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DESIGNING GEOTOURISM AS A TOOL FOR DISASTER EDUCATION

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Abstract

Designing optimal geotourism-based education for disaster-prone regions is the goal of this research, focusing on the Lembang Fault Zone in Bandung, West Java, Indonesia. The study employs inductive qualitative research methodologies. Primary data were collected through observation, interviews, and documentation, while secondary data were gathered from literature, policy papers, and previous studies. The collected data underwent content analysis, map analysis, and qualitative descriptive analysis. The Lembang Fault is highly susceptible to geological disasters due to its complex underlying geological structure. Additionally, non-geological factors, such as heavy rainfall, can lead to flooding and soil movement. The Geotourism Route, informed by the Lembang Fault Earthquake catastrophe mitigation, offers interpretation to aid disaster education. Given the North Bandung region's designation as a geological disaster-prone area, geotourism can inform and educate visitors about the Lembang Fault's hazardous conditions. By creating geotourism routes for each disaster-vulnerable location, it is possible to guide tourist destination operators and local governments in implementing mitigation initiatives. This study has the potential to be applied to tourist destinations nationally and internationally that are considered disaster-prone.

Keywords: Disaster education, Disaster prone areas, Disaster risk reduction, Geotourism, Geotourism route, North Bandung area.

1. Introduction

Sustainable economic growth on a local to global level benefits from tourism, yet this industry's growth is extremely susceptible to natural calamities [1, 2]. Disasters have impacted tourist locations over the past 20 years and have turned into one of the elements impeding the development of a sustainable tourism industry [3, 4]. Education plays a part in the endeavour to increase tourists' knowledge of catastrophe risk in tourist areas [5, 6]. A type of tourism based on disaster education for sustainable development is sparked by the convergence of catastrophe risk, tourism, and education [7-9]. In order to create education-based geotourism in disaster-prone areas, a number of research on the value of education in efforts to mitigate catastrophe risk in tourist destinations are of particular concern [10-12].

Education, geotourism, and disaster-related topics have long received attention in both public and scholarly media [13, 14]. According to earlier studies, disaster education is crucial for lowering catastrophe risk and benefits both the local population and visitors [6, 15]. Disaster education can be implemented by advice on geotourism routes and through the use of a variety of media and information [14-18]. Pre-disaster and post-disaster education packaged by the local community through engaging stories geared toward the tourist market segment can be achieved through educational tourism in disaster-prone areas [7, 10, 19]. Furthermore, because they explain the causes and impacts of disasters, post-disaster educational tours are frequently referred to as "dark tourism" [20, 21]. Following the natural catastrophes that struck numerous areas, such as the Yogyakarta and Lombok earthquakes, the Aceh, Pangandaran, and Sunda Strait tsunamis, disaster education tourism began to develop in Indonesia [19, 22-25]. Disaster education is done through geotourism, which takes the form of interpretative structures that can improve the visitor experience and encourage them to learn more [26, 27]. These objectives can be achieved in a variety of ways in a variety of tourist locations, particularly in geotourism sites that have a level of importance for knowledge acquisition and dissemination [28].

The North Bandung Area, a protected resort and agricultural region with a great potential for development as a tourism area, includes the Lembang Fault disaster-prone area [29]. Additionally, the North Bandung region is vulnerable to geological natural disasters such as earthquakes, ground tremors, and volcanic disasters. The tourist industry is centred around these geological disasters [27, 30]. However, due to its classification as a national tourism region, the North Bandung Area continues to be a national priority area. There is a high probability of geological disasters in the North Bandung area, and tourists are particularly vulnerable to them. Due to the attractions of travel places with higher disaster risk, there is an increase in both the number and activities of tourists [31, 32]. Understanding what visitors, tourism industry professionals, and the local community should know and do before, during, and after a disaster is crucial for lowering the risk of disaster in the Lembang Fault.

The local government has worked to promote tourism in disaster-prone areas as a means of fostering sustainable development. However, since a number of natural catastrophes have occurred in the previous ten years, initiatives to lower disaster risk in tourist regions have drawn more attention. Geotourism that emphasizes education has the potential to lessen vulnerability among visitors, residents, and tourism stakeholders in disaster-prone locations like the Lembang Fault. The

purpose of this research is to create the optimum geotourism-based teaching paradigm for disaster-prone areas.

2. Materials and Methods

The aim of this qualitative study is to develop geotourism models for disaster-prone locations, with an emphasis on education. The research was conducted over eight months, from March to November 2022, in the Lembang Fault disaster-prone area of North Bandung. Study subjects included managers of tourist attractions, tourism offices in Bandung and West Bandung districts, catastrophe specialists, and tourism experts. Participants were selected using a purposive sampling strategy.

The thematic tourist route concept, which includes gateways, staging zones, and tourist attraction clusters [33], served as the data source for developing disaster-based geotourism. The concept of a geotourism box, encompassing process, form, tourism, geobasic, geohistory, and geo+ [34], was used to interpret geotourism attractions. Additionally, the framework for disaster literacy, covering disaster attitudes, skills, and knowledge, was integrated into the study. Primary data collection aimed to provide an unbiased overview of the education-based geotourism model in disaster-prone areas. This involved observation and semi-structured interviews with selected stakeholders using an interviewing guide and a secondary data checklist. Secondary data were gathered through a desk study of various policy papers, literature, and previous research on education-based geotourism models and their implications for sustainable development.

