Developing evacuation scenario for ecotourism based on hazard assessment in Borobudur area

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Abstract. Borobudur area is identical to the existence of Borobudur Temple which is an international tourist destination, besides that this area actually also has other potential to be developed as a tourist destination, especially tourism which elevates geological and geomorphological uniqueness in the Borobudur Purba Lake region. Based on previous studies identified objects that can be recommended as ecotourism include Springs around Pawon Temple, Former Swamp between Bumisegoro Village and Sabrangrawa Village, Saltwater Eyes in Kaliduren Village, and Elo and Progo River Meetings, some of these objects are then packaged through design spatial planning in order to become an ecotourism that can attract tourists. In addition, on the other hand there is the potential for ecotourism, there is a disaster threat in the area, there are variations in disasters in the ecotourism area, namely landslides and floods, therefore the purpose of this study is 1) Identifying the types of disasters in the Borobudur Ecotourism area 2) Creating a SOP design for disaster management in the Borobudur Ecotourism area, to answer the objectives of the study, this study uses descriptive methods with GIS analysis with buffering methods. From this study produced a SOP for disaster management, for the first object, namely The spring around the Pawon Temple is recommended for the first evacuation route to the wide field in front of Candi Pawon, for the third object, namely the Salty Springs in the Kaliduren Village in handling disasters in this area, it is recommended that the first evacuation route to the bridge above the Springs object be located much higher than the disaster-prone area, for the next object, the Salty Well in Ngentak Village, it is recommended that the first evacuation route go to an open field around the object area, then for the last object, namely the meeting of the Elo and Progo rivers, it is recommended that the first evacuation route to be crossed is towards the upper cliff which is on the courtyard of the residents' house near the object. The SOP for each object has been determined by the network analysis method. Therefore, the most effective pathway for the evacuation maintenance in Borobudur Purba area is obtained.

1. Introduction
The tourism sector is a new industrial sector that is strategic, rapidly and provides prospective results contributing to achieving 17 world aspirations as outlined in the Sustainable Development Goals (SDGs), The United Nation of (2018) reports that at least this sector is able to achieve 5 aspirations in the world, namely the 12th, 13th, 1, 4 and 8 goals at the ‘responsible consumption and production’,
'climate action', 'no poverty', 'quality education' and 'decent work and economic growth'. Various international organizations have reported that in the past 5 years, the tourism industry has been a sector that has a large role in global economic growth, marked by creation of employment opportunities and being able to reduce poverty in various countries. This industry contributes US $ 7.6 trillion in the global economy and has been able to create 292 million jobs worldwide. This means that 1 in 10 jobs in the world are in the tourism sector. Indonesia is one of the countries that specifically places tourism as a development destination in the era of President Joko Widodo's leadership as well as being one of the prospective sources of state revenue, according to statistical data this sector is the largest source of foreign exchange in the country since 2013. The data shows a significant increase from 4th to 2nd in 2016 and is projected to be ranked 1st in 2017 until 2019 [1].

One other thing that needs to be considered, the tourism sector has the effect of a multiplier effect, where this effect economically provides opportunities for the surrounding area to develop. Such conditions encourage many countries to develop the tourism sector. At the regional level of ASEAN countries, in the period of January - October 2017 the country of Indonesia is ranked second as the country with the highest tourism growth rate of 24%. Vietnam was ranked as the first rank with a growth rate of 25.2%. In the order after Indonesia respectively Thailand is 5.05%, Singapore is 3.83%, and Malaysia is 0.87%. The situation has been well read by the Indonesian government through reports of economic developments in the tourism sector by the National Planning Agency (2018). The recommendations produced are the development of tourism destinations through improved infrastructure readiness and quality, diversification of attractions and integration of tourist services between destinations so that tourism activities are not only dependent on iconic sites.

Tourism in Indonesia has at least 10 priority destinations consisting of newly developed sites and those that have been well developed to become one of the national tourism icons. In the list, Borobudur Temple is a destination which has the largest number of visitors and contributors to foreign exchange. So far the site of the Borobudur Temple is known as a world heritage site by UNESCO, tourism activities that are currently carried out are only limited to the temple complex. The area around Borobudur Temple when observed with another perspective has the potential to be diversified. Integration of science with spatial studies in a geographical perspective can comprehensively describe interesting and other prospective things in order to diversify.

