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Threat of landslides hazard at the core zone of Cultural Conservation Strategic Area of Gunung Padang megalithic site, in Cianjur District

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ABSTRACT

The megalithic site of Gunung Padang is an area prone to landslides. Based on the Regulation of Cianjur District No. 17 of 2012, this site area is designated as a Cultural Conservation Strategic Area. This study aims to analyze the potential for landslide hazards in the Gunung Padang Megalithic Site area. The research method is quantitative. Primary data was collected through observation and interview experts; secondary data was collected through literature studies and agency surveys. The analytical method used is quantitative through analysis of Geographic Information Systems (GIS), with overlay and weighting techniques. The results showed three landslide susceptibility classifications: very high, medium, and very low. A very high level of landslide hazard is found in the area around the site, which is currently exposed, amounting to 9.03% of the core zone of the Cultural Conservation Strategic Area.

ABSTRAK

Situs megalitikum Gunung Padang merupakan kawasan rawan longsor. Berdasarkan Peraturan Bupati Cianjur No. 17 Tahun 2012, kawasan situs ini ditetapkan sebagai Kawasan Strategis Cagar Budaya. Penelitian ini bertujuan untuk menganalisis potensi bahaya longsor di kawasan Situs Megalitikum Gunung Padang. Metode penelitian adalah kuantitatif. Data primer dikumpulkan melalui observasi dan wawancara ahli, data sekunder dikumpulkan melalui studi literatur dan survei keagenan. Metode analisis yang digunakan adalah kuantitatif melalui analisis Sistem Informasi Geografis (SIG), dengan teknik overlay dan pembobotan. Hasil penelitian menunjukkan tiga klasifikasi kerawanan longsor yaitu sangat tinggi, sedang dan sangat sangat rendah. Tingkat kerawanan longsor yang sangat tinggi terdapat di wilayah sekitar tapak yang saat ini terpapar, yaitu sebesar 9,03% dari zona inti kawasan strategis cagar budaya.

Keywords: *Cultural conservation, landslides, strategic area*

INTRODUCTION

Gunung Padang megalithic site is a cultural conservation site with a national rating by the Minister of Education and Culture No. 023 / M / 2014. The site is in the form of the largest terraced punden in Southeast Asia(Ramadina,2013). The site is a megalithic relic estimated to be between 500 and 200 years BC based on carbon dating and is estimated to have been built between the IV-XVI centuries (Rusata, 2019).

Based on the Cianjur District Regulation no. 17 of 2012 About The Cianjur District Spatial Plan 2011-2031, the Gunung Padang megalithic site is strategic cultural conservation. According to the Spatial Planning Law of the Republic of Indonesia no 26 of 2007, the Strategic Cultural Conservation Area is an area whose spatial planning is prioritized because it has a significant social and cultural influence. Based on the Cultural Conservation Area Law of the Republic of Indonesia no 11 of 2010, cultural conservation areas need to be conserved because they have essential values for history, science, education, religion, and culture. As a Strategic Cultural Conservation Area, the site's conservation is essential because, until now, archaeological research in this Strategic Cultural Conservation Area is still ongoing. Many factors can cause site damage; apart from human behavior, there are also natural factors, one of which is landslides. Landslides are a form of erosion where the transportation or movement of the soil mass occurs at a time in a relatively large volume (Suripin, 2002; Istiadi & Priatna, 2021). Wong et al. (2017) and Yang (2018) stated that the occurrence of landslides is related to various factors such as precipitation, geology, distance from the fault, vegetation, and topography.

The Gunung Padang megalithic site is located at an altitude of about 800-1200 above sea level (Bronto & Billy, 2016). In addition, the site is located at the intersection of the Cimandiri and the Gede-Cikondang fault (Bronto & Billy, 2013). Based on Cianjur District Regulation 17 of 2012 about Cianjur District Spatial Plan 2011-2031, the Gunung Padang megalithic site is an area of land movement and landslides. Landslides are a type of soil or rock mass movement, or a combination of the two, that descends or exits a slope due to

disturbance of the stability of the soil or rock making up the slope. (Dewi & Abdi, 2017). The danger of landslides in the Gunung Padang megalithic site is a threat to the existence of the site. Therefore, in the context of mitigation, it is necessary to analyze the level of landslides hazard as a basis for mapping landslides hazard in the Gunung Padang megalithic site area. Landslides hazard mapping is a form of non-structural mitigation. In reducing disaster risk, non-structural mitigation is more sustainable because it provides security in the long term (Dewi & Istiadi, 2016).

