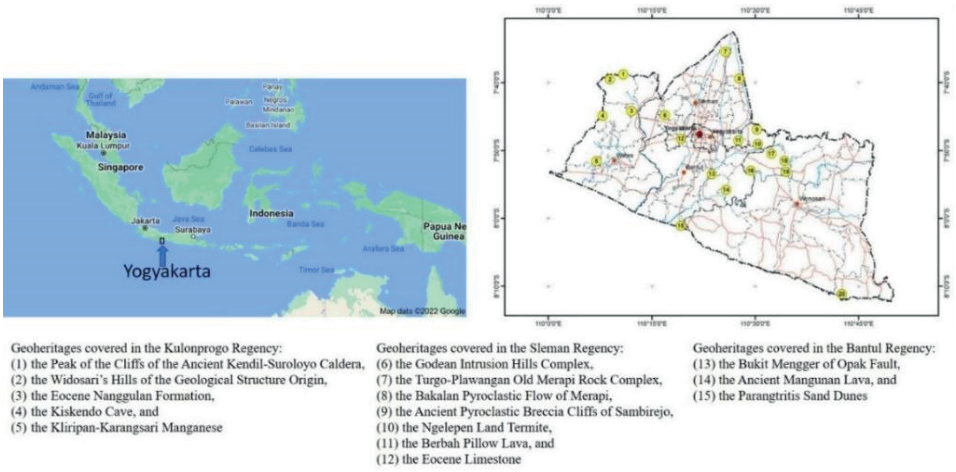

Figure 1: Situation map of the study area and the distribution of the 15 geoheritages determined in the DIY.

process of the area [6, 10, 11]. Of the unique and rare properties of geodiversity, to make sure sustainability, conservation is needed. In Indonesia, the legacy of geoheritage is regulated under the Ministry of Energy and Mineral Resources decree.

Geoheritages in geopark should have certain characteristics for individual and multi-object and are an inseparable part of the evolution of geological formation [12, 13]. Geosites have important values in education purposes, beautiful landscapes, and tourism. A UNESCO Global Geopark, such as Jeju Island, Langkawi, Al Madina, and Gunung Sewu has been transformed and established into a modern tourism destination [4, 7, 9, 14–16]. Geotourism is an effort to conserve geological conditions and data that is unique and limited, educational in nature, and able to improve the standard of living of local communities [17, 18]; geotourism is an activity that is interrelating between geodiversity, biodiversity, and cultural diversity [13, 19]. Geotourism invites and influences tourists to explore themselves and enjoy various experiences in knowing nature and its creators. People are also invited to conserve nature.

The study aims to describe one method of disaster management in DIY through a geopark-based tourism approach. It is important because disasters are mostly frightening, causing anxiety and an uneasy life, so it requires full vigilance. This study is intended to provide an overview of the benefits of a conserved area due to geological disasters to be used wisely as an early warning and education system for its management.

2. Methods

The method was applied for the 15 inventoried sites that were proposed as the constituents of the Aspiring Jogja Geopark. Respondents consist of prospective tourism visitors, prospective managers, and the people around them. Respondents filled out a questionnaire that had been distributed and it included several questions about the matters of their sustainability. Questionnaires addressed to respondents who live around the geosites, especially for those who had experience with disasters are very important to clustering the traumatic people and the un-traumatic people. The questions were related to the importance of education, early warning, economic improvements, and the agreements about the next Jogja Geopark near them. The third questionnaire was for academicians and tourism professional entrepreneurs. They filled out a form related to the supporting knowledge nor their availability as active tourism agents who can develop geopark-based tourism in the region. For each criterion, the assessors were invited to describe the real conditions as well as what they knew or experienced. To improve objectivity, different people assessed different sites. All data were collected and clustered using the RapidMiner software to the potential geotourism developments. Then, the resulting clusters have been analyzed to predict the sustainability of the Aspiring Jogja Geopark.

3. Results and Discussion

Three main components play a role in the development of tourist destinations, namely managers, tourism agents, and visitors [20][13]. The result of labeling determination found two components in tourism development. The first component consists of Community Empowerment and Tourism Development Working Group is tasked with serving all visitor needs, i.e., supporting attractions, accessibility, amenities, and accommodation. Under their respective duties and authorities, they are responsible for efforts to improve the economy of the community in the destination area. Table 1 explains the resulting clusters of community empowerment and tourism development working groups, which consisted of the commitment of the community, local government, and *POKDARWIS*, based on the questionnaires. Those were 10 questions related to the label of knowledge of the Aspiring Jogja Geopark, 10 questions about the label of opinions of the Aspiring Jogja Geopark, 15 questions about the label of perceptions in tourism-based conservation, 15 questions about the label of ecotourism development, 15 questions about the label of geotourism, and 10 questions about the label of geoproducts.

