

Tourism hazard potentials in Mount Merapi: how to deal with the risk

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Abstract. Mount Merapi as one of the most popular natural tourism destination in Indonesia, indicated as disaster prone area. Hazard management is required to ensure visitors safety. Hazard identification and mapping are prerequisite in developing proper hazard management recommendation. This study aimed to map hazard potentials' geographical positions obtained with geographical positioning system and to identify the hazard management being implemented. Data collection was carried out in Mei – June 2017 through observation and interview. Hiking trail and Lava tour area was selected as the study site, since the sites are the main areas for tourism activities in Mount Merapi. The type of hazards found in the area included lava, tephra, eruption cloud, ash, earthquake, land slide, extreme weather, slope and loose rock. Early warning system had been developed in this area, however the mechanism to regulate tourism activities still had to be improved. Local tourism entrepreneurs should be involved in the network of early warning system stakeholders to ensure tourist safety, and their capacity should be improved in order to be able to perform the measures needed for handling accident and disaster occurrences. Interpretive media explaining hazard potentials may be used to improve visitors' awareness and ability to cope with the risk.

1. Introduction

There is a wide understanding that Indonesia is a mega biodiversity country and possesses exceptional natural beauty. This richness has become its main tourist attraction. But behind its charm, many tourism areas in Indonesia are actually disaster prone areas, being located between the Ring of Fire and the Alpide Belt [1].

Mount Merapi, as one of the most active volcanoes in Indonesia, erupted in 2010 with Volcanic Explosivity Index (VEI) 4. As a comparison, Krakatau eruption in 1883 was 100 times bigger with VEI 6 and Tambora Eruption in 1815 had VEI 7. However, a VEI 4 eruption is already a strong eruption with volume of erupted tephra amounted 10 Km^3 and the height of eruption column ranging from 10 -25 Km [2]. Mount Merapi is located in Special Region of Yogyakarta and Central Java Provinces. Special Region of Yogyakarta with its cultural uniqueness is one of the main tourist destinations in Indonesia. In 2015, there were approximately 308,485 international tourists and 3,814,450 domestic tourists occupying hotels in Yogyakarta [3]. On the other hand, Yogyakarta is a prone area for many natural disasters such as tsunami, earthquake, flood, extreme weather, land slide, drought, and volcano eruption. Disaster management has become increasingly crucial with the increase number of people visiting this area, since there will be more and more people involved in the disaster.



Like any other economic sectors, the tourism industry is highly vulnerable to disaster and its impact [4]. Natural hazards, such as the volcano eruption, earthquakes, landslides, ice storms in high mountain areas, high waves, torrential rains and storms in coastal areas, may affect tourist activities and tourist destinations, and can also cause significant change to the landscape of a region [5]. Hazards are commonly found in tourism attraction [6]. Considering that visitor safety is one of the most important aspects in ensuring the satisfaction of the visitors, managers are responsible for hazard management actions to reduce the likelihood of accident and/or the severity of the loss [6]. The purpose of Disaster Risk Management is to reduce the underlying factors of risk and to prepare for and initiate an immediate response when disaster occur [7]. It also plays an important role in tourism marketing [8].

Identifying the current condition of disaster management may help improving the management to achieve the best model. Therefore this research aimed to identify the existing condition of disaster management in Mount Merapi tourism and provide recommendation for improvement.

2. Methodology

2.1. Study area

This research was conducted in Mount Merapi, Indonesia. Mount Merapi, located on two provinces in Indonesia, i.e. Central Java and Special Region of Yogyakarta, is managed under the Mount Merapi National Park. The mountain is one of the most active volcanoes in Indonesia, which had erupted regularly. The most recent eruption occurred in 2010, causing nearly 300 fatalities and destruction of thousands of houses in dozens of villages.