Based on this, the research aims to analyze and map the level of landslide hazard at the core zone of the Cultural Conservation Strategic Area of the Gunung Padang megalithic site. As for the benefits, it is hoped that the local and central governments will be able to mitigate these dangers so that the Gunung Padang megalithic cultural conservation area can be protected from severe damage caused by debris, flows, and falls.

METHODS

Based on the Cianjur District Spatial Plan 2011-2031, the Gunung Padang Strategic Cultural Conservation Area is divided into three zones; the Core, Buffer, and Development Zones. However, based on expert research, the Gunung Padang site is estimated to be very wide and exceeds what is seen now. Based on this, the Gunung Padang Strategic Cultural Conservation area is set in 2 villages, namely Karya Mukti and Cimenteng Villages.

This research was conducted at the core zone of the Strategic Cultural Conservation Area of Gunung Padang Megalithic Site in Karyamukti and Cimenteng Villages, Campaka subdistrict, Cianjur district. Located at 6°59,664'S 107°3,375'E, the site has a total area of 28.79 km^2. For more details regarding the scope of the region can be seen in Figures 1 and 2.

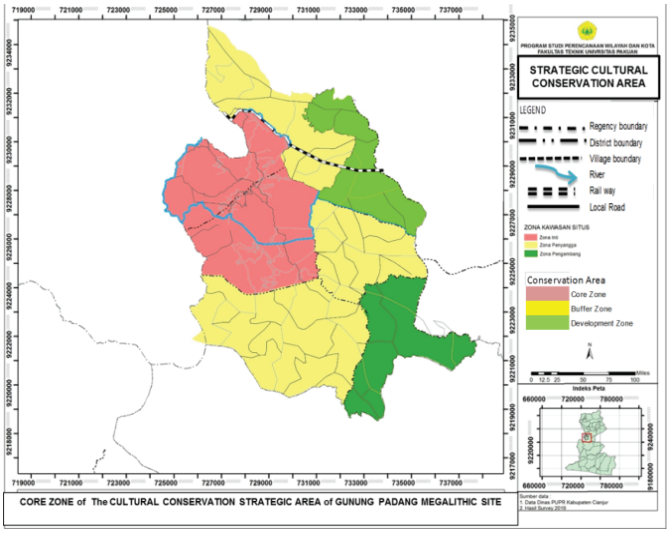

Figure 1. Strategic Cultural Conservation Area of Gunung Padang megalithic site.

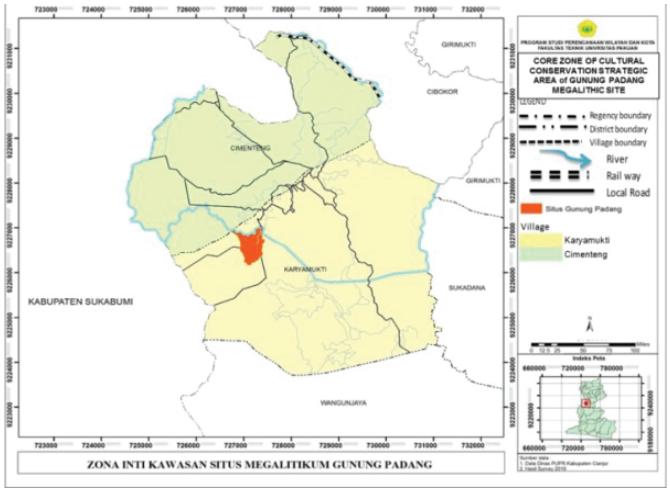

Figure 2. Core zone of Strategic Cultural Conservation Area of Gunung Padang site.

Primary data was taken in July 2019. Field observations were to assess the physical condition of the core zone. Expert interviews were conducted with three sources: the Head of BPBD Cianjur District, Historians and Archaeologists, and Environmental Geomorphologists. The interview is intended to measure the weight of the landslide hazard and hazard variables.