The study employed content analysis, map analysis, qualitative descriptive analysis, and quantitative analysis techniques. Qualitative analysis, through online interviews, observation, and documentation, was used to assess respondents' opinions on disaster literacy in the Lembang Fault. Data and spatial information were processed using geographic information system software (such as Esri ArcGIS and Google My Maps) and graphic design tools (Adobe Illustrator) for data input, management, graphing, and conversion during the construction of geotourism routes. The steps of data analysis included pre-fieldwork analysis, data reduction, data presentation, and conclusion-drawing, utilizing secondary analysis techniques.

3. Results and Discussion

3.1. Lembang fault disaster conditions

The Lembang Fault, running west-east with downward fault motions, dominates the North Bandung region. This area features Quaternary volcanoes, such as Mount Sunda Purba and Mount Tangkubanparahu, and historical geological events like the Ci Tarum dam that created Lake Bandung Purba. Other significant geological features include basalt lava outcrops and karst hills along the Citatah - Tagog Apu - Rajamandala route. The geological complexity makes the North Bandung area highly susceptible to natural disasters, including volcanic eruptions, seismic activity, and landslides. Heavy rainfall further exacerbates the risk of flooding and soil movement.

The Lembang Fault, a 29 km long fracture, has historically been linked to earthquakes with recorded magnitudes of about 3 in 1834, 1879, 1919, 2003, and 2011. The fault zone is divided into areas of moderate and high earthquake risk, with the eastern portion experiencing the highest risk. The region's geological and

non-geological conditions underscore the necessity for disaster education and mitigation strategies.

3.2. Disaster-based geotourism on the Lembang fault

The Lembang Fault's tourist attractions are categorized into geodiversity, biodiversity, and cultural diversity, with 19 attractions identified, including 1 biological, 9 cultural, and 9 geological sites. The selection of these sites for geotourism routes is based on physical attributes and accessibility, coordinated by the West Java Provincial Government, State-owned Enterprises, and private sectors. The identified attractions' coordinates are provided for easier planning and management.

Geotourism Reinterpretation to Support Lembang Fault Disaster Education: (1) **Mt. Batu Lembang**: Created by lava from an ancient eruption, offers panoramic views and historical significance; (2) **Waterfalls in Tahura Djuanda (Lalay, Kidang, Koleang, Omas, Maribaya)**: Formed by ancient basalt lava flows, these waterfalls provide scenic beauty and cultural tales; (3) **Batu Batik**: An igneous rock with cultural significance, located in Ir. H. Djuanda Forest Park; (4) **Tebing Keraton**: A cliff formed by tectonic activity, offering dramatic views; and (5) **Mt. Palasari**: The eastern tip of the Lembang Fault, significant for its height and cultural heritage.

On the Lembang Fault, there are several tourist destinations, including geotourism attractions and supporting attractions, that are situated in earthquake-prone regions that are designated as Earthquake Hazard Areas at Lembang Fault et al. The Lembang Fault area is considered to be a disaster-prone location because it has a geotourism attraction that is supported by ecological and cultural tourist destinations. This provides a range of geotourism activities, and their interpretations related to geological occurrences. Table 1 shows the geotourism zoning that adjusts to the circumstances of disaster-prone areas on the Lembang fault.

Table 1. Geotourism areas in Lembang fault disaster prone areas.

Disaster-Prone Area	Geotourism Attraction	Supporting Tourism Attraction	
		Biodiversity	Cultural Diversity
Lembang Fault Earthquake Area	1. Dago Waterfall 2. Mt. Batu Lembang 3. Lalay Waterfall 4. Kidang Waterfall 5. Batu Batik 6. Koleang Waterfall 7. Omas Waterfall 8. Maribaya Waterfall 9. Tebing Keraton	Mt. Palasari	1. Dutch fort Tugu Secapa Lembang 2. Terrace Cikapundung BBWS 3. Watervang Leuwilimus 4. Inscription of the King of Siam 5. Dago Bengkok hydropower plant 6. Japanese Cave 7. Dutch Cave 8. Lembang Fault View Tower 9. Kabuyutan Batu Loceng Site

Based on the distribution of tourist attractions, accessibility, and the physical characteristics of disaster-prone locations, geotourism routes are created. These include the Lembang Fault Geotourism Route and the Ci Kapundung Geotourism Route, both designed to educate visitors about geological and disaster-related phenomena.

This map outlines the geological and biological tourism routes in the Lembang Fault area (Fig. 1), highlighting the region's vulnerability to earthquakes and the potential impact on tourist sites. The first route runs from the Keraton cliffs to

Mount Palasari, covering one-third of the fault length, while the second route follows the Ci Kapundung River, featuring historical and natural sites, and ends at Ir. H. Djuanda Forest Park, often known as a river trek.

Fig. 1. Map of the geotourism route in the Lembang Fault earthquake prone area.

4. Conclusion

Geotourism on the Lembang Fault can enhance visitor experience by combining high tourist activity with disaster education, teaching about geological hazards and promoting safety. Defined geotourism routes can help local governments and destination managers implement effective mitigation initiatives, ensuring tourists feel secure. Establishing disaster information centres and explanatory boards at each site can support self-guided tours and integrate disaster awareness into travel guidance. Further research should explore the role of local communities in developing these routes and contributing to both structural and non-structural disaster risk reduction.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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