Like other tourists who only visited Yogyakarta, most of the tourists visiting Mount Merapi also used Yogyakarta international airport as their transportation gate and visited other attraction, such as cultural attraction, on its vicinity. While Special Region of Yogyakarta is a natural disaster prone area [9] it also is one of Indonesia main tourism destinations. Since the eruption of Mount Merapi affected a broader area, which include Special Region of Yogyakarta and its vicinity, tourism hazard management of mount Merapi should be integrated with Yogyakarta disaster management system.

The study was focused on two hiking trail and lava tour area in Mount Merapi. The first trail, Sapuangan hiking trail, is located within the coordinates $S7^{\circ} 34.067'$ $E110^{\circ}28.086'$ and $S7^{\circ}32.345'$ $E110^{\circ}27.494'$. The second trail, Selo hiking trail, is located within $S7^{\circ}30.949'$ $E110^{\circ}27.162'$ and $S7^{\circ} 32.384'$ $E110^{\circ} 26.817'$. Lava tour area is located on $S7^{\circ}41'$ $E110^{\circ} 25$ and $S7^{\circ}34'$ $E110^{\circ}26'$.

2.2. Data collection

Data on types and forms of hazards, tourism activities, occurrences of accidents, the likelihood and severity of the accidents, the existing management action, management plan, and stakeholders involved and their role in hazard management were collected in this study. Data were collected in May – June 2017 through field observation and interview. Field observation was carried out in Mount Merapi tourism area by participating in tourism activities in two hiking trails and lava tour. Interview with the manager of Mount Merapi National Park, local communities, visitors, local government, and local tourism agency were also conducted. The tool used in this research was digital camera, Global Positioning System (GPS), recording device, stationery, disaster prone area map, interview guide, and ArcGIS 10.3 software.

2.3. Data processing

Data of geographical position of each hazard was extracted from the GPS to prepare it for mapping of hazard potentials. Based on interview with area manager, local government, local community, visitors, and field observation, a list of identified hazards in Mount Merapi were developed. Information from the interview were used to decide on the likelihood and severity of each hazard potentials. There are five classes of likelihood (table 1) based on the probability of occurrences or how often each hazard

can occur, and five classes of severity (table 2) based on how severe the impact, lost or injury that can happened if one type of hazard occur.

2.4. Data analysis

The map of hazard potentials' in Mount Merapi was generated using Landsat 8 satellite imagery as basic map. Geographical position of each hazard potential was mapped using the ArcGIS 10.3 software. The potential hazards, which had been classified into its likelihood and severity classes, were then mapped into a qualitative matrix of risk analysis (table 3) to determine risk level for each hazard.

Table 1. Likelihood classification for risk assessment [10-11].

Likelihood	Description
Almost certain	Is expected to occurs in most circumstances
Likely	Will probably occurs in most circumstances
Possible/ Moderate	Frequently occur at some time
Unlikely	Could occur at some time
Rarely	May occur in exceptional/extreme circumstances

Table 2. Severity classification for risk assessment [10-11].

Severity	Description
Catastrophe	Fatalities/death
Major	Extensive injuries, with occasional death
Moderate	Seriously (Permanent) injury, medical treatment required
Minor	Minor consequences/injury: first aid treatment
Insignificant	Insignificant consequences, no injury

Table 3. Level of risk and management option needed [11].

Likelihood	Severity				
	Insignificant	Minor	Moderate	Major	Catastrophe
Almost certain	H ^b	H ^b	E ^a	E ^a	E ^a
Likely	M ^c	H ^b	H ^b	E ^a	E ^a
Possible/ Moderate	L ^d	M ^c	H ^b	E ^a	E ^a
Unlikely	L ^d	L ^d	M ^c	H ^b	E ^a
Rarely	L ^d	L ^d	M ^c	H ^b	H ^b

^a Extreme risk, immediate action require. Management option: **avoid risk**

^b High risk, senior management attention needed. Management option: **transfer risk**

^c Moderate risk, management responsibility must be specified. Management option: **reduce risk**

^d Low risk: Manage by routine procedures. Management option: **accept tolerable risk**

