GEOMORPHOLOGICAL FEATURES OF SIDAMULYA, SUKABUMI REGENCY, CILETUH PALABUHANRATU UGG

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ABSTRACT

The Sidamulya region, located in the Ciracap Subdistrict of Sukabumi Regency, is part of the Ciletuh Palabuhanratu UNESCO Global Geopark (UGG) and has distinct geomorphological characteristics impacted by geological volcanic structures and surface processes. This study examines the area's geomorphology from a morphographic, morphometric, and morphogenetic perspective utilizing Digital Elevation Model (DEM) data processed with ArcGIS and field verification. The study identified five geomorphological units, which include denudational and volcanic hills with various slope gradients, drainage patterns, and lithological compositions. Exogenic processes such as erosion, weathering, and sedimentation shape these units, which contain lithologies such as sandstone, breccia, and andesitic-basaltic lava. The thematic maps generated by this study provide significant insights into the region's landscape change and contribute to sustainable management within the geopark area.

Keyword: Sidamulya, Morphography, Morphometric, Morphogenetic, Geomorphology

INTRODUCTION

The subduction and collision have long influenced the geological structure of Indonesia during the Cenozoic (Hall, 2009). Such movements have generated diversity of landform in Indonesia, one of which is located on the southern coast of Java Island, namely the Ciletuh–Jampang area in the form of a basin due to the boundary between tectonic plates. Geomorphology is the study of the characteristics, origin, and development of landforms (and the processes that shape them) including the relationship between landforms, lithology and geological structures (Verstappen, 1983). Geomorphological processes are the physical and chemical forces that shape the surface features and topography of the earth (Thornbury, 1969).

This study was conducted in the Sidamulya area and its surroundings, located in Ciracap Subdistrict, Sukabumi Regency,at coordinates 06°26'53.98" - 106°29'33.347"E and 7°19'4.85" - 7°16'22.07"S. The study covers an area of 5 × 5 km, using a map with a scale of 1:12,500.

The oldest formations in the study area were deposited during the Late Oligocene to Early Miocene (Prinaldi et al., 2023; Ramdhani, 2024; Pratiwi et al., 2024). Physiographically, the study area belongs to the Southern Mountains Zone of West Java (van Bemmelen, 1949), which stretches from the westernmost to the eastern part of West Java, running parallel to the southern coast of Java Island (Figure 1). This zone was formed during the Tertiary Period due to tectonic and volcanic activities, shaping the region into undulating terrain with steep valleys (Martodjodjo, 1984; Rosana et al., 2019).

The geological history of the area is complex, predominantly influenced by the subduction of the Indo-Australian Plate beneath the southern margin of Java Island. Tectonic activity, combined with geomorphic processes, has played a significant role in shaping the region's morphology and contributing to the evolution of the Earth's surface (Manggara et al., 2022). This study seeks to provide a detailed analysis of geomorphological processes, offering deeper insights into the forces that have influenced the landscape and physical environment of the region.

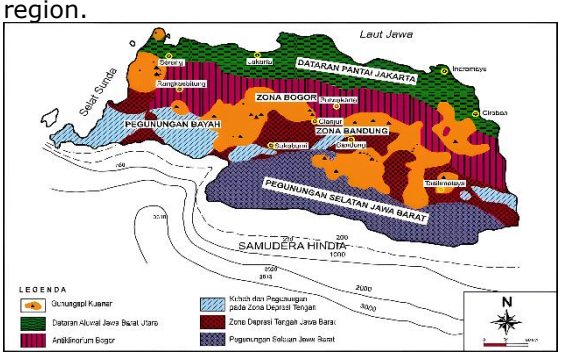

Figure 1. Regional Physiography of West Java (van Bemmelen, 1949)

RESEARCH METHODS

This research analyzed morphographic, morphometric, and morphogenetic to determine the geomorphological characteristics of the Sidamulya area and its

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surroundings within Ciracap Subdistrict, as part of the Ciletuh Palabuhanratu Geopark. Data gathering was done using Digital Elevation Model (DEM) images and processed using ArcGIS and Global Mapper software.

Morphographic element specifies the features of the surface, since landforms can be described in terms of elevation classes, (van Zuidam, 1983 on Bermana, 2006), and characterize drainage patterns that reflect lithology and erosion processes (Howard, 1967). The morphometric aspects relate to slope gradient, while morphogenetic aspects are about the processes responsible for shaping the surface features and affected by internal and external factors.