All the questionnaires were filled by 10 respondents of POKDARWIS, 10 respondents from the local community, 10 respondents from the local youth organization, and 10 respondents of farmers; 30 respondents from 17 districts in Sleman Regency and 12 districts in Kulonprogo Regency; and 10 CSR respondents of Bank BPD, Bank Mandiri, Bank BRI, Bank BCA, Bank BNI, Bank Sinar Mas, BSI, and Bank CIMB. Positive responses came from 15 POKDARWIS and their local community, some districts from Sleman Regency, and the CSR was by BPD Bank. The results of clustering all questionnaires are presented in Table 1.

Table 1: The questionnaire for the local community, local government, and POKDARWIS to the geotourism development.

Questionnair/Respondent	Pokdarws And The Local Community	Local Government	CSR (Bank BPD DIY)
The Aspiring Jogja Geopark	It has been socialized	Socialization has been carried out intensively	It has been well notified
The Geoturism Sustainability	They commit to organize the eco- and geotourism	They commit to educate the local community	BPD commits to fund the local small and middle enterprises as the amenity and accommodation agent
The Effort On Education, Conservation, And Economic Improvement	Education, empowering, and mentoring are needed	Networking to utilizing and improve geopark are needed	Funding from BPD will be discussed with the stakeholders and the governments
Improving The Geotourism Varibales (5A)	Business incubator, networking, and acceleration are needed	Developing interconnection and facilitations	It will be discussed with the local communities and the local government
The Promotion And Marketing	Optimizing the local resources and sector, media, internet	Optimizing the local media, startup promotion	-
The Sustainability Developments	Certification: guider, CHSE, healthy	Penta helix empowerments	Economic based community

The second component is visitors, tourism observers, and stakeholders who are interested in enjoying all the efforts provided by the first component including attractions, activities, accommodations, accessibilities, and amenities. The subject label is grouped into three main subjects, i.e., disasters, cultures, and geological phenomena. Merapi is an active volcano as the first subject, destinated in Sleman, and has 2 sites that are covered in the Aspiring Jogja Geopark. Eruptions with hundreds of losses of life happened in 2010. Other fatality disasters are recorded by the buried temples that were dated their burying volcanic deposits using the ^{14}C method, which consists of pyroclastic density currents in the base of Kadisoko Temple is 1445±45 y BP (455 AD), in the base of Kedulan temple is 740±50 y BP (1285 AD), and in the base of Jongkangan Temple is 1090±50 y BP [21, 22]. During the last 10.000 years, hundreds of fatality eruptions were

recorded based on volcano-stratigraphic studies [23–27]. The largest of >5 Volcano Explosivity Index (VEI) happened once in 100-150 years' time duration, the larger with 4-5 VEI were once in 50 years, and the large eruptions of 2-3 VEI were once in 10-20 years, the usually are once in 1-2 years [21, 28–31]. Geoheritages related to the volcanic eruptions covered by this Jogja Geopark are Bakalan Pyroclastic Flow and its fatalities by the eruption in 2010 and Turgo Plawangan Old Merapi Complex (Figure 1).

Opak Fault is defined as the main epicenter earthquake in Yogyakarta; trending north-south, it cut off the western side of Southern Mountain. The fault slices Merapi Volcano, splitting Imogiri, Pleret, and Parangtritis, and remains triangular facets along the northern and western Southern Mountains. Largest earthquakes are recorded based on structural geological data once in 50-100 years [22, 32–34]. Those were predicted with the magnitude of 5-6 SR. As the product of tectonics subduction, the fault was periodically reactivated. It still active and has a potential disaster in the future. It needs socialized and educated so that people will not be easy to forget. Geoheritages developed by the earthquakes during the historical records are the Bukit Mengger of Opak Fault, the Ancient Mangunan Lava, the Ngelepen Land Termite, and the Berbah Pillow Lava. Cultural-geological heritages of the Kliripan-Karangsari Manganese, the Kiskendo Cave, the Widosari Hills, and the Ancient Kendil-Suroloyo Caldera indicate people live in DIY are respectful to the presence of ancestral culture; as the remain of mine, paleo-slides, and the geological uniqueness related to the local historical geology of West Progo Dome. The Kliripan-Karangsari Manganese was a mine of the Dutch East Indies government during the colonial period until the late 1970s. In this area, many ex-mining holes are found, some of which have been converted into groundwater sources and some have been closed to avoid accidents. The Kiskendo Cave is a natural karst geomorphology. A long story of puppet story of the monkey family (Subali and Sugriwa) in their struggle to defeat the tyrants Mahesasura and Lembusura, until the birth of Hanuman, son of Sugriwa and Dewi Tara is crafted within the wall of the cave. Visitors able to learn the karst topography, shallow marine fossils of Jonggrangan Formation, and the post volcanism within the central facies which was slowly subsided forming reef sedimentation. The Widosari Hills are the remains of landslides triggered by an active Progo Fault trending northeast-southwest that followed by the appearance of the last Menoreh volcanism formed the wide caldera of Kendil-Suroloyo. Questionnaire consisted of 20 questions related to the attractions and activities of the Aspiring Jogja Geopark; 5 questions related to the existence, 5 questions related to the interconnection of the geoheritages, 5 questions related to the amenities should be, and 5 questions related to the promotion methods. Correspondents were visitors in waiting for aircraft