The potential in question is unique to the physical environment in the Borobudur Temple site area. The perspective used to help explain this uniqueness is to observe history and what has happened in this region. Geological and geomorphological approaches such as augmented reality can illustrate the evolution of landscapes that have occurred in this region. [3] explains the position of the Borobudur region as a lowland surrounded by mountains. The Menoreh Mountains extend with east-west lines along the 20km to the south, on the north and west are active volcanoes, namely Merapi Volcano, Merbabu Volcano, and Cleft Volcano. [4] describe in the Borobudur area a former ancient lake that has been formed since the time of end Pleistocene. This Purba Borobudur Lake has disappeared slowly but its footprint can still be recognized at this time both physically and from the traces of toponym regions[8]. The existence of Borobudur Lake and the evolution of landscapes that occur is an interesting aspect to be appointed as an attraction for tourism diversification and can complement and support the existence of Borobudur Temple which has developed as a major tourist destination in the region [4].

But on the other hand, the discussion of the chronology or evolution of landscapes is interesting in addition to connecting us with the past, looking for something interesting and of high scientific value can also recognize the threat of disasters in the region, namely natural disasters. The threat can interfere with the success of tourism in realizing the ideals of the SDGs discussed earlier, namely points 8, 11, 13, 15, 16 specifically in the points of 'decent work and economic growth', 'sustainable cities and communities', climate action ', ' life on land 'and' peace, justice and strong institutions', respectively. So that discussed the concept of sustainability in particular becomes an evaluation point in the ranking of tourism in the countries of the world by the World Economic Forum. In 2017 Indonesia was ranked 42nd, up 8 ranks from before. But in the regional sector it is still ranked 4th.
under Singapore, Malaysia and Thailand. Economically, sustainability in Indonesia reaches the top 5 internationally, however in terms of security aspects Indonesia occupies 91st position, and environmental sustainability in 131st position out of 136 countries. In addition, specifically efforts to protect and preserve cultural heritage have been pursued by UNESCO, especially archaeological sites.

Therefore to reduce the risk of accidents, an effort is needed by building disaster management, with one of them being the implementation of preventive measures. Disaster risk reduction in tourism activities aims to increase the capacity of stakeholders. This will increase the readiness of the local community and have implications for what should be done by tourism actors (UNEP, 2007). The latest disaster research does not only emphasize the relationship between danger and society but is more complex in the uniqueness of a region. That is, the management of volcanic disasters in Merapi Volcano will be different from Volcano in Hawaii or flood management in Semarang, of course it will be different in Jakarta. Or in other words, the theoretical approach of study of landforms from one region to another will not be the same, with certain landscape characteristics associated with different potential disasters. The role of geomorphology in geography studies is assisted by a comprehensive spatial analysis that can identify threatening disasters in the area around the Borobudur Temple so that the role is to prepare preventive efforts in the form of special preparation of evacuation routes. Furthermore, the sophistication of geospatial technology can be relied upon to represent the results of analysis in a visual form so that it can be understood both for the government and managers to realize sustainable tourism.

2. Literature Review

Ecotourism is a tourism awareness movement related to environmental issues that are starting to develop globally. Ecotourism is characterized by activities that are scientific, understand and enjoy aesthetic, and live philosophical values and meanings. Therefore, enthusiasts of ecotourism have different characteristics from tourists in general. They are usually not only concerned with the environment but also have local cultural attention and appreciation [3].