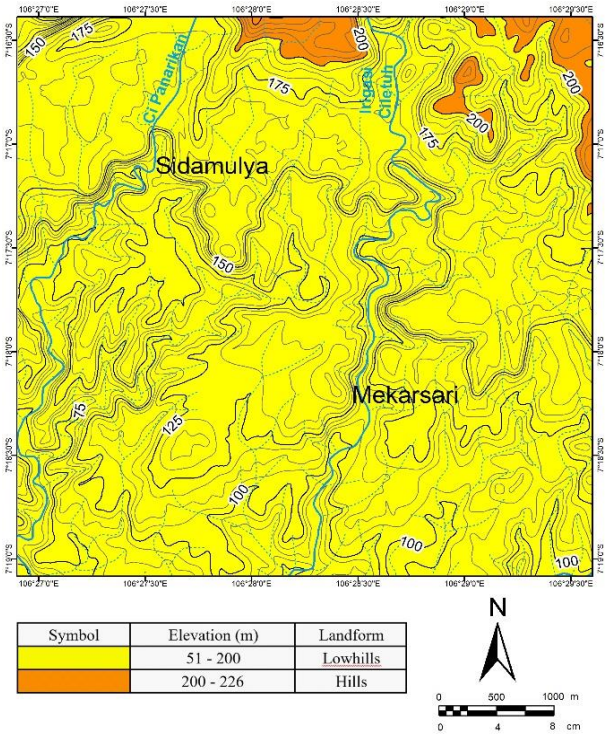

Figure 2. Morphological Map based on DEM/SRTM data and field observations in Sidamulya

RESULT AND DISCUSSION

The reconstruction of the topographic map and Digital Elevation Model (DEM) shows that the landforms in the study area can be divided into two classes based on landforms. The study area is located in an elevation zone of 50 to 226 meters (Figure 2) and characterized by low hills that cover almost the entire study area. A small area is covered by hills in the north and northeast, with altitude ranging from 200 to 226 meters.

The drainage pattern of the study area can be classified into two major types, which are dendritic and sub-dendritic (Figure 3). The dendritic type is typically usually observed in areas with relatively uniform rock types and have low tectonic activities. In the study area, the dendritic type is most dominant in the eastern to southwestern parts. This pattern shows extensions that are similar to tree branches, indicating areas with less slope gradients and rock strata that are easily erodible. The sub-dendritic drainage pattern is found in the western to northern parts of the study area. This pattern shows the influence of differential rock resistance, which dictates the movement of water through rock units.

According to slope gradient classes of van Zuidam (1983), the study area falls into four classes of slope gradients: flat slopes, gentle slopes, moderately steep slopes, and steep slopes (Figure 4)**.**

- **Flat Slope (0-2%)**, shown as green color on the map, covers approximately 10% of the total study area. It is located from the eastern to the western sides of the study area.
- **Gentle Slope (8-13%)**, shown as yellow on the map, covers around 25% of the total study area. This slope occurs in the southeast to southwest of the study area.
- **Moderately Steep Slope (14-20%)**, shown as orange on the map, covers around 30% of the total study area.

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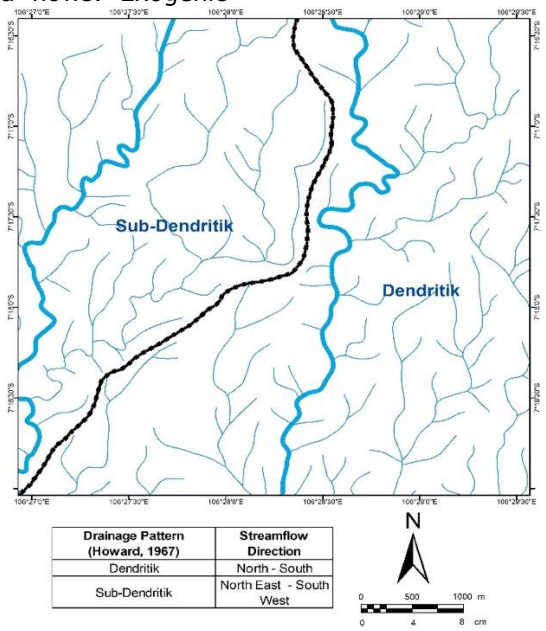
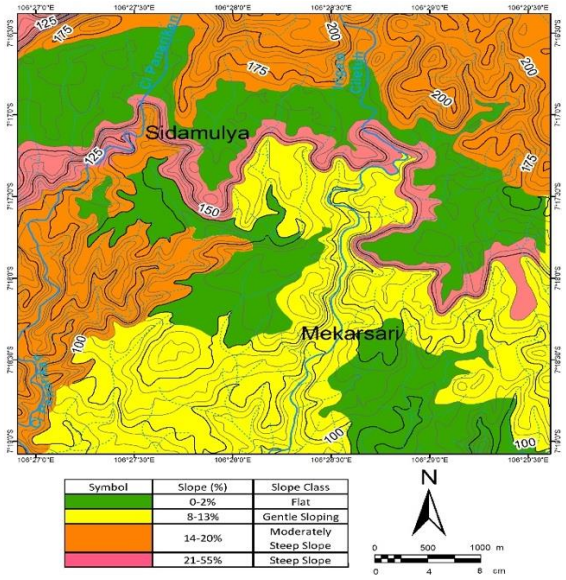
- **Steep Slope (21-55%)**, which is pink color on the map, covers around 35% of the total study area. The area extends from the west to the east of the study area. These slopes indicate a relatively high risk of landslides and erosion.