Risk level of hazards ranged from low risk to extreme risk, which requires different management option. Management option is mitigation in risk management strategy. The risk level will determined the priorities of management option. Four options were available for tourism hazard management, i.e. accept tolerable risk, reduce risk, transfer/sharing risk, and avoid/terminate risk, which could be explained as follow [9, 10, 12]:

1. Tolerate: accept the risk, when it is not possible or practical to respond to the risk by the other strategies, or a response is not warranted by the importance of the risk, or the risk is not significant.
2. Reduce: reduces the probability and/or impact of an adverse risk event to an acceptable threshold. Even if this is costly but is often more effective than trying to repair the damage.
3. Transfer or sharing: let someone else take share of the risk (by insurance or passing responsibility for the risk to a contractor). The consequence is there are cost that need to be paid.
4. Avoid/Terminate: agree that the risk is too high and do not proceed with the activity.

3. Result and Discussion

3.1. Mount Merapi

Mount Merapi is divided into 3 areas based on their vulnerability for eruption, i.e. Disaster Prone Area level I, II, and III. Disaster Prone Area level III is a highly potentially devastated area of hot clouds, lava flows and lava, poisonous gases, bursts of rock (incandescent) and heavy ash rains (figure 1). There is no house allowed in this area, only temporary activities such as tourism, collecting grass for livestock, and collecting firewood were allowed. Community activities in disaster-prone areas of Mount Merapi are arranged according to the level of threat of eruption. There are four levels of volcano activities, as follow:

1. Level 1: Communities in disaster-prone areas III, II, I can perform daily activities. Especially for activities in the peak areas, the center of eruption, communities should remain vigilant and comply with local government regulations according to technical advice from the Center for Investigation and Technology Development of Geological Disaster.
2. Level 2: Communities in Disaster Prone Areas III, II, I can perform daily activities. Particularly for activities in disaster-prone areas III, communities must remain vigilant and comply with local government regulations according to technical advice from the Center for Investigation and Technology Development of Geological Disaster.
3. Level 3: Communities in Disaster Prone Areas III and II must prepare to evacuate by orders from local government according to technical advice from the Center for Investigation and Technology Development of Geological Disaster.
4. Level 4: Communities in Disaster Prone Area III must have been evacuated. In case of escalation of the threat of eruption, people in the Disaster Prone Area II should also evacuate, following the orders of the local government in accordance with technical advice from the Center for Investigation and Technology Development of Geological Disaster. Communities in Disaster Prone Areas I who live close to the river to further increase his vigilance against lava threats in case of rain.

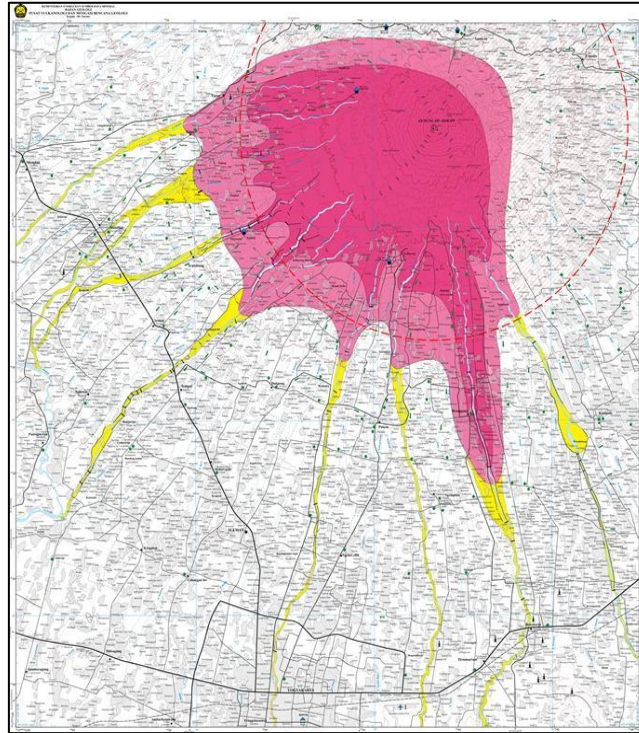


Figure 1. Mount Merapi disaster prone area [13].