According to Nuraini and Pramono, there are directions for ecotourism development. the first stage in developing ecotourism development is to first develop the physical and social elements related to ecotourism development. Physical elements include (1) development of regional spatial planning for tourism in accordance with regional classes, (2) development of physical and wild animal conservation areas, and (3) development of ecotourism infrastructure. The social elements can be divided into human resource development and economic development [8]

Disaster risk is the possibility of damage or loss in the form of casualties, injuries, loss of property, damage to housing, etc., as a result of interactions between hazards and vulnerable human conditions (UN-ISDR, 2002). Elements of risk include hazards, vulnerabilities that can be combined with coping capacity. Simply put the risk can be written as $R = f (H, V, C)$ where $R$ is the risk, $H$ is the danger, $V$ is vulnerability, and $C$ is the ability to overcome the disaster (Sunarto, 2011). Hazards are physical events, natural phenomena, or human activities that have the potential to result in death, injury, property loss, socio-economic disruption, and / or environmental damage (UN-ISDR, 2002). Vulnerability can be interpreted as the characteristics and situation of a person or group including physical, environmental, social, and economic factors that increase the likelihood of suffering the effects of a hazard (UN-ISDR, 2002). Capacity is the result of a preparation planned before a disaster occurs.

Borobudur area is one of the places on Java that has geological and geomorphological uniqueness in terms of aspects of landscape evolution. Based on the division of the Van Bemmelen physiographic zone the Borobudur area is located in the central zone and depression which has a plateau 225-240 masl. The Borobudur area is in the lowlands, on the south side there are elongated mountains in the east-west direction along the 20 km called the Menoreh Mountains. In addition, around the Borobudur area there are also several active volcanoes, including Mount Merapi, Mount Merbabu, and Mount Sumbing [5] So far, the Borobudur area is still synonymous with Borobudur Temple which is an international tourist destination and also a UNESCO world heritage site. However, this area actually
still has other potential to be developed as a tourist destination, especially educational tourism, which elevates the geological and geomorphological uniqueness of the former Purba Lake area of Borobudur. Around the Borobudur Temple in the past there were lakes formed during the Late Pleistocene. The existence of the lake can be identified through lake outcrops of black clay. Cover material for ancient lake sediment in the form of volcanic material and sedimentation from the Menoreh Mountains. Most of the lake's landforms have turned into alluvial plains and trails of marshes. Factors that cause siltation of rivers can be observed from sediment cover material found in lakes, namely material derived from volcanic activity, tectonics, land and rock mass movements, human activities. In the end Lake Borobudur disappeared slowly over a long period of time and its tracks can still be known today [7] The existence of Borobudur Ancient Lake and the evolution of landscapes that occur is an interesting aspect to be appointed as a tourist attraction, complementing the existence of Borobudur Temple which has developed as a major tourist destination in this area. Some objects that have shown this potential include physical aspects such as former swamps between Bumisegoro and Sabrangrawa Villages, the presence of fault and saltwater structures on the Sileng River in the Kaliduren Hamlet, Progo River fault structure under the Sigug bridge, "OAF" breccia, sediments fan estuary / conglomerate and deposits of the Elo River and the Progo River with old Pabelan River delta fan deposits. From the socio-cultural aspect there are toponyms named Dusun Bumisegoro, Dusun Sabrangrowo, Dusun Teluk, and Desa Tanjung, which are related to the aquatic environment but are currently no longer found.

3. Methodology

This study uses descriptive research methods. Descriptive methods are intended to reveal a problem or situation based on the facts in the field. The approach used in this study is the geographic approach, namely the spatial approach and emphasizes the geographical theme, namely location (location) and place (place) in the discussion. Related to the population, this study uses sampling, namely the entire Ecotourism area which covers the Bentanglahan area of Purba Borobudur Lake which has a threat of disaster. Data collection is done by observation, literature study and documentation. The instruments used in data collection are GPS, observation sheets, rainfall data, population density data, soil type data and other secondary data.

The analysis used to answer the problems in this study is analysis with the appreciation technique supported by descriptive analysis by taking into account the spatial aspects. An appreciation analysis is carried out to determine the level developed from Flanagan et al (2011). The analysis begins with an increase in the potential for disasters in each ecotourism area. Furthermore, the results of the award are visualized in the form of an ecotourism evacuation scenario based on hazard assessment in the Borobudur area using an appreciation.
Figure 1. Landslide Hazard Analysis Technique

Table 1 Medan Criteria and Assessment for Landslide Hazards
Criteria and Value for Rock outcrop

| No | Criteria       | Skor |
|----|----------------|------|
| 1  | Not yet        | 1    |
| 2  | little         | 2    |
| 3  | medium         | 3    |
| 4  | many           | 4    |
| 5  | verymuch       | 5    |