The morphogenesis of the study area is influenced by both endogenic and exogenic processes shaping the landforms. Endogenic processes, including volcanism, have resulted in lithologies such as lava flows. Exogenic processes, such as weathering, erosion, and sedimentation, are regulated by external conditions, primarily climate and vegetation. The influence of exogenic processes is evidenced in the high rate of weathering of the rocks. Physical and chemical weathering are responsible for the color and hardness variation in these rock structures. In addition, erosion and sedimentation processes control the formation of denudational landforms found in the south to northwest part of the study area.



Drainage Pattern (Howard, 1967)	Streamflow Direction
Dendritik	North - South
Sub-Dendritik	North East - South West

Figure 3. The drainage pattern in Sidamulya, Sukabumi



Symbol	Slope (%)	Slope Class
	0-2%	Flat
	8-13%	Gentle Sloping
	14-20%	Moderately Steep Slope
	21-55%	Steep Slope

Figure 4. Morphometric Map of Sidamulya, Sukabumi

Geomorphology

Based on the morphographic, morphometric, and morphogenetic aspects from the DEM data and fieldwork, the geomorphology of Sidamulya, Sukabumi is divided into five geomorphological units (Figure 5).

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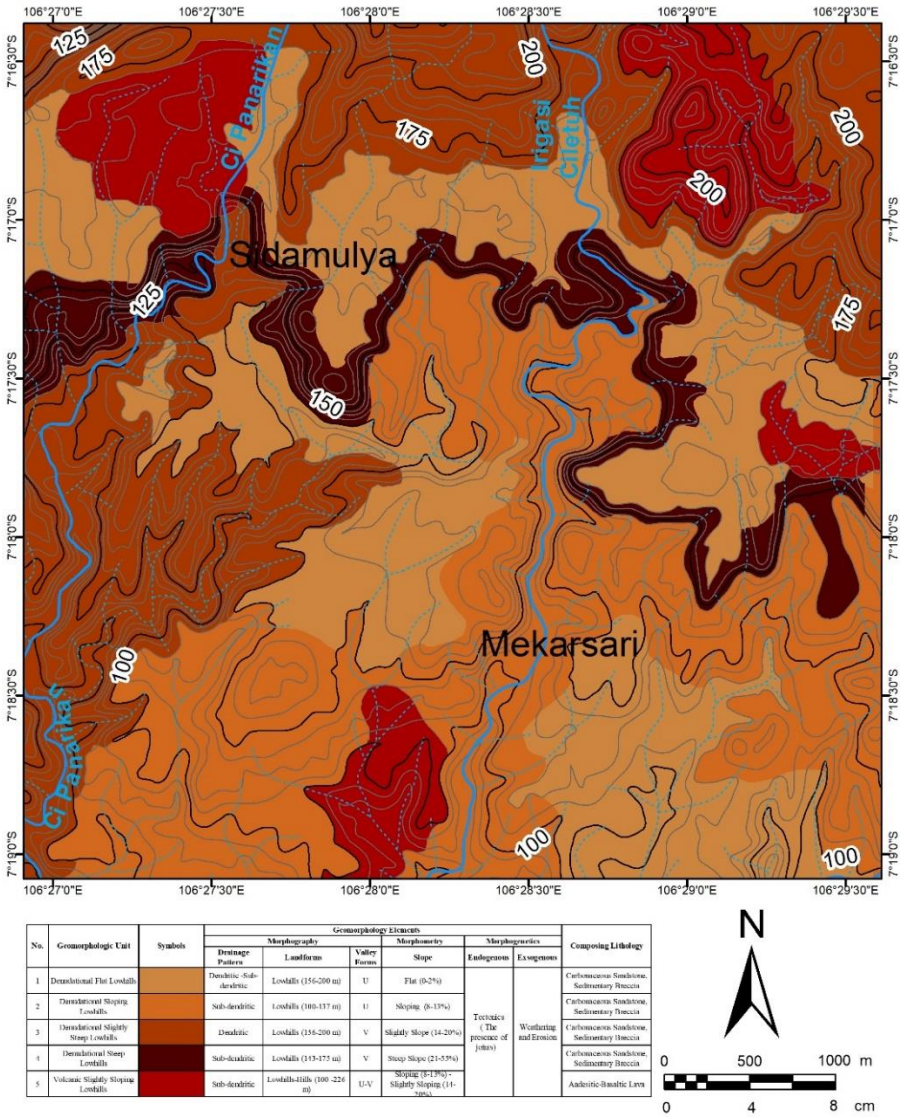
1. Low Denudational Hills (Flat)

This geomorphological unit occupies about 30% of the total study area in the southeastern part, extending from west to east. The morphology consists of low hills with elevations ranging from 156 to 200 meters above sea level. The river drainage pattern is dendritic to sub-dendritic, with U-shaped valleys. Morphometric analysis shows a flat slope (0-2%). Exogenic processes such as weathering and erosion influence this unit. The lithology is dominated by carbonate sandstone and breccia.

