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| Research Article |

Geomorphological Characteristics of Denudational Landforms in Cibalong, Tasikmalaya Regency, West Java, Indonesia

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Abstract: The Cibalong area, Tasikmalaya Regency, West Java, is dominated by denudational landforms developed on volcaniclastic and clastic rocks of the Jampang and Bentang Formations. However, systematic geomorphological documentation of denudational landforms in this area remains limited, particularly regarding the relationship between lithology, slope characteristics, drainage patterns, and active denudational processes at a 1:25,000 mapping scale. This study aims to analyze the geomorphological characteristics of denudational landforms and their relationship with lithological units in the study area. The methods used include interpretation of DEMNAS data with a spatial resolution of approximately 8.1 m, processed using ArcGIS 10.8, combined with morphographic and morphometric analysis, drainage pattern analysis, and field verification to identify relief, slope gradient, lithology, and active geomorphic processes. The results show that the Cibalong area is dominated by Low Denudational Hills and Denudational Hills units. Slope classes of 15–30% and 30–70% dominate the study area, indicating undulating to hilly relief. Denudational landforms mainly develop on tuff of the Jampang Formation and tuffaceous sandstone, sandstone, and claystone of the Bentang Formation, which are relatively susceptible to weathering and erosion. The sub-parallel drainage pattern and the presence of rotational slides indicate that denudational processes remain active. Therefore, the geomorphology of Cibalong is mainly controlled by lithological characteristics, slope morphometry, drainage development, and the intensity of denudational processes. These findings provide scientific insight into denudational landscape development in the Southern Mountains of West Java and offer practical baseline information for geomorphological mapping, slope hazard assessment, and land-use planning in similar hilly terrains.

Keywords: Geomorphology, Denudational, Lithology, Landforms, Cibalong

INTRODUCTION

Geomorphology is a branch of Earth science that examines landforms, their formative processes, and landscape changes resulting from the interaction between endogenous and exogenous factors (Huggett, 2017). In geological studies, geomorphological analysis is essential for understanding the relationship between surface relief, lithology, geological structures, drainage patterns, weathering, and erosion intensity. Denudational landforms commonly develop in areas dominated by exogenous processes, particularly weathering, erosion, mass movement, and surface material transportation.

The study area is located in Cibalong District and its surroundings, Tasikmalaya Regency, West Java Province, within the coordinates of S 07°46'00"–S 07°51'00" and E 108°04'00"–E 108°09'00", covering approximately 81 km² or 9 × 9 km at a mapping scale of 1:25,000 (Figure 1). Physiographically, the area belongs to the Southern Mountains of West Java, which developed under the influence of the regional tectonic setting of Java Island (Haryanto & Sudradjat, 2018). Previous morphotectonic studies in the Tasikmalaya region also indicate that regional geological structures influence topographic configuration, drainage development, and landscape evolution (Wulandari & Sutriyono, 2023). In the Cibalong area, this regional setting is expressed by undulating to hilly relief, slope variation, and the dominance of denudational processes, including weathering, erosion, and mass movement, which actively modify the landforms.

Based on geological mapping, the Cibalong area is mainly composed of the Jampang Formation and the Bentang Formation. These formations play an important role in the development of denudational landforms because they consist of tuff, tuffaceous sandstone, sandstone, and claystone, which are relatively susceptible to weathering and erosion. The physical properties of these rocks influence slope resistance, drainage pattern development, and the formation of denudational hills distributed across the study area. Therefore, the geomorphological characteristics of Cibalong are strongly controlled by the interaction between lithological conditions and surface degradation processes (Anhaer et al., 2024).

Denudational landforms develop through the interaction of weathering, erosion, lithological resistance, topographic relief, and drainage processes. Therefore, geomorphological analysis should integrate terrain characteristics with geological and morphometric information to understand the spatial variation of denudational processes. The integration of geomorphic indices and topographic parameters can provide quantitative information on landscape development and drainage-basin characteristics (Gusti et al., 2023).

However, systematic geomorphological documentation of denudational landforms in the Cibalong area remains limited. In particular, no detailed geomorphological mapping at a 1:25,000 scale has specifically explained the relationship between volcaniclastic and clastic lithologies, slope morphometry, drainage patterns, and denudational landform development in this part of the Southern Mountains of West Java. As a result, the role of the Jampang and Bentang Formations in controlling landform distribution, slope degradation, and active morphodynamic processes in Cibalong has not been clearly documented.

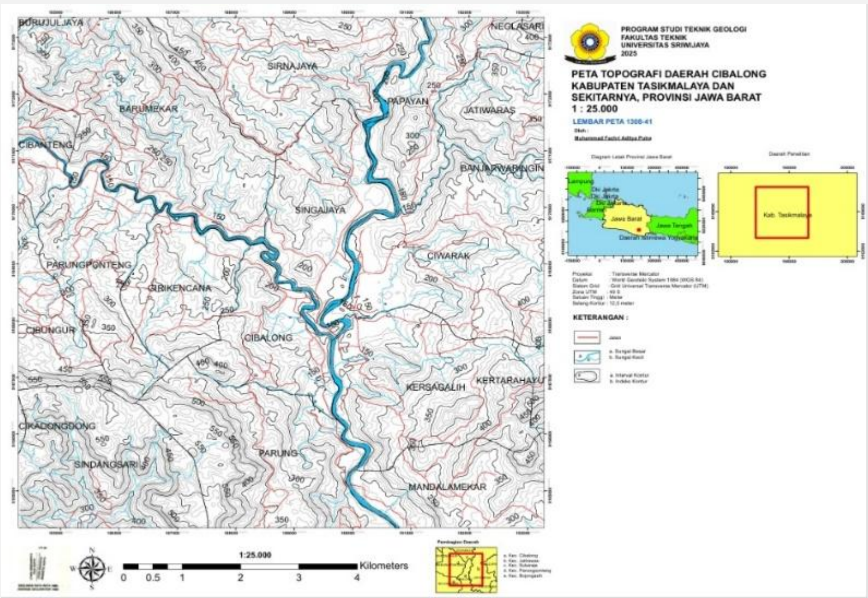

Figure 1. Topographic Map of the Research Area in Cibalong District, Tasikmalaya Regency, West Java Province and Its Surroundings.