Criteria and Value for Vegetation density

| No | Criteria                                      | Skor |
|----|-----------------------------------------------|------|
| 1  | Large high density vegetation                 | 1    |
| 2  | Small high density vegetation, large medium density vegetation | 2    |
| 3  | Medium density small vegetation, large low density vegetation | 3    |
| 4  | Low density small vegetation                  | 4    |
| 5  | Free density                                  | 5    |

Criteria and Value for Land use

| No | Criteria                      | Skor |
|----|-------------------------------|------|
| 1  | Forest, mixed garden          | 1    |
| 2  | Check the bush                | 2    |
| 3  | Stretch                       | 3    |
| 4  | Fields                        | 4    |
| 5  | Emptyland                     | 5    |

Table 2. Ecotourism Regional Landslide Hazard Classes

Criteria and Value for Land use

| Interval | Criteria                          | Skor |
|----------|-----------------------------------|------|
| 31 - 35  | The level of hazard is very high | I    |
| 21 - 30  | High levels of hazard            | II   |
| 16 – 20  | The level of hazard medium       | III  |
| 11 – 15  | Low danger level                 | IV   |
| 5 - 10   | The level of danger is very low  | V    |
Figure 2 Flood Hazard Analysis Technique

| Criteria and value for Land use |
|--------------------------------|
| **Interval** | **Criteria**         | **Skor** |
|---------------|---------------------|---------|
| 10 – 15       | High danger level   | III     |
| 5 – 10        | Medium danger level | IV      |
| 3 – 5         | Low danger level    | V       |
Criteria and value for Altitude of the land

| No | Criteria       | Skor |
|----|----------------|------|
| 1. | >300m          | 1    |
| 2. | 101m – 300m    | 2    |
| 3. | 51m – 100m     | 3    |
| 4. | 21m – 50m      | 4    |
| 5. | 0m – 20m       | 5    |

Criteria dan harkat untuk Buffer Sungai

| No  | Criteria               | Skor |
|-----|------------------------|------|
| 1.  | 0% – 17,6% (free)      | 1    |
| 2.  | 17,7% – 32% (not prone)| 2    |
| 3.  | 32,1% – 50% (somewhat prone) | 3  |
| 4.  | 50,1% – 51,4% (prone)  | 4    |

Criteria and value for Rainfall

| No | Criteria       | Skor |
|----|----------------|------|
| 1. | <1000 (very dry) | 1    |
| 2. | 1000 - 1500 (dry) | 2    |
| 3. | 1501 - 2000 (just wet) | 3    |
| 4. | 2001 - 2500 (wet)  | 4    |
| 5. | >2500 (very wet)   | 5    |

4. Results

4.1. Description area

Based on recommendations from previous studies (Murwanto, 2015) the landscape area of Borobudur Ancient Lake needs to be carried out in the development of ecotourism to increase tourism potential which includes the former swamp between Bumisegoro and Sabrangrawa Hamlets, fault and saltwater structures in Sileng River, Kaliduren Hamlet, Progo River fault structure under Sigug bridge, springs around Pawon Temple, OAF breccia outcrop, conglomerate fan / river deposit and a meeting between Sungai Progo and Elo. However, after field observations and SWOT analysis carried out in previous studies, objects that are considered suitable as educational-based ecotourism attractions are springs located around Pawon Temple, Former Swamp between Bumi Segoro and Sabrangrawa Villages, Salt Water areas in the Kaliduren Village, and Meeting of the Elo and Progo Rivers.

The spring around Pawon Temple is located in Hamlet Wanurejo, District of Borobudur, Magelang, Central Java precisely behind Candi Pawon, and is located between the coordinates 413733 MU-9158778 MT; the object of this spring belongs to the type of contact spring (valley). According to [5] his type of spring is influenced by litho conditions and topographic conditions. Lithostratigraphic conditions in the land area of lacustrine and landforms of the foot of Mount Merapi and Sumbing rock are composed of two rock units that are different in nature from water absorption. he rock is a layer of water-resistant sedimentary rock and above it is covered by
volcanic sedimentary rocks that can escape water. The process of forming a river valley will cut the layer of sediment which has different permeability, as a result the spring appears in the middle of the river valley above the contact limits of the two.