Law No. 11 of 2010 concerning Cultural Conservation, Law No. 24 of 2007 concerning Disaster Management, Minister of Public Works Regulation No. 22 of 2007 about Spatial Planning in Landslides Disaster Areas, and Cianjur District Regulation No. 17 of 2012 about Regional Spatial Planning Cianjur District 2011-2031 are document used for secondary data. Another secondary data include map of Cianjur Regency 1: 125,000; Rainfall 1:125,000; Soil Type 1:125,000, Land Use 1:125,000, Slope 1:125,000, River flow 1:125,000, and the National Model Elevation Digital Map (Demnas) of 2018 with a resolution of 12.5 m.

Data analysis used Geographic Information System (GIS) with ArcGIS 10.3. Analysis of the landslides hazard level is carried out in 2 stages. The first stage analyzes landslide hazards through 5 variables: slope, land use, soil type, river density, and rainfall (**Table 1**).

In the second stage, the vulnerability analysis results are refined by adding two variables: the frequency of landslide events and secondary disasters due to landslides. The consideration is that the more frequent landslides occur, the higher the threat of landslides in that location. Secondary disasters are also considered because the intensity of landslide hazards is getting immense with the emergence of secondary disasters due to landslides. Furthermore, each variable is classified into five classes: very low, low, medium, high, and very high, with a value of 1 to 5. The weights are obtained from the results of expert interviews. The score is the multiplication of the value with the weight. (**Table 2**).

Table 1. Landslides susceptibility variables.

Variable	Classification	Range	Value	Weight (%)	Score
Rain Fall (mm/Y)	Very Low	<2000 mm/Y	1	24	0.048
	Low	2000-2500 mm/Y	2		0.096
	Medium	2501-3000 mm/Y	3		0.114
	High	3001-3500 mm/Y	4		0.192
	Very High	>3500 mm/Y	5		0.24
Land use	Very Low	Forest	1	17	0.034
	Low	Farm	2		0.068
	Medium	Fields, Moor, Shrublands	3		0.102
	High	Rice Fields, Mining	4		0.136
	Very High	Settlement	5		0.17
Slope	Very Low	0-8%	1	42	0.084
	Low	8-15%	2		0.168
	Medium	15-25%	3		0.252
	High	25-40%	4		0.336
	Very High	>40%	5		0.42
Soil Type	Very Low	Aluvial	1	11	0.022
	Low	Latosol	2		0.044
	Medium	Litosol	3		0.066
	High	Podsolik	4		0.088
	Very High	Grumosol	5		0.11
River Density	Very Low	0,25-5 km/km^2	1	6	0.012
	Low	5-10 km/km^2	2		0.024
	Medium	10-15 km/km^2	3		0.036
	High	15-25 km/km^2	4		0.048
	Very High	>25 km/km^2	5		0.06

Source: Analysis 2020

Table 2. Landslides hazard variables.

Variable	Classification	Range	Value	Weight (%)	Score
Suceptibility	Very Low	0,012-0,093	1	48	0.096
	Low	0,094-0,175	2		0.192
	Medium	0,176-0,257	3		0.288
	High	0,258-0,339	4		0.384
	Very High	0,340-0,420	5		0.48
Frequency	Very Low	0	1	26	0.052
	Low	1x	2		0.104
	Medium	2x	3		0.156
	High	3x	4		0.208
	Very High	>4x	5		0.26
Secondary Disaster	Very Low	non	1	26	0.052
	Low	once	2		0.104
	Medium	rarely	3		0.156
	High	often	4		0.208
	Very High	very often	5		0.26

Source: Analysis 2020

The level of landslide hazard is classified into five classes. Class division can use the formula: i = (VHS-VLS)/n. Where i is the interval, VHS = the highest score, VLS = the lowest score, and n = 5 is the number of classes; the GIS analysis (Table 3).

Table 3. The level of landslides hazard.