Recent geomorphological studies in humid tropical volcanic and tectonically active landscapes emphasize that denudational landform development is controlled by the interaction among lithological resistance, rainfall-driven erosion, drainage morphometry, and slope instability. Moore et al. (2024) showed that volcanic-arc weathering in humid tropical settings is strongly influenced by the interplay between physical erosion and precipitation, indicating that erosion processes are important in maintaining the supply of fresh minerals to the weathering zone. Similarly, Adams et al. (2020) demonstrated that erosion rates in tectonically active landscapes are closely related to fluvial relief and mean annual rainfall, highlighting the importance of climate–topography coupling in landscape development. In Indonesia, studies from volcanic and tectonically active terrains have shown that the integration of DEM analysis, GIS-based mapping, field observation, and geomorphic indices is effective for identifying landform characteristics, landslide-prone zones, and active morphodynamic processes (Bachri et al., 2021; Gentana et al., 2018; Pratiwi et al., 2024). These studies provide an important comparative framework for analyzing the denudational geomorphology of Cibalong as part of a tropical volcanic-arc landscape in West Java.

This study addresses this gap by using integrated primary and secondary data to analyze denudational landforms in the Cibalong area. Primary data were obtained through field observations, while secondary data were derived from DEM analysis, slope maps, drainage pattern maps, river sinuosity interpretation, and lithological-stratigraphic data. Quantitative analysis of slope class distribution, drainage patterns, and the relationship between landform units and lithology was applied to explain the controlling factors of landscape development (Widyatmanti et al., 2016). Therefore, this study aims to characterize denudational landforms based on morphographic, morphometric, and morphogenetic aspects, identify the distribution and characteristics of Low Denudational Hills and Denudational Hills, and evaluate the influence of lithology and denudational processes on landscape evolution in the Cibalong area.

METHOD

This study employed a geomorphological mapping method with a descriptive-quantitative approach to identify the characteristics of denudational landforms in the Cibalong area, Tasikmalaya Regency. The study area covers approximately 81 km², or 9 × 9 km, with a mapping scale of 1:25,000. The data used in this study consisted of primary and secondary data. Primary data were obtained through field observations to identify actual geomorphological conditions, including relief forms, slope characteristics, lithological types, rock weathering intensity, erosion features, and the occurrence of mass movements or landslides. Field observations were also conducted to verify the initial interpretation derived from DEM data and thematic maps. Secondary data were obtained from Digital Elevation Model (DEM) data, elevation maps, slope maps, drainage pattern maps, and regional geological data containing lithological and stratigraphic information of the study area.

Data analysis was carried out by interpreting DEM data to determine elevation variations, relief forms, and topographic conditions of the study area. Slope analysis was conducted to identify the dominant slope classes and their relationship with denudational processes. Drainage analysis was performed by extracting the drainage network from DEM data and evaluating it using quantitative morphometric parameters, including stream order based on the Strahler method, drainage density, bifurcation ratio, and river sinuosity index. These parameters were used to support the interpretation of drainage characteristics and substantiate the classification of the sub-parallel drainage pattern in the study area. The interpretation results from DEM data, slope maps, drainage morphometry, and field observations were then correlated to ensure that the determination of geomorphological units corresponded to actual field conditions. Landform classification was conducted by integrating morphographic, morphometric, morphogenetic, lithological, and drainage morphometric aspects, resulting in the identification of denudational geomorphological units and the controlling factors of landscape development in the Cibalong area. This integrated analysis was also used to recognize zones indicating dominant surface degradation processes, particularly in undulating to hilly relief areas, which generally develop due to continuous weathering, erosion, and material transportation processes (Dewi et al., 2025).

The geomorphological analysis was conducted by integrating digital elevation model data, satellite imagery, geological information, drainage-network analysis, and field observations. This method integrated DEM-based morphometric analysis with observations of lithology, geological structures, and surface morphology (Sahara et al., 2022).

Data Collection

Data collection was conducted using both primary and secondary data. Primary data were obtained through direct field observations to identify the actual geomorphological conditions of the study area. Field observations included relief forms, slope characteristics, lithological conditions, degree of rock weathering, indications of surface erosion, and the occurrence of mass movements or landslides. In addition, field observations were used to verify the initial interpretation derived from topographic data and thematic maps, so that the information obtained more accurately represented actual field conditions. This field-based verification is important in geomorphological mapping because landform interpretation requires the integration of terrain characteristics, surface processes, and field evidence.

Secondary data were obtained from Digital Elevation Model (DEM) data, elevation maps, slope maps, drainage pattern maps, and regional geological data containing lithological and stratigraphic information of the study area. DEM data were used to provide information on topographic conditions, elevation variation, and relief characteristics. Slope maps were used to determine the distribution of slope classes, while drainage pattern maps were used to analyze the relationship between surface runoff, slope gradient, and lithology. Geological data were used as a basis for relating landform characteristics to their constituent rock units.

Drainage analysis was conducted quantitatively to support the interpretation of drainage pattern and its relationship with denudational processes. The drainage network was extracted from DEMNAS data and topographic maps, then classified using the Strahler stream-order method. Several morphometric parameters were calculated, including stream order, total stream length, drainage density, bifurcation ratio, and river sinuosity. Drainage density was calculated by dividing the total stream length by the study area, while bifurcation ratio was calculated by comparing the number of streams in one order with the number of streams in the next higher order. River sinuosity was calculated by dividing channel length by straight-line valley length. These quantitative parameters were used to substantiate the interpretation of sub-parallel drainage pattern and to evaluate the influence of slope gradient, lithology, and denudational processes on drainage development in the Cibalong area.