3.2. Tourism in Mount Merapi and the hazard potentials

Generally, there were two tourism activities in Mount Merapi, which included hiking and jeep tour around the remaining of volcano eruption that known as ‘Volcano tour or Lava tour’. After 2010 eruption, only 2 hiking trails were opened, i.e. Selo and Sapuanging (Deles) hiking trail. Kinahrejo trail, an older trail severely damaged by the 2010 eruption, had been closed for hiking. However, because this trail was used for traditional ceremony called “Labuhan”, local community had started cleaning the area. Therefore, even though it was not an official trail, some hikers were still found going through this trail. There was a path in Kinahrejo trail called the Sand Bridge, where the path that must be passed is a narrow sandy road with 8-10 meters-deep cliff on the right and left side of the trail (figure 2).



Figure 2. Example of hazard potential in hiking trail (from left to right: sand bridge, the summit).

Thirteen locations had been identified as having potential hazards along the trails. The type of hazards found in the area included lava, tephra, eruption cloud, ash, earthquake, land slide, extreme weather, slope and loose rock (figure 3). There were two cases of hypothermia, but they were not severe cases. Pasar Bubrah, and places higher than it, were forbidden area because of the loose rock, but some hiker were still going up, trying to get to the summit. The Garuda summit was destroyed in 2010 eruption, and considering the hazards along the trail from Pasar Bubrah to Garuda Summit, the reckless action of visitors forcing their way to the summit is very dangerous. This dangerous behavior is related to visitor perception toward the activity [14] when the motivation to do the activities is bigger than their caution for hazard.