2. Low Denudational Hills (Gentle)

This geomorphological unit covers about 23% of the total study area in the southern part, spreading mainly in the southern part with extension in the central. It is a low hill unit with an altitude of 100 to 137 meters above sea level. The drainage pattern is sub-dendritic in nature with U-shaped valleys. Slopes are gently sloping with gradient values, ranging from 8 to 13%. Exogenic processes such as erosion and weathering, predominantly control this unit. Non-carbonate sandstone is the dominating lithology.



No.	Geomorphologic Unit	Symbols	Geomorphology Elements						Composing Lithology
			Morphography			Morphometry	Morphogenetics		
			Drainage Pattern	Landforms	Valley Forms	Slope	Endogenous	Exogenous	
1	Denudational Flat Lowhills		Dendritic -Sub-dendritic	Lowhills (156-200 m)	U	Flat (0-2%)	Tectonics (The presence of joints)	Weathering and Erosion	Carbonaceous Sandstone, Sedimentary Breccia
2	Denudational Sloping Lowhills		Sub-dendritic	Lowhills (100-137 m)	U	Sloping (8-13%)			Carbonaceous Sandstone, Sedimentary Breccia
3	Denudational Slightly Steep Lowhills		Dendritic	Lowhills (156-200 m)	V	Slightly Slope (14-20%)			Carbonaceous Sandstone, Sedimentary Breccia
4	Denudational Steep Lowhills		Sub-dendritic	Lowhills (113-175 m)	V	Steep Slope (21-55%)			Carbonaceous Sandstone, Sedimentary Breccia
5	Volcanic Slightly Sloping Lowhills		Sub-dendritic	Lowhills-Hills (100 -226 m)	U-V	Sloping (8-13%) - Slightly Sloping (11-20%)			Andesitic-Basaltic Lava

Figure 5. Geomorphology Map of Sidamulya, Sukabumi

3. Low to Moderate Denudational Hills (Moderately Steep)

This geomorphological unit occupies approximately 25% of the entire study area, found in the western region, extending from the north to the northeast. The land has low to moderately sloping hills with an elevation ranging between 156 to 266 meters above sea level. The lithology is mainly controlled by carbonate sandstones and breccia. The drainage pattern is dendritic, featuring V-

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shaped valleys. Morphometric analysis shows moderately steep slopes ranges from 14 to 20%. Exogenic processes, such as erosion and weathering, are the most dominant.

4. Low Denudational Hills (Steep)

This geomorphological unit occupies about 10% of the total study area in the western part, extending eastward. The region consists of low hills with elevations ranging from 143 to 175 meters above sea level. The drainage pattern is sub-dendritic, with V-shaped valleys. The slope is steep, with an angle ranging from 21 to 55%. Erosion and weathering are the main exogenic processes. The lithology is dominated by carbonate sandstone and breccia.

5. Low Volcanic Hills (Gentle to Moderately Steep)

Low Volcanic Hills covers approximately 12% of the total study area, primarily in the northwest, northeast, and southern regions with dominant lithologies are andesitic-basaltic lava. It consists of low hills with elevations ranging from approximately 100 to 175 meters above sea level. The drainage pattern is subdendritic, with U- and V-shaped valleys. Morphometric analysis indicates slope gradients ranging from gentle (8–13%) to moderately steep (14–20%).

CONCLUSION

The study area, located within the Ciletuh Palabuhanratu UNESCO Global Geopark, exhibits diverse geomorphological features shaped by both endogenic and exogenic processes. The landscape is predominantly composed of denudational and low volcanic hills, with elevations ranging from 50 to 226 meters. The drainage pattern varies from dendritic to subdendritic. Through the integration of field observations and Digital Elevation Model (DEM) data, thematic maps have been produced, offering an overview of Sidamulya's geomorphology. Morphometric analysis reveals a range of slope gradients, with moderately steep slopes being the most prominent, indicating a susceptibility to erosion and landslides. The area's lithological composition consists of sandstone, breccia, and andesitic-basaltic lava, which influence landform development and drainage patterns. This study contributes to a better understanding of the region’s geomorphology, supporting sustainable management and disaster risk mitigation.

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