Data Analysis

Data analysis was conducted in an integrated manner using morphographic, morphometric, morphogenetic, and lithological approaches. Morphographic analysis was carried out to identify relief forms, elevation differences, and the general landscape characteristics of the study area. Morphometric analysis was conducted by processing slope gradient data to determine the dominant slope classes and their relationship with denudational processes. Drainage pattern analysis was performed to identify the characteristics of the drainage network and to assess the influence of topography and lithology on morphological development (van Zuidam et al., 1985).

Furthermore, the interpretation results from DEM data, elevation maps, slope maps, and drainage patterns were correlated with field observation data. This correlation aimed to ensure consistency between spatial data and actual geomorphological conditions in the field. Lithological analysis was conducted by relating landform units to their constituent rocks, particularly the Jampang Formation and the Bentang Formation, which play an important role in the development of denudational landforms. The final results of this analysis were used to determine the geomorphological units of the study area, namely Low Denudational Hills and Denudational Hills, as well as to explain the controlling factors of landscape development in the Cibalong area.

The use of DEM-based interpretation, slope classification, drainage pattern analysis, and field verification in this study follows recent approaches in quantitative and applied geomorphology. GIS- and remote-sensing-based geomorphological analysis has been widely used to relate landform characteristics to slope instability and landslide susceptibility in Indonesian volcanic and hilly terrains (Bachri et al., 2021; Nurwatik et al., 2022). In addition, quantitative geomorphic indices, such as drainage density, bifurcation ratio, basin shape, valley-floor width to valley-height ratio, and asymmetry factor, have been applied to evaluate the influence of tectonic and morphometric controls on drainage basin development (Gentana et al., 2018). Therefore, the integration of morphographic, morphometric, morphogenetic, and lithological parameters in this study provides a more systematic basis for interpreting denudational landforms in Cibalong.

RESULTS & DISCUSSION

The results and discussion section examines the geomorphological conditions of the Cibalong area, which are dominated by denudational landforms based on morphographic, morphometric, morphogenetic, lithological, drainage, and geomorphic unit analyses. The discussion includes variations in relief and elevation, slope gradient distribution, drainage characteristics, active geomorphic processes such as erosion and landslides, and the identification of the main geomorphic units, namely Low Denudational Hills and Denudational Hills. To ensure reproducibility, the distinction between these two units was defined using operational criteria adapted from the van Zuidam (1985) framework, including elevation range, relative relief, slope class, diagnostic morphological indicators, constituent lithology, and dominant denudational processes. Low Denudational Hills are characterized by lower elevation, generally around 50–200 m and locally up to approximately 300 m, low to moderate relative relief, gentle to moderately steep slopes, rounded hilltops, smoother slopes, wider contour spacing, and weaker topographic dissection. This unit is mainly associated with tuff of the Jampang Formation and is controlled by weathering, surface erosion, and minor mass movement. In contrast, Denudational Hills are characterized by higher elevation, generally around 200–500 m, moderate to high relative relief, gentle to steep slopes, undulating to hilly morphology, denser contour spacing, stronger topographic dissection, and a more developed drainage network. This unit mainly develops on tuffaceous sandstone, sandstone, and claystone of the Bentang Formation and is strongly influenced by fluvial erosion, slope degradation, and small-scale mass movement. In general, the discussion confirms that the landscape of Cibalong is controlled by lithology, topography, drainage development, and the intensity of denudational processes.

The morphology of denudational landscapes reflects the balance between landform-forming processes and landscape degradation through weathering, erosion, and fluvial incision. Areas dominated by erosion generally display more irregular and dissected morphology, whereas relatively linear and steep landforms may indicate stronger structural or tectonic control (Marbun et al., 2025).

General Geomorphological Overview of the Study Area

Based on the mapping results, the study area shows a close relationship between denudational geomorphology, stratigraphy, and local geological conditions. Stratigraphically, the study area is composed of the Bentang Formation, Jampang Formation, and Kalipucang Limestone. Based on raster-based area estimation, the Bentang Formation covers 32.38 km² or 39.97% of the total study area and consists of tuffaceous sandstone, sandstone, claystone, calcareous sandstone, and other clastic lithologies. The Jampang Formation covers 28.56 km² or 35.27% and is dominated by andesite-fragment breccia and tuff, while the Kalipucang Limestone occupies 20.06 km² or 24.76% of the study area. Geomorphologically, denudational landforms dominate the Cibalong area, with Denudational Hills covering 29.32 km² or 36.20% and Low Denudational Hills covering 24.81 km² or 30.63%. Together, these denudational units occupy about 54.13 km² or 66.83% of the total area. The remaining geomorphic units consist of Fault Zone Hills, covering 15.14 km² or 18.69%, and Karst Plains, covering 11.74 km² or 14.49%. These results indicate that denudational landforms mainly develop on volcaniclastic and clastic lithologies of the Jampang and Bentang Formations, whose relatively low resistance to weathering and erosion supports the formation of denudational hilly relief, particularly in zones affected by intensive surface degradation and fluvial modification (Fatimah et al., 2022).

Based on the geomorphological map of the Cibalong area, denudational landforms represent the dominant units and are widely distributed across the study area. These units are represented by Denudational Hills and Low Denudational Hills (Figure 2). Denudational Hills generally occupy the western to northwestern parts of the study area, particularly around Parungponteng, Girikencana, Barumekar, and Singajaya. This unit is characterized by undulating to hilly relief, relatively dense contour patterns, and small drainage networks that develop following the slope direction. These characteristics indicate that weathering, surface erosion, and material transportation processes occur intensively. In contrast, Low Denudational Hills develop in the central part of the study area, particularly around Cibalong and along the main river valley. This unit exhibits lower relief and relatively wider contour spacing compared to Denudational Hills, indicating weaker topographic dissection while still being controlled by denudational processes.