No	Level of Landslides Hazard	Score
1	Very Low	0.052-0.137
2	Low	0.138-0.223
3	Medium	0.224-0.309
4	High	0.310-0.395
5	Very High	0.396-0.480

Source: Analysis 2020

RESULT AND DISCUSSION

The results of the analysis of the landslide susceptibility level show that there are three levels of landslide susceptibility at the core zone of the Strategic Cultural Conservation Area of the Gunung Padang megalithic site: very low (24.49%), low (52.69%), and moderate (17.82%). This result occurs because, from the five susceptibility variables, only rainfall strongly influences landslide susceptibility. The average annual rainfall is 3000-3500 mm. The use of residential land, rice fields, and mining which can trigger landslides are low (31.37% of the core zone area). Areas with slopes above 25%, which can trigger landslides, are low (19.14% of the core zone area). The soil type at the core zone area is latosol. Latosol has very low erodibility (Taslim et al., 2019). The Gunung Padang site area has a very high river density(27.05 km/km^2), and areas that have high river density are very low (0.40% of the core zone area) (**Figure 3**).

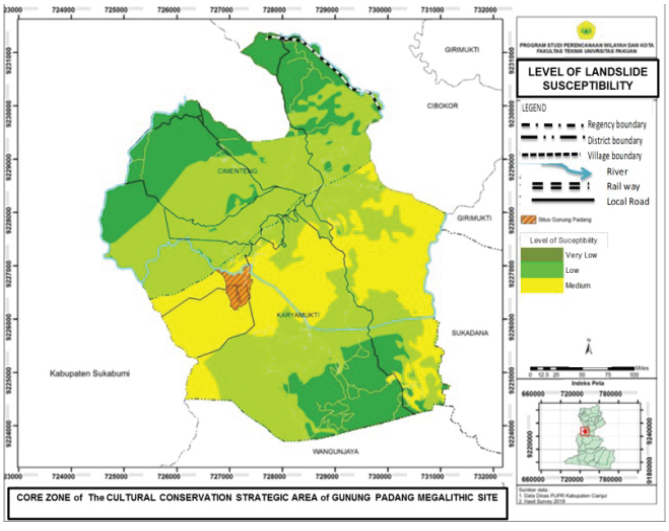

Figure 3. Landslides susceptibility level at the core zone of the Strategic Cultural Conservation Area of Gunung Padang megalithic site.

Based on data from the Cianjur Regency Tourism Office, the site's land area that can be seen is more or less 0.30 Km^2, located in Karyamukti Village, with an altitude between 800-975 m above sea level. The structure of the Gunung Padang megalithic site is made up of a set of polygonal rock columns. These columns were formed when lava cooled into igneous andesite or basalt rock (Ramadina, 2013). The Gunung Padang megalithic site is a terraced building commonly referred to as 'punden terraces,' consisting of five terraces or levels. The higher the level or terrace, the narrower the terrace area (Ramadina, 2013).

The hazard analysis results show that the exposed site is in moderate susceptibility. The occurrence of landslides at the core zone of Strategic Cultural Conservation Area of the Gunung Padang megalithic site from 2017-2019 is shown in Figure 4.

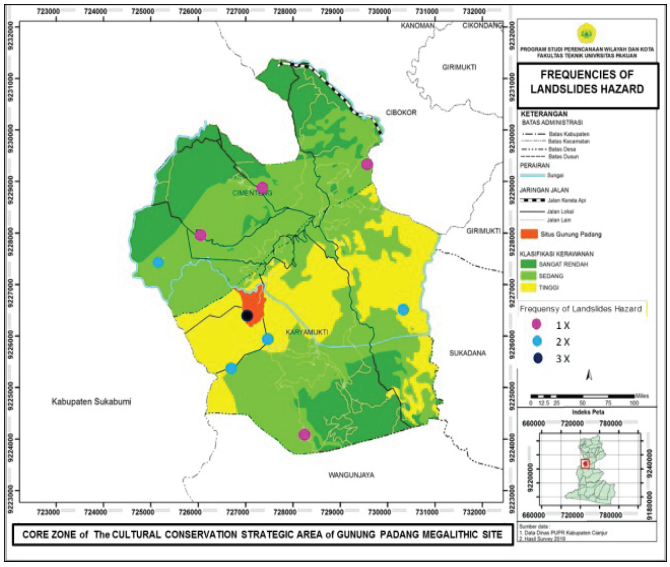

Figure 4. Landslides disaster locations 2017-2019 at the core zone of the Strategic Cultural Conservation Area of Gunung Padang megalithic site.