Salty springs are administratively located in Kaliduren Village, Borobudur Subdistrict, Magelang Regency, Central Java which is at the coordinate point between 414410 MT to 9156940 MU. The principle of geomorphology is not far from the key sentence, namely the present is the key to the past or a reflection of the events of the past, so that all the events that occur today occur in slow and continuous processes. uniform with the processes that are currently in force. Likewise with the existence of these springs which of course are mutually sustainable with the existence of the landscape of ancient Borobudur lakes in the past. Based on the results of the interpretation of Nossin and Voute (1986), the direction of the flow of the Tangsi River in the northwest of the Borobudur Plain is influenced by the fault structure. This structure resulted in a deflection of the Tangsi River by 90°. The pattern of straightness of the Tangsi River after deflection can be followed until the meeting with the Progo River, with the northeast-southwest direction. The straightness pattern of the Tangsi River can be followed up to 10 km, starting from the Klulkan River in the southwest to the Gending River in the northeast. Supporting data on fault structure in the Borobudur Plain is the presence of salty hot springs that appear through the solids that cut the volcanic breccia unit of the Sumbing volcano product. Saltwater eyes were also found to the west of Ngasinan Village, in the Sungai Kljual valley. The burly structure that caused the emergence of salt water was thought to be the result of a secondary process from the Tangsi Fault.

The meeting of the Elo and Progo Rivers is administratively located in Mbejen Hamlet, Borobudur Subdistrict, Magelang, Central Java and is located at the coordinates between 414985 MT to 9158285 MU. The Progo River is a river that starts at Mount Sindoro and crosses Kedu. At the time of the estuary lake formation it is estimated that it is located in the village of Bumiajarjo while the Elo River is a river that originated on Mount Merbabu flowing to mainland lakustrin and empties into Bojong Hamlet, meeting these two rivers due to a fault line due to the presence of tectonic forces [5].

4.2 Disaster Risk Level Analysis in the Ecotourism Area of Borobudur Lake Purba

A. Water Ecotourism Object around Pawon Temple

| Variabel Skoring | Criteria | Skor |
|------------------|----------|------|
| Slope | 30 % | 5 |
| Texture | Dusty clay loam | 4 |
| Soil Solum | 50 | 2 |
| Permeability | 0.5 cm | 4 |
| Rock outcrop | medium | 3 |
| Vegetation density | Small vegetation | 2 |
| | Medium density | |
| Land use | Forest, mixed garden | 1 |
| **Total** | | **21** |

Based on the scoring / rating to determine the potential for landslide hazards in the ecotourism area of the Springs around Pawon Temple obtained a total score of 21, the results were then matched with the standards for determining the hazard class in (table 2), this area is classified as a high hazard level. landslides, therefore a disaster management SOP is
needed in this object area in order to minimize the negative impacts that will cause harm both from the tourist sector and ecotourism processors.

### Table 5. Flood Disaster Scoring Analysis

| Variabel Skoring | Criteria          | Skor |
|------------------|-------------------|------|
| Rainfall         | 16615,5 mm        | 3    |
| Ground height    | 50 m              | 4    |
| Buffering        | 35%               | 3    |
| **Total**        |                   | **10** |

Based on the scoring / rating to determine the potential for flood disasters in the ecotourism area of the Springs around Pawon Temple obtained a total score of 10, the results were then matched with the standards for determining the hazard class in (table 4), this area is classified as a danger of being flooded.

**A. Tourist attraction of Kaliduren saltwater**

### Table 6. Landslide Disaster Scoring Analysis

| Variabel Skoring | Criteria          | Skor |
|------------------|-------------------|------|
| Slope            | 35 %              | 5    |
| Texture          | Dusty clay        | 5    |
| Soil Solum       | 30                | 2    |
| Permeability     | 0,5 cm/           | 4    |
| Rock outcrop     | Medium            | 3    |
| Vegetation density | Small Vegetation , low density | 2 |
| **Land use**     | Empty land        | 5    |
| **Total**        |                   | **26** |

Based on the scoring / rating to determine the potential for landslide hazards in the Saltwater ecotourism area in Kaliduren Village to get a score of 23, the results are then matched with the standards for determining the landslide hazard class in (table 2), this area is classified as a high hazard level Avalanche.