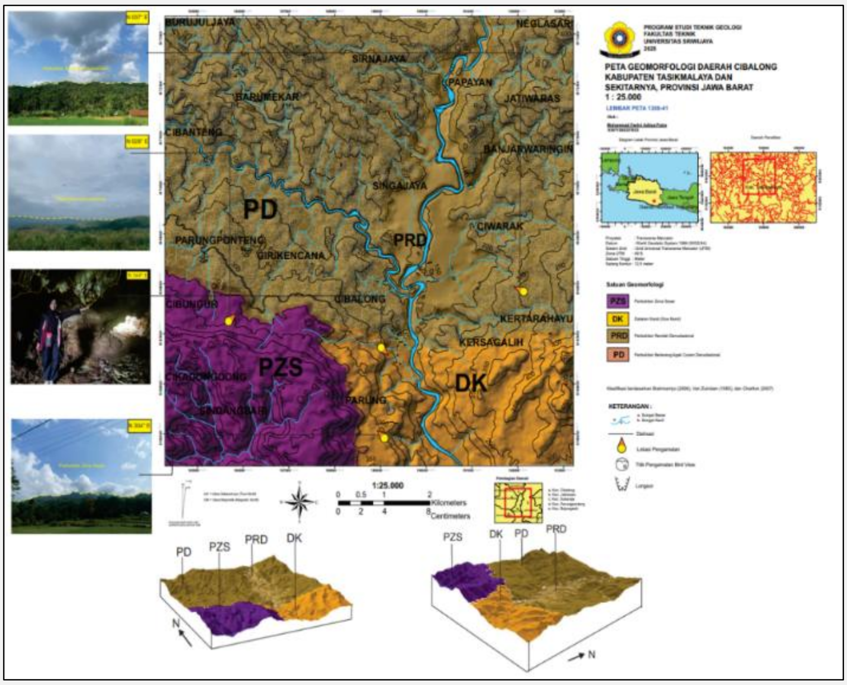

Figure 2. Geomorphological Map of the Research Area in Cibalong District, Tasikmalaya Regency, West Java Province and Its Surroundings.

Based on the integration of morphographic, morphometric, and morphogenetic analyses, the dominant geomorphic units in the study area are Low Denudational Hills and Denudational Hills. Both units reflect the strong influence of denudational processes on volcaniclastic and clastic rocks through weathering, erosion, mass movement, and surface material transportation. The undulating to hilly relief developed in these units indicates that denudation intensity plays an important role in shaping the landscape configuration of the study area. The presence of major and minor rivers on the geomorphological map also indicates that fluvial processes contribute to the modification of denudational landforms, particularly through slope erosion and valley formation. Therefore, the geomorphology of the study area is mainly controlled by lithological characteristics, topographic conditions, and the effectiveness of denudational processes (Suratiyono et al., 2024).

The dominance of denudational landforms on the Jampang and Bentang Formations shows that weathered volcaniclastic and clastic rocks strongly influence relief development, was shaped by regional tectonics and later modified by weathering and erosion (Haryanto & Sudradjat, 2018).

Morphography of the Study Area

Morphographically, the study area shows relief variations ranging from lowlands to high hills. Based on the classification of van Zuidam et al. (1985), elevation is divided into lowlands (<50 m), low hills (50–200 m), moderate hills (200–500 m), high hills (500–1000 m), and mountains (>1000 m); therefore, the elevation classification in Table 1 must be corrected by setting Class 4, High Hills, at 500–1000 m and Class 5, Mountains, at >1000 m. In the Cibalong area, the dominant elevation ranges from low hills to moderate hills, with low hill zones generally developing around river valleys and relatively flat areas, while moderate hills dominate the central part of the study area and form the main relief characteristics of the region. The elevation range of 112–300 m represents a transition from low hills to lower moderate hills, whereas elevations of around 300–700 m correspond to moderate to high hills and form the dominant morphological type (Huggett, 2017). High hills, particularly elevations above 500 m, mainly occur in areas associated with the volcanic units of the Jampang Formation. These elevation variations indicate that Cibalong is not a homogeneous plain, but a transitional landscape shaped by volcanic inheritance, carbonate units, and clastic sedimentary rocks that have undergone deformation and denudation. The distribution of low to moderate hills also reflects relatively intensive topographic dissection and the dominance of denudational processes, resulting in undulating hills and incipient valley formation, consistent with the concepts of van Zuidam et al. (1985) and Huggett (2017) that elevation variation can be used to interpret landform development stages.