departures at YIA Airport, Adisucipto Airport, Tugu Station, Lempuyangan Station, and some tourists visiting Malioboro, Tebing Breksi, Lava Bantal Brebah, Sentul Market, Kaliurang, and Parangtritis, Baron, Kukup, Krakal and Glagah Beaches.

An imaginer line connecting Merapi Volcano, Yogyakarta's city, and the Sea is a sacral geo-cultural heritage [35, 36]. A philosophic statement is explained by the line, as the unity of people and their rulers, a prosperous gentle volcanic town in the rest of earthquakes [35–37], lahars, slides, and glowing avalanches of Merapi Volcano [38]. Buried temples were exposed, as evidence of their activities during the long period. The base of some temples looked shocked by earthquakes, while some very heavy statues were thrown from their original position. The biggest earthquake and the most casualties were recorded on May 27, 2006. The open museum (field) of Bakalan is evidence of the disaster index of the volcanic eruption, so it needs to be designated as geoheritage. Pyroclastic density currents, ashes, mud, and lahars threatened the cultural heritage. But those deposits are also having prosperity, virginity, and grandeur in the city. Yogyakarta has its majesty by the corridor gold position between Merapi Volcano as the prosperity source, the ocean as its wealth and power, and the mountains as its influence. Tectonism in the forms of earthquakes and tsunamis are also has added a long line of Yogyakarta city in maturing itself to face various geological disasters. The culture of the people to always act wisely by completely depending on their fate and destiny on God is the essence of the imaginary line of Merapi, the city of Yogyakarta, and the South Sea. Those are basic capital in developing a geo-cultural heritage that should be conserved but very useable in the education of disaster management, geology, volcanology, history, and culture. Table 2 is presenting the sustainability of Jogja Geopark according to the public community. The important thing of the conservation, socialization, and education of the Merapi and earthquake disaster management should be presented in the interested package of the Jogja Geopark and the tourism.

4. Conclusion

DIY has tremendous wealth in terms of its geodiversity potential. This wealth cannot be exploited to meet the needs of rock, mineral, and energy resources. This area also has a long history of geological disasters. Conservation is needed which can educate, give early warning, and at the same time improve the economy of local communities through the development of geopark and geotourism. The community has agreed to it and is ready to implement it. Visitors have not understood it yet, so socialization and education are needed, but they are very happy to welcome it.

TABLE 2: The questionnaire filled out by visitors; discusses the importance of Jogja Geopark as the motivating habit for conservation, education, and socialization of disaster management in tourism destination.

No.	Responden/ Questionnaire Label	The Attractions and Activities	The Sustainability	The Interconnection	Effort On Conservation	Amenties and Accommodation
1.	Domestic Tourists	47% know as tourism destination	Many choices in Yogyakarta; 30% is interested	70% answered The accessibility is good	70% is available	40% is available
2.	Academician	70% know as natural lab, tourism, and conservation area	80% is very interested	67% answered The accessibility is well	90% is available	60% is available
3.	Stakeholders (Researcher)	50 % know as natural lab and conservation area	71% is excited	67% answered The accessibility is well	90% is available	70% is available
4.	Local Community	95% know as tourism village	100% is supporting	50% answered the accessibility is bad, and 50% answered good	90% is available	40% is available
5.	Students	60% know as tourism village and conservation area	90% is needing socialization and education	50% answered the accessibility is good	90% is available	30% is available
6.	Passengers	40% know as tourism area	50% is needing clarification and explanation	70% answered the accessibility is good	90% is available	50% is available

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