**B. Ecotourism Objects Meeting Elo and Progo River**

### Table 7. Flood Disaster Scoring Analysis

| Variabel Skoring | Criteria          | Skor |
|------------------|-------------------|------|
| Rainfall         | 16615,5 mm        | 3    |
| Ground height    | 30 m              | 4    |
| Buffering        | 50 %              | 4    |
| **Total**        |                   | **11** |

Based on the scoring / rating to determine the potential for flood disasters in the ecotourism area of the Springs around Pawon Temple obtained a total score of 11, the results were then matched with the standard hazard class determination in (table 4), this area is classified as a high danger of flooding.

### Table 8. Landslide Disaster Scoring Analysis

| Variabel Skoring | Criteria          | Skor |
|------------------|-------------------|------|
| Slope            | 50 %              | 5    |
| Texture          | Sandy clay loam   | 4    |
| Soil Solum       | 76                | 4    |
| Permeability | 2 cm | 4 |
|--------------|------|---|
| Rock outcrop | Medium | 3 |
| Vegetation density | Low vegetation | 2 |
| High density | | |
| Land use | Shrubs | 2 |
| Total | | 24 |

Table 9. Flood Disaster Scoring Analysis

| Variabel Skoring | Criteria   | Skor |
|------------------|------------|------|
| Rainfall         | 16615.5 mm | 3    |
| Ketinggian tanah | 76         | 4    |
| Buffer Sungai    | 50 %       | 4    |
| Total            |            | 11   |

Based on the scoring / rating to determine the potential for flood disasters in the ecotourism area The Elo and Progo River meetings got a total score of 11, the results were then matched with the hazard class determination standard in (table 4), this area is classified as a high hazard.

4.3 SOP for Disaster Management

a) Tourism Objects at Waterside around Pawon Temple

In this tourist attraction the disaster that is most likely to occur is a landslide when viewed from a scoring analysis. The results of the scoring analyst are equal to 21, where the results show a high level of danger, therefore, a disaster management SOP is needed on this tourist attraction. When landslides occur, the evacuation scenario that is carried out is directing the tourists to the place of Pawon Temple. The location of Pawon Temple is above the spring and is flat. But it can also direct the tourists to the terrain which is to the west of the spring. This field is considered quite effective in accommodating tourists. On the tourist disaster mitigation map, the author recommends making disaster evacuation posts.

b) Saltwater Tourism Objects in the Kaliduren

In this tourist attraction the disaster that is most likely to occur is a landslide with a score of 26 which is included in a high level of danger. Therefore, a SOP for disaster management is needed on this tourist attraction. when a landslide occurs, the evacuation scenario that is carried out is going up to the bridge or an area higher than the object.

c) Tourism Object Meeting of Elo and Progo Rivers

In the scoring analysis that has been done, the scoring states that the potential for high disaster is a landslide, although it does not rule out the possibility of flooding also being a threat of disaster, this is because the area is a fairly swift river with quite steep gorges, which causes this area is prone to landslides and floods. The main mitigation is to stay away from disaster-prone areas both landslides and floods. SOP The handler is to evacuate visitors to the safe lane that has been provided at the vacant post away from the river bank and the swift currents of the rive.

5. Conclusion and Recommendation

From this study it can be concluded that the Borobudur Ancient Lake area has a unique geology and geomorphology that has the potential to be used as ecotourism, but on the other hand there is also a threat of disaster on each of the ecotourism objects. After scoring analysis with variations in disasters, namely landslides and floods. The results showed that the first object, namely the spring around Pawon Temple, had a greater potential for landslides than floods, for the second and
third objects, namely the Caliduren Spring Water and the meeting of the Elo River with Progo had a disaster threat which could be said to be equivalent to floods and land landslide.

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