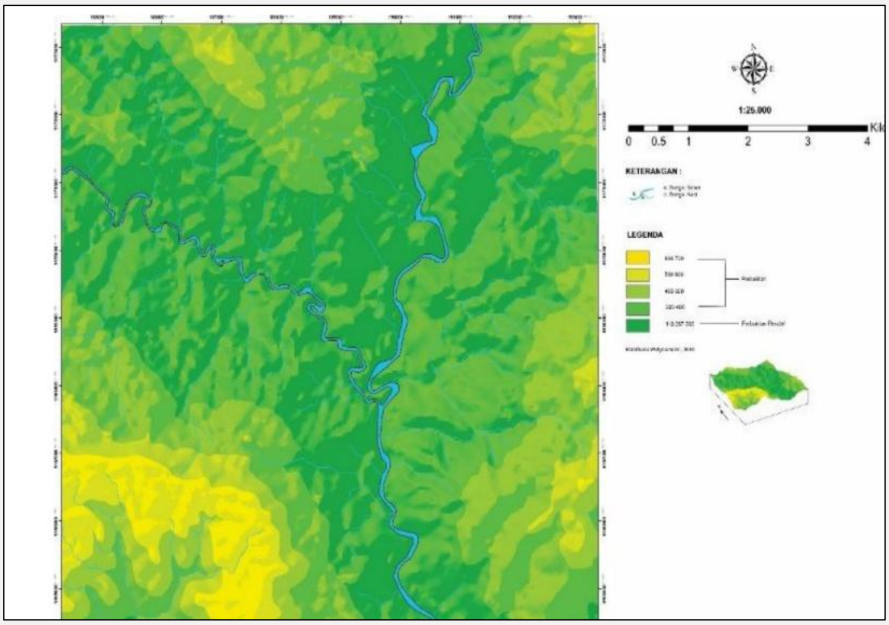

Figure 3. Elevation Map of the Research Area in Cibalong District, Tasikmalaya Regency, West Java Province and Its Surroundings.

Table 1. Morphology Classification from Van Zuidam, 1985

Class	Morphology	Absolute Elevation (m)
1	Lowland	< 50
2	Low Hills	50-200
3	Moderate Hills	200-500
4	High Hills	50-1000
5	Mountains	>10000

Morphometry and Slope Distribution

Morphometric analysis shows that the study area is dominated by moderately steep to steep slopes, particularly within the 15–30% and 30–70% slope classes (Figure 4). This condition reflects undulating to hilly topography shaped by intensive denudational processes (Huggett, 2017). Gentle slopes in the 7–15% class generally occur in transitional zones between valleys and hill footslopes (Table 2), while very gentle to flat slopes in the 2–7% and 0–2% classes are limited to floodplains and main river channels (Huggett, 2017). Very steep to extremely steep slopes exceeding 70% have limited distribution but are geomorphologically important because they indicate zones of high erosion intensity and greater landslide susceptibility.

Table 2. Slope Gradient Classification from Widyatmanti, 2016

Class	Description	Slope Gradient (%)
1	Flat	0-2
2	Very Gentle	2-7
3	Gentle	7-15
4	Moderately Steep	15-30
5	Steep	30-70
6	Very Steep	70-140
7	Extremely Steep	>140

Overall, slope variation in the Cibalong area indicates the dominant role of denudational processes in shaping regional relief (Huggett, 2017). The prevalence of moderately steep and steep slopes confirms that slope erosion, surface runoff, and small-scale mass movements are key processes in the landscape evolution of Cibalong. In less consolidated rocks, these slope gradients accelerate weathering and erosion. This interpretation is supported by several rotational slide landslides observed in the study area, indicating that slope morphodynamics remain active (Erfani et al., 2024).

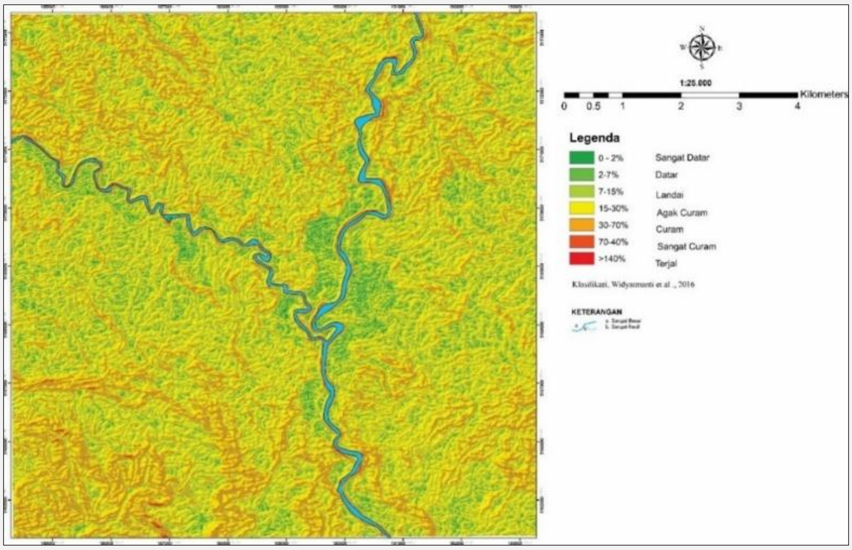

Figure 4. Slope Gradient Map of the Research Area in Cibalong District, Tasikmalaya Regency, West Java Province and Its Surroundings.

The dominance of the 15–30% and 30–70% slope classes further suggests that Cibalong is an active geomorphic setting undergoing slope degradation. These gradients directly influence surface runoff, erosion rates, and mass-movement potential, causing less consolidated rocks to be more easily degraded. Therefore, topography acts as an important controlling factor in landform development (Huggett, 2017).

Morphogenetic Analysis of The Study Area

Morphogenetic analysis examines how landforms are formed and modified by various physical and chemical processes occurring on the Earth's surface (Huggett, 2017). From a morphodynamic perspective, the study area indicates ongoing surface geomorphic activity, particularly in the form of landslides and soil mass movements. These processes play an important role in modifying denudational landforms through the downslope movement of materials, which is influenced by weathering, slope gradient, and rock resistance. In the study area, two landslide points were identified, indicating that denudation remains active in shaping the regional morphology.

Both landslides are classified as rotational slides, characterized by a curved slip surface and the rotational downslope movement of soil mass. At one location, the upper part of the slope, which is still covered by vegetation, appears to be tilted in the direction of movement, indicating that the landslide developed gradually within weathered materials (Isbahuddin et al., 2024). These landslide occurrences indicate that slope conditions, the characteristics of weathered materials, and vegetation cover are the main factors controlling slope stability. Therefore, landslide activity in the study area reflects the important role of morphodynamic processes in the development of denudational geomorphology.