In 2019, landslides occurred on the second terrace at a site location that has been exposed. The cliff fell on the second terrace, buried the gardens and the Cikuta river at the bottom. The landslide incident caused a secondary hazard between flash floods and the Cikuta river embankment bursting so that the mud-covered two compartments of rice fields.

The landslide hazard level analysis at the core zone of the Cultural Conservation Strategic Area of the Gunung Padang megalithic site (**Figure 5**) shows that the landslide hazard level varies from very low to very high. The very low, moderate, and very high levels are 38.83%, 52.14%, and 9.03%, respectively, of the cultural conservation area core zones.

The level of landslide hazard is very high in the Gunung Padang megalithic site, which has been exposed on terraces 5, 4, 3, and part of terraces 2 (**Figure 6**).

This landslide hazard level varies because the terraces are between 800-975 m above sea level and have a steep slope of 25% and 40%. This finding is in line with research carried out by several researchers at the megalithic site of Gunung Padang. According to

Sampurno (2002), cited in Yondri (2020), there are three forms of natural disasters that threaten the punden rock structure of Gunung Padang, such as debris, falls, and flows. The construction of the terrace wall made of andesite stone blocks arranged vertically at the top of the hill is very prone to collapse. The construction of the terrace wall, which is on a hillside slope, is very prone to fall hazards, and the construction arrangement, which is in an area with a gentle slope, is also very prone to flow hazards (Yondri, 2020). Furthermore, Yondri's research stated that on the terraces of the megalithic site of Gunung Padang, traces and remnants of the avalanche

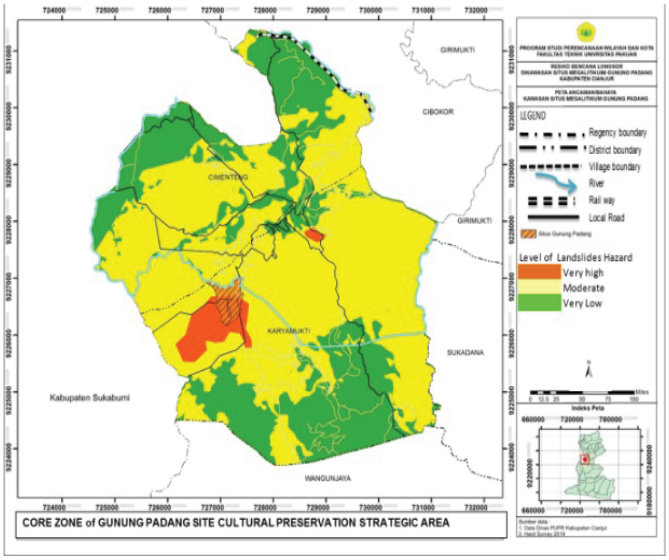

Figure 5. Landslides hazard level at the core zone of the Strategic Cultural Conservation Area of Gunung Padang megalithic site.

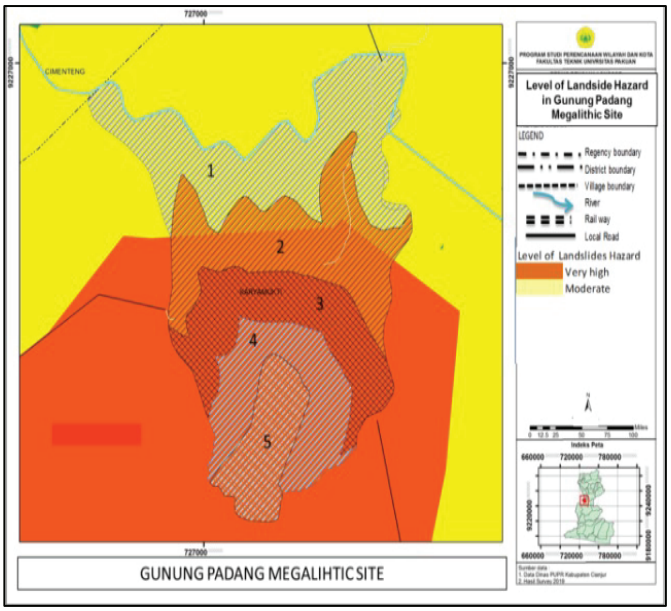

Figure 6. Level of landslides hazard in the Gunung Padang megalithic site.

were found (Yondri, 2020). Furthermore, on the eastern, western, northern, and northeastern slopes of Gunung Padang, stone columns with long axis tilted in the direction of the sloping plane are evidence of repeated landslides (Bronto & Billy, 2016).