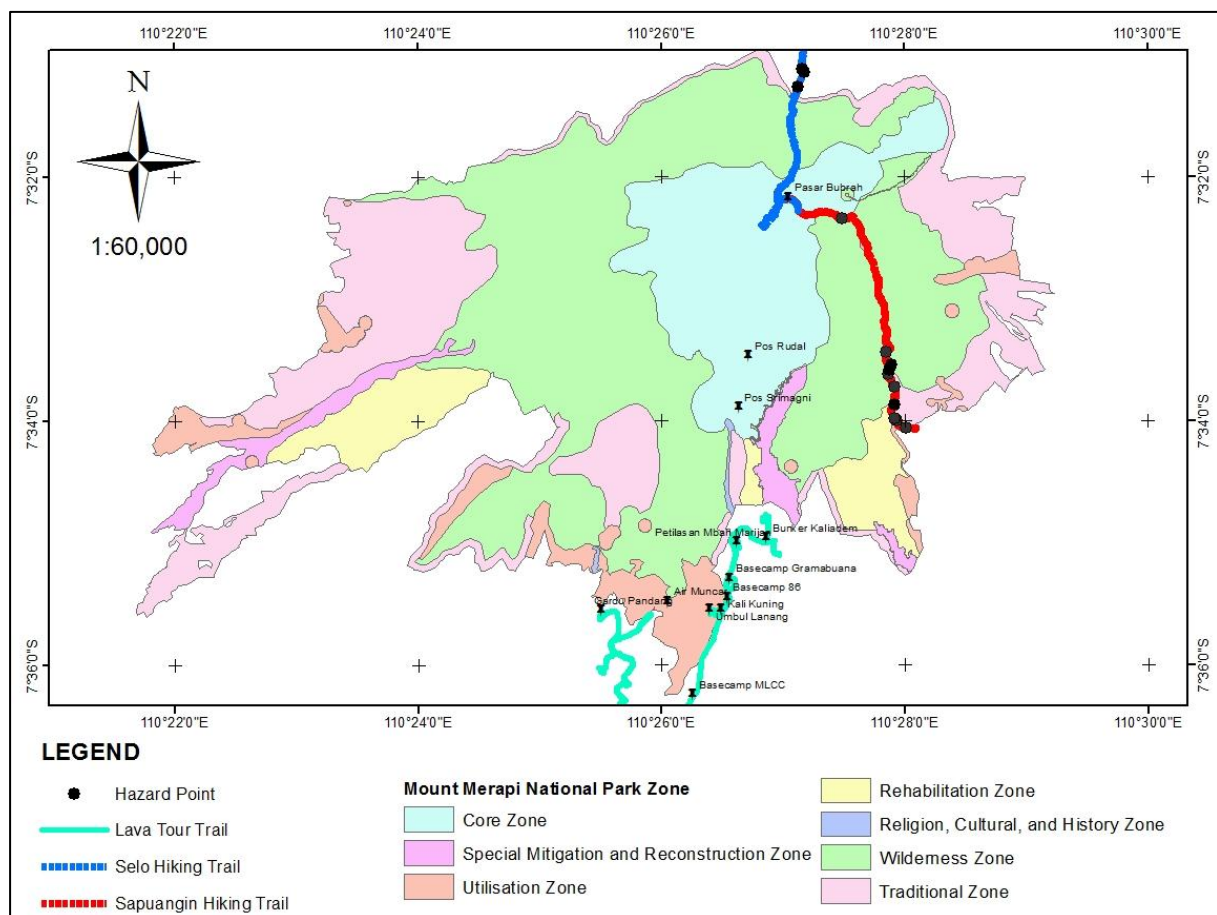


Figure 3. Mount Merapi tourism hazard point.

The remains of 2010 eruption were being used as tourist attractions in a tour program known as lava tour. This destination is an example that risk can be portrayed as part of the manifest attraction of certain activities [15]. There were 34 Jeep Communities found in Kaliadem and Kaliurang area. The jeeps were private property of the local community who also drives the jeep for the tour. The whole communities were incorporated in the Merapi Hill Tourism Jeep Association (*Asosiasi Jeep Wisata Lereng Merapi*). The jeep base camps were located in Kinahrejo and Kepuharjo village, which were included in the **level I** disaster prone area, while the tours took place in Kepuharjo village, Kaliadem, which is included in the **level III** disaster prone area, the most dangerous area. The attraction of this tour are the remains of 2010 Merapi eruption, such as house debris, lava path in river, bunker, Mbah Maridjan's (Mount Merapi spiritual caretaker) grave, etc (figure 4). Every driver know about early

warning system, evacuation trail and emergency action needed, but they had not yet shared this information with the tourist in their interpretation along the tour.



Figure 4. Lava tour destination (From left to right: ‘my remaining property’ museum, Gendol river, bunker, Mbah Maridjan grave).

Accident was rarely happened in this Volcano tour. The record showed only one incident when a loose rock caused the passing jeep slightly slipped, but there was no one hurt. Until now, there had not been any exploration for new paths to develop the Volcano tours. When there is flood threat, there will be a warning from Regional Agency for Disaster Management in the form of siren and all Volcano tour activity will be put on hold in save area.

3.3. Existing Hazard Management in the Tourism Area of Mount Merapi

Management option for tourism hazard management in mount Merapi were classified from avoid risk, transfer risk, and reduce risk based on the hazard type. This management option is taken based on the classification of severity and likelihood of every hazard potential being identified (table 4.)

Table 4. Hazard management option.