The presence of rotational slides shows that morphogenetic processes in the study area are still active. The combination of relatively steep slopes, weathered materials, and rock properties with varying responses to water increases slope susceptibility. This finding emphasizes the importance of material characteristics and surface process dynamics in landform modification (Isbahuddin et al., 2024).

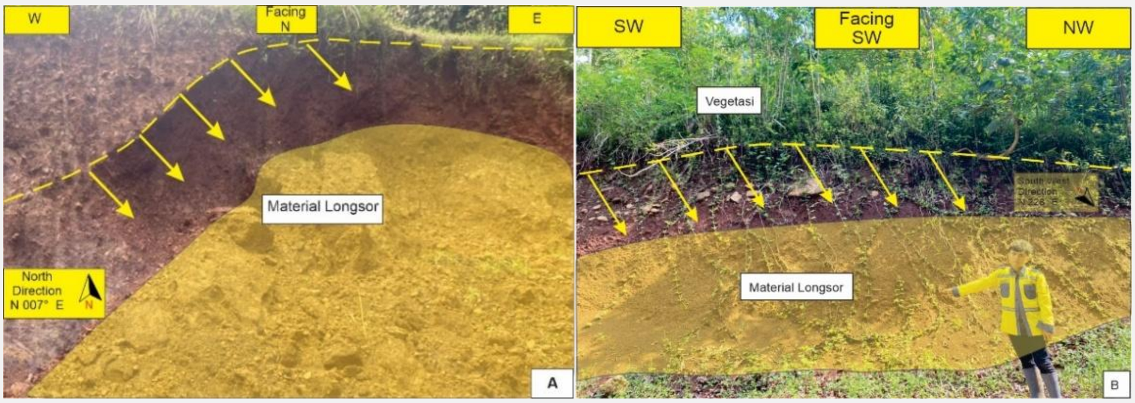

Figure 5. Landslide features in the study area. (A) Kersagalih Landslide (rotational slide), and (B) Cibalong Landslide (rotational slide).

Geomorphic Units

Landform determination in the study area was conducted through an integrated analysis of morphographic, morphometric, morphogenetic, and lithological parameters following the geomorphological classification framework of van Zuidam et al. (1985). In this study, Low Denudational Hills and Denudational Hills were distinguished using operational criteria based on elevation range, relative relief, slope gradient, morphological expression, constituent lithology, and dominant surface processes. Low Denudational Hills are defined as denudational landforms occurring at lower elevations, generally around 112–250 m above sea level, with relatively low relief, wider contour spacing, smooth slopes, rounded hilltops, and very gentle to gentle slopes ranging mainly from 2–15%, locally reaching 15–30%. This unit commonly develops on tuff of the Jampang Formation and is mainly controlled by weathering, sheet erosion, surface runoff, and gradual material transportation. In contrast, Denudational Hills are defined as denudational landforms occurring at higher elevations, generally around 250–500 m above sea level, with stronger topographic dissection, denser contour spacing, more variable slope gradients, and gentle to moderately steep or steep slopes ranging mainly from 7–30%, locally reaching 30–70%. This unit mainly develops on tuffaceous sandstone, sandstone, and claystone of the Bentang

Formation and is controlled by weathering, fluvial erosion, slope erosion, and small-scale mass movement. Therefore, the classification of these two geomorphic units is not only based on visual interpretation but also on measurable terrain characteristics and lithological controls.

The distinction between Low Denudational Hills and Denudational Hills indicates that landform classification in the study area was based on a combination of measurable terrain parameters and field-based geomorphic evidence. The differences in elevation, relief intensity, slope gradient, contour density, lithology, and dominant denudational processes provide a systematic basis for separating the two units. This approach strengthens the reproducibility of geomorphic unit interpretation and allows the classification to be validated against the van Zuidam et al. (1985) framework.

Low Denudational Hills

This landform was formed by continuous denudational processes, including weathering (Figure 6), surface erosion, and mass movement, which gradually eroded the constituent rocks and produced a hilly morphology characterized by rounded hilltops and smooth slopes (Huggett, 2017). The constituent lithology consists of tuff from the Jampang Formation, which has relatively low compactness, making it easily weathered and eroded by surface runoff. Genetically, these hills represent the degradation of structural landforms that have undergone chemical weathering and fluvial erosion over a long period following tectonic uplift (Anhaer et al., 2024). Rainwater runoff that erodes the slopes accelerates the removal of soil and weathered rock, while the dominance of weak materials, particularly tuffaceous sandstone, makes the slopes susceptible to small-scale collapse and mass movement during high rainfall. These processes form a low hilly landscape that is relatively stable but remains geomorphologically dynamic (Nuriyatman et al., 2025).

Low Denudational Hills indicate an advanced stage of denudation on materials with relatively low resistance. Rounded hilltops and smooth slopes suggest that the original structural landforms have been significantly reduced by dominant weathering and surface erosion processes. Therefore, the tuff of the Jampang Formation plays an important role as a lithology that is highly responsive to morphological degradation (Priyayi & Pratiwi, 2026).

Figure 6. Morphological appearance of Low Denudational Hills in the study area.

Denudational Hills

Denudational hills are formed through intensive surface degradation processes, mainly by weathering, surface erosion, and small-scale mass movement (Figure 7). Elevations of 250–500 m above sea level and gentle to moderately steep slopes (7–30%) indicate that this landform has undergone an advanced stage of geomorphic evolution, in which hilltops become rounded and slopes become gentler due to prolonged denudational activity. The lithology, consisting of tuffaceous sandstone, sandstone, and claystone of the Bentang Formation, is relatively susceptible to weathering and plays an important role in accelerating slope degradation processes (Isbahuddin et al., 2024). The interaction between weak materials, intense rainfall, and surface runoff promotes fluvial erosion and increases susceptibility to small-scale mass movements. Overall, these conditions indicate that denudational hills are landforms produced by long-term weathering and erosion, forming an undulating surface that is relatively stable but continuously modified by geomorphic processes (Priyayi & Pratiwi, 2026).