CONCLUSIONS

The level of landslide hazard at the core zone of the Strategic Cultural Conservation Area of the Gunung Padang Megalithic site consists of Very Low, Medium, and Very High. The threat level of landslides hazard is very high around the Gunung Padang megalithic site, which has been exposed on terraces 5, 4, 3, and part of terraces 2, which can threaten the sustainability of the site.

Based on the study's results on the level of landslide hazard, structural and non-structural mitigation efforts are needed to maintain the site's sustainability. To maintain the Gunung Padang site's safety, structural and non-structural measures are required. The structural measures include reinforcing the steep terrace wall, and the non-structural measures include restricting tourist access to high-risk landslides. In addition, it is necessary to increase the capacity of local government officials and the community through socialization about site security and its rules, as well as increase public awareness of the need to participate in the preservation of the site.

REFERENCES

Bronto, S., and Billy, S.L.,(2016), Geologi of The Mount Padang and Surronding Area, Cianjur District-Wet Java, *Jurnal Geologi dan Sumberdaya Mineral*, 17(1): 37-49.

Dewi, I.K., and Abdi, F.,(2017), Evaluasi Kerawanan Bencana Tanah Longsor Di Kawasan Permukiman Di Daerah Aliran Sungai (Das) Ciliwung Hulu, *in Procc. Perencanaan Pembangunan Inklusif Desa-Kota*, Mar.2017, paper D.7, p381.

Dewi, I.K., and Istiadi, Y., (2016), Disaster Mitigation on Traditional Community Against Climate Change in Kampong Naga Subdistrict Salawu, Tasikmalaya District, *Journal of People and Environment*, 3(1):129-135.

Istiadi, Y., and Priatna, D., (2021). Analysis of the determinants and typology of hydrometeorological disaster in Sukajaya Subdistrict, Bogor Regency, West Java, Indonesia. *Indonesian Journal of Applied Environmental Studies*, 2(1): 41-46.

Ramadina, S.P.,(2013), Analisis Perupaan Situs Megalitik Gunung Padang di Cianjur, Jawa Barat, *ITB Journal Of Visual Art And Design*, 4(1):51-66.

Rusata, T., (2019), Local Community Participation in Development Sustainable Tourism Destinations: Case Study of the Gunung Padang Site in Cianjur", *Jurnal Kepariwisataan Indonesia*, 13(2):79 – 96.

Suripin. (2002). Pelestarian Sumberdaya Tanah dan Air. Penerbit Andi, Yogyakarta.

Taslim, R.K., Mandala, M., and Indarto, I., (2019), Prediksi Erosi di Wilayah Jawa Timur, *Jurnal Ilmu Lingkungan*, 17(2):323-332.

Wong, D.F., Spencer, C., Boyd, L., Burkle, F.M. & Archer, F., (2017). Disaster metrics: A comprehensive framework for disaster evaluation typologies. *Prehospital and Disaster Medicine*, 32 (4): doi: 10.1017/S1049023X17006471.

Yang, J., (2018). Landslide damage from extreme rainstorm geological accumulation layers within Plain River basins. *Journal of Coastal Research*, 82(1): 1-11. DOI: 10.2112/SI82-001.1.

Yondri,L.,(2020),Situs Gunung Padang dan Ancaman, Kebencanaan pada Masa Lalu". Bhumisodhana : *Ekologi Dan Bencana Dalam Refleksi Kebudayaan Nusantara* , M.R. Sutrisno, S.J. Suyono, I.Muhtarom (Eds) . Yogyakarta : BWCF and Sulur Pustaka.