No	Hazard	Severity	Likelihood	Risk Level	Management Option
1	Eruption	Major	Likely	Extreme	Avoid Risk
2	Land slide	Moderate	Possible/ Moderate	High	Transfer Risk
3	Earthquake	Minor	Possible/ Moderate	Moderate	Reduce Risk
4	Flood	Minor	Likely	High	Transfer Risk
5	Hiking accident	Minor	Likely	High	Transfer Risk

Management option for extreme risk level is to avoid the risk. Avoiding risk should be taken because the risk is so great that it is better to get people out of dangerous area and/or to prevent people to go in. Mount Merapi National Park handled extreme risk level hazard of eruption by applying entry

prohibition for visitors in accordance with technical advice from the Geology Disaster Technology Development and Research Center. This action can be classified as **avoid the risk**. Hazard potential with high risk level should be handled with transferring the risk to the other party. Of course there are systems that make it work such as insurance etc. The hiking suggestion limitation to Pasar Bubah emphasized that the summit is off limit and not covered by insurance. This action can be classified as **transfer the risk**. The patrol and installation of warning board in disaster prone area can be classified as **reduce the risk**.

Since some of the tourism areas were located outside the national park, more stakeholders were involved in hazard management of the area. The stakeholders that had been identified in this research included Mount Merapi National Park, Special Region of Yogyakarta Government, Central Java Government, National Agency for Disaster Management, Regional Agency for Disaster Management, The Geology Disaster Technology Development and Research Center, local community, and tourist. Each stakeholder had their own role in hazard and disaster management in Mount Merapi. Center for Investigation and Technology Development of Geological Disaster provided daily data of mount Merapi activity. They also collaborated with the Regional Agency for Disaster Management, who was responsible for community safety when natural disaster happened. This regional agency had a search and rescue team and a number of volunteers in every villages. If an emergency occurred, the volunteer that live near the site would perform the rescue operation in cooperation with the other local communities.

Yogyakarta special region have an early warning system involving government agencies, village officers, handy talkie community, and residents (figure 5). Early warning system is a set of functions required to provide warning information to enable people in a hazard-threatened area to take appropriate action to minimize risk [16].

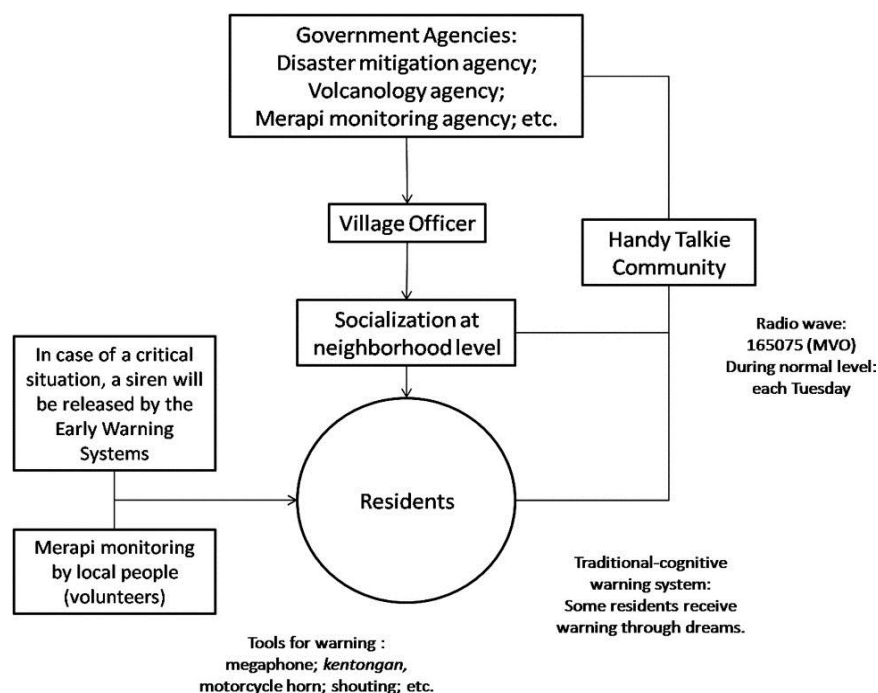


Figure 5. Mount Merapi early warning system [17].

This system had already been running effectively, with each stakeholder fulfilling their role. This running system can be used not only when disaster occurred, but also when there were cases of accident with the opposite bottom-up flow. This mechanism is possible because Yogyakarta's early warning system was classified as community based early warning system. This kind of early warning

system involved community driven collection and analysis of information that enable warning messages to help a community to respond to a hazard and reduce the resulting loss or harm [18].