Denudational Hills show a relatively more pronounced degree of dissection because they develop on higher relief with greater slope variation. The Bentang Formation, which is relatively susceptible to weathering, is capable of forming undulating to hilly relief but is also more vulnerable to fluvial erosion and small-scale mass movements. Compared with the Low Denudational Hills unit, this landform shows a more distinct influence of lithological variation and topographic position (Suratinoyo et al., 2024).

Denudational Landform Characteristic

Denudational landforms in Cibalong are mainly represented by Low Denudational Hills and Denudational Hills. Low Denudational Hills develop on the tuff of the Jampang Formation, which has relatively low compactness. This material characteristic makes the unit easily weathered and susceptible to erosion by surface runoff (Huggett, 2017). Morphologically, this unit is characterized by rounded hilltops and smooth slopes, indicating that the initial relief has undergone prolonged degradation following regional uplift.

Denudational Hills predominantly develop on the Bentang Formation, which consists of tuffaceous sandstone, sandstone, and claystone. This unit commonly occurs at elevations of approximately 250–500 m above sea level, with gentle to moderately steep slopes. Due to the relatively weathered nature of the constituent rocks, the interaction between rainfall, surface runoff, and weak materials promotes the development of fluvial erosion. At the same time, steeper slopes are susceptible to small-scale mass movements. These conditions produce an undulating landscape with rounded hilltops and slopes that continue to undergo geomorphic adjustment.

Figure 7. Morphological appearance of Denudational Hills in the study area.

Discussion

Denudational landforms in the Cibalong area are mainly represented by two geomorphic units: Low Denudational Hills and Denudational Hills. These units indicate that the landscape of the study area is primarily shaped by weathering, surface erosion, material transportation, and mass movement. Low Denudational Hills develop on the tuff of the Jampang Formation, which has relatively low compactness and is therefore easily weathered and eroded by surface runoff. Morphological characteristics such as rounded hilltops and relatively smooth slopes indicate that this unit has undergone an advanced stage of denudation. Thus, this landform reflects a relatively more stable stage of relief degradation, although it continues to be gradually modified by ongoing exogenous processes.

The Denudational Hills unit shows more distinct relief characteristics than the Low Denudational Hills because it develops at higher elevations and has more variable slope gradients. This unit mainly occurs on the Bentang Formation, which consists of tuffaceous sandstone, sandstone, and claystone. Denudational hills are mainly influenced by erosional processes and slope instability, which increase their potential for landslide occurrence, especially in areas characterized by steep slope gradients (Gusti, 2026). These lithologies are relatively susceptible to weathering, allowing the interaction between rainfall, surface runoff, and weak rock materials to promote more active fluvial erosion. The undulating to hilly relief, rounded hilltops, and gentle to moderately steep slopes indicate that the denudational hills in Cibalong are the result of long-term weathering and erosion processes. Compared with the Low Denudational Hills, this unit is more susceptible to slope erosion and small-scale mass movements due to its higher topographic position and greater slope variation.

The denudational character of Cibalong is consistent with the broader geomorphological framework of the Ciletuh–Jampang region described by Haryanto & Sudradjat (2018). Their study explains that the Southern Mountains of West Java preserve a complex geological and geomorphological setting influenced by regional tectonic development and later modified by exogenous processes such as weathering, erosion, and mass wasting. In Cibalong, this regional framework is expressed at a more local scale through the dominance of undulating to hilly denudational relief developed on volcaniclastic and clastic rocks of the Jampang and Bentang Formations. Thus, the findings of this study confirm that the Cibalong landscape is part of the larger Ciletuh–Jampang geomorphological system, while also extending previous regional interpretations by providing more detailed evidence of how lithology, slope gradient, drainage pattern, and active denudational processes interact at a 1:25,000 mapping scale.

The findings of this study also correspond with recent research on tropical volcanic and tectonically active landscapes, where denudation is strongly influenced by the interaction between lithology, rainfall, erosion, and slope processes. Moore et al. (2024) emphasized that in humid tropical volcanic-arc settings, physical erosion plays an important role in controlling weathering fluxes by supplying fresh minerals to the weathering zone. This is consistent with the Cibalong area, where tuff, tuffaceous sandstone, sandstone, and claystone are relatively susceptible to weathering and erosion. Adams et al. (2020) further showed that erosion in tectonically active landscapes is linked to rainfall and fluvial relief, supporting the interpretation that slope gradient, runoff, and drainage development are important controls on denudational processes in Cibalong. Compared with landform and landslide studies in other Indonesian volcanic terrains, such as Malang and the Sumbing Volcanic Landscape, the Cibalong results similarly demonstrate that slope variation, weak lithology, and geomorphic process activity contribute to landscape instability and mass movement occurrence (Bachri et al., 2021; Pratiwi et al., 2024). However, this study extends those previous works by focusing specifically on denudational landforms developed on the Jampang and Bentang Formations in the Southern Mountains of West Java.

Compared with previous morphotectonic studies in the Tasikmalaya region, the geomorphology of Cibalong also shows that regional geological conditions influence topographic configuration and drainage development (Wulandari & Sutriyono, 2023). However, this study emphasizes that the present landform characteristics are not only controlled by inherited geological structure, but also by the susceptibility of local lithologies to weathering and erosion. The sub-parallel drainage pattern, moderately steep to steep slopes, and the occurrence of rotational slides indicate that denudational processes remain active. Therefore, the results do not contradict previous regional geomorphological models; instead, they refine those models by showing that local lithological resistance plays a major role in controlling the distribution and intensity of denudational landforms in Cibalong.