Early warning system in Mount Merapi was divided into hard early warning system and soft early warning system. Hard early warning system took form of siren, sound of *kentongan* (wooden alarm devise), handy talkie, mosque speaker, radio and television. Soft early warning system took shape of disaster prone map, warning signs and evacuation tracks (figure 6), disaster education and training, volcano activities daily reports, etc. This soft early warning system helped community and tourists to be more aware of the hazard helped people to find direction during the fright when disaster occurred.



Figure 6. Evacuation direction and warning board.

Regional Agency for Disaster Management conducted training program to prepare the community, which is called Destana (*Desa Tangguh Bencana*/disaster resilient village). The people were trained to understand what they must do when disaster occur: to give first aid, to manage the crowd moving to a safer place, to know who they have to call, etc. Even students were prepared to know what they have to do in emergency situations. In order for the educational activities in school to be able to continue running during the time of disaster, the school have a “sister school” where students can join the educational activities until their school situation is safe.

3.4. Recommendation of Hazard Management Improvement

The existing hazard management in Mount Merapi has been well conducted. They had integrated early warning system and because of the last eruption, most of the stakeholders were aware of their role and had high willingness to help others. Yogyakarta local communities already had important role in collecting and analysing natural phenomenon to determine the hazard. However, improvement may be carried out, which include increasing their knowledge in designing, monitoring and managing early warning system, to make them the basis for the system. A community-based early warning system is a system in which the communities became the active participants in the design, monitoring and managing the system [19].

Visitor is also important stakeholder that should participate in the early warning system of Mount Merapi. However, they were not yet involved in the hazard management of the area. High number of visitors may either become a weakness or strength to Mount Merapi hazard management, depending on their understanding of emergency situation. If visitors had low understanding of emergency situation, they might hinder the action taken to minimize risk of the hazard, but if they had high understanding, they might be able to provide assistance in the action. Therefore, improving their capability in terms of hazard management may be necessary. There are several ways to achieve it, i.e. developing interpretation program that extend the basic knowledge of hazard for visitors, provide brief explanation for the hikers about the potential hazards and how to cope with them before they do their activities, and developing an integrated tourism information system. Using realistic visual media can improve tourist understanding of hazard and disaster that can happen [20], better tourist maps with information on potential hazard spots may reduce overall risks [21]. Jeep operators may take the role of educational agent for the tourists in lava tour. Financial contribution may influence participation

[22] and for this reason, engaging the jeep operators who generate their income from the tourist may be more helpful. As for hiking, the national park ranger can give the information and warning. With this improvement, the tourists are expected to be able to make the right action.

Summit restriction was still more of a request rather than a strict rule, because Mount Merapi National Park did not have the resources to make sure that the hikers obey the restriction. Therefore, providing the hikers with the necessary information, thus making them aware of the consequences of their action and how to avoid the risk, may help in reducing the risk for hikers.

4. Conclusion

Hazard management in Mount Merapi had applied both preventive and repressive actions, which included early warning system, evacuation scenario, evacuation, and rescue system. The hazard management had involved various stakeholders, including local residents, handy talkie community, and government institutions, leaving out the tourist from the system. The system was also focused more on the hazard of eruption, and less on other tourism hazard. To fill this gap, increasing tourist awareness of hazard management may become important. This may be done by giving tourist crucial information on hazard potentials (eruption and other hazards) using various instruments, such as warning sign, siren, and briefs on evacuation plan before they undertake tourism activities.

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5. References

- [1] UNDP [United Nation Development Programme] Indonesia 2014 *Institutionalizing Post-Disaster Recovery*. (Indonesia UNDP) p 6
- [2] Wheeling Jesuit University / Center for Educational Technologies 2006-2018 Volcanic Explosivity Index (VEI) Washington Ave http://ete.cet.edu/gcc/?/volcanoes_explosivity/
- [3] Dinas Pariwisata Daerah Istimewa Yogyakarta 2016 *Statistik Kepariwisata tahun 2016* (Yogyakarta Indonesia: Dinas Pariwisata Daerah Istimewa Yogyakarta) p 19
- [4] Me'heux K and Parker E 2006 Tourist sector perceptions of natural hazards in Vanuatu and the implications for a small island developing state *Tourism Management* **27** (2006) pp 69–85
- [5] Ilieş DC, Dehoorne O and Ilieş A 2011 Some examples of natural hazards affecting Geosites and tourist activities *Geo Journal of Tourism and Geosites* **7** (1) pp 33-38
- [6] Jubenville A, Twight B and Becker RH 1987 *Outdoor Recreation Management, Theory, and Application*. (Oxford Circle United Kingdom: Venture Publishing, Inc).
- [7] Baas S, Ramsamy S, de Prick JD, Battista F 2008 *Disaster Risk Management System Analysis* (Rome: Food and Agriculture Organization of the United Nations)
- [8] Rittichainuwat BN 2013 Tourists' and tourism suppliers' perceptions toward crisis management on tsunami *Tourism Management* **34** (2013) pp 112-121
- [9] Badan Nasional Penanggulangan Bencana 2010 *Disaster Risk Index Map in DI Yogyakarta Province* (Jakarta Indonesia: BNPB)
- [10] UNEP [United Nation Environment Programme] 2008 *Disaster Risk Management for Coastal Tourism Destinations Responding to Climate Change. A Practical Guide for Decision Marker* (France: UNEP)
- [11] Wilks J and Moore S 2004 *Tourism risk management for the Asia Pacific region: an authoritative guide for the managing crises and disasters* (Gold coast: CRC for Sustainable Tourism Pty Ltd.)
- [12] Cater CI 2004 Playing with risk? participant perceptions of risk and management implications in adventure tourism *Tourism Management* **27** (2006) pp 317–325

- [13] Balai Penyelidikan dan Pengembangan Teknologi Kebencanaan Geologi 2010 *Peta Kawasan Rawan Bencana Gunung Berapi* (Yogyakarta, Indonesia: BPPTKG)
- [14] Gstaettner AM, Rodger K and Lee D 2017 Visitor perspectives of risk management in a natural tourism setting: an application of the Theory of Planned Behavior *Journal of Outdoor Recreation and Tourism* **19** pp 1–10
- [15] Enterprise Risk Management Program 2012 *Guide to Risk Assessment and Response* (USA: The University of Vermont)
- [16] UNDP 2010 Community-based Best Practice for Disaster Risk Reduction (Maputo Mozambique: UNDP and EUROPEAN Commission Humanitarian Aid)
- [17] Mei ETW and Lavigne F 2012 *Influence of the institutional and socio-economic context for responding to disasters: case study of the 1994 and 2006 eruptions of the Merapi Volcano, Indonesia* (London: Geological Society) pp 171-186
- [18] Macherera M and Chimbari M J 2016 A review of studies on community based early warning systems *Jàmbá: Journal of Disaster Risk Studies* **8** (1)
- [19] Smith P J, Brown S, and Dugar S 2017 Community-based early warning systems for flood risk mitigation in Nepal *Natural Hazards and Earth System Sciences* **17** pp 423–437
- [20] Yang B 2016 GIS based 3-D landscape visualization for promoting citizen's awareness of coastal hazard scenarios in flood prone tourism towns *Applied Geography* **76** pp 85–97
- [21] Becken S, Hughey K F D 2013 Linking tourism into emergency management structures to enhance disaster riskreduction *Tourism Management* **36** (2013) pp 77-85
- [22] Ofuoku AU 2011 Effect of community participation on sustainability of rural water projects in Delta Central agricultural zone of Delta State, Nigeria *Journal of Agricultural Extension and Rural Development* **3** (7) pp 130-136