From a landscape evolution perspective, the denudational systems in Cibalong can be interpreted as being in an advanced but still active stage of geomorphic development. The Low Denudational Hills represent areas that have experienced prolonged relief reduction, as indicated by smoother slopes and rounded hilltops. In contrast, the Denudational Hills represent relatively more dissected terrain, where higher elevation, steeper slopes, and weaker lithologies continue to support active erosion and slope instability. The coexistence of these two units suggests differential denudation, in which less resistant materials are progressively lowered and smoothed, while steeper areas continue to undergo slope retreat, valley incision, and localized mass movement. This condition implies that the Cibalong landscape is not geomorphologically static, but is still evolving through ongoing surface degradation processes.

Overall, the development of denudational landforms in Cibalong shows a strong relationship between lithology, slope gradient, drainage pattern, and the intensity of denudational processes.

Relatively weathered rocks accelerate the formation of loose materials, while moderately steep to steep slopes increase surface runoff and material transport downslope. The presence of sub-parallel drainage patterns and rotational slide landslides indicates that denudational landforms in the study area are still undergoing active geomorphic adjustment. Therefore, the denudational landforms in Cibalong not only represent the results of past geomorphological processes but also reflect ongoing morphodynamic processes, particularly slope erosion, surface runoff, and mass movement.

Nevertheless, this study has several limitations. First, the geomorphological interpretation was conducted at a 1:25,000 mapping scale, so smaller landform variations and microtopographic features may not be fully represented. Second, the analysis relied on DEM-based interpretation, whose accuracy depends on the spatial resolution and quality of the elevation data used. Third, the landslide inventory was limited to two observed rotational slide locations, so it cannot yet represent the complete distribution of slope instability across the entire Cibalong area. Fourth, field verification was conducted within a limited field campaign, meaning that seasonal variations in erosion, runoff, and mass movement processes were not fully observed. Future studies should integrate higher-resolution topographic data, more extensive landslide inventories, rainfall records, geotechnical material properties, and repeated field observations to provide a more comprehensive understanding of denudational processes and slope hazard potential in the Cibalong area.

CONCLUSION & RECOMMENDATIONS

The Cibalong area, Tasikmalaya Regency, is dominated by denudational geomorphology that developed through the interaction between lithology, slope morphometry, and surface degradation processes. The main denudational landforms identified in the study area are Low Denudational Hills and Denudational Hills, which mainly develop on the tuff of the Jampang Formation and the tuffaceous sandstone, sandstone, and claystone of the Bentang Formation. The relatively weathered nature of these rocks promotes intensive weathering, surface erosion, and material transportation, resulting in undulating to hilly relief.

Morphometric analysis shows the dominance of the 15–30% and 30–70% slope classes, reflecting the strong development of denudational topography. The generally sub-parallel drainage pattern indicates the influence of slope gradient and lithology on the morphological development of the area. In addition, the presence of rotational slide landslides indicates that slope morphodynamic processes remain active and continue to modify the landforms.

The geomorphology of the Cibalong area is predominantly controlled by lithological characteristics and the intensity of denudational processes, as reflected in the development of denudational hills, slope dynamics, and landscape evolution in the study area. Based on these findings, more detailed geomorphological mapping is recommended, particularly in zones with slopes of 15–70% and in locations showing indications of active mass movement, so that slope hazard characteristics can be identified more accurately. Future studies should also integrate rainfall data, geotechnical properties of materials, and slope stability analysis to strengthen the interpretation of denudational processes and support spatial planning, disaster mitigation, and more adaptive land management in the Cibalong area.

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REFERENCES

Anhaer, N., Novian, M. I., & Novita, D. (2024). Facies analysis and sedimentation mechanism of volcaniclastics of cikarang member of jampang formation in west java. *Riset Geologi Dan Pertambangan, 34*(2), 111–129. http://dx.doi.org/10.55981/risetgeotam.2024.1343

Adams, B. A., Whipple, K. X., Forte, A. M., Heimsath, A. M., & Hodges, K. V. (2020). Climate controls on erosion in tectonically active landscapes. *Science Advances, 6*(42), eaaz3166. https://doi.org/10.1126/sciadv.aaz3166

Bachri, S., Shrestha, R. P., Yulianto, F., Sumarmi, Utomo, K. S. B., & Aldianto, Y. E. (2021). Mapping landform and landslide susceptibility using remote sensing, GIS and field observation in the Southern Cross Road, Malang Regency, East Java, Indonesia. *Geosciences, 11*(1), 4. https://doi.org/10.3390/geosciences11010004

Dewi, T. A. S., Nh, R., & Malik, A. (2025). Mengidentifikasi Geomorfologi Di Pulau Sumatera. *Pediaqu : Jurnal Pendidikan Sosial dan Humaniora, 4*(2), 2572–2581.

Erfani, S., Wijaya, R. C., Djana, M., Septiana, T., Naimullah, M., Gracia, C., Rizkiano, A., & Mulyasari, R. (2024). Identifikasi potensi longsor kawasan patahan Semangko menggunakan foto udara UAV (Studi kasus: Way Kerap, Semaka, Kabupaten Tanggamus). *Journal Online of Physics, 9*(2), 61–72. https://doi.org/10.22437/jop.v9i2.31987

Fatimah, S., Kasim, M., & Akase, N. (2022). Potensi Airtanah Menggunakan Metode Geolistrik Resistivitas Di Desa Molingkapoto, Kecamatan Kwandang, Kabupaten Gorontalo Utara, Provinsi Gorontalo. *Geosfera: Jurnal Penelitian Geografi, 1*(1), 1–9. https://doi.org/10.34312/geojpg.v1i1.14317

Gentana, D., Sulaksana, N., Sukiyah, E., & Yuningsih, E. T. (2018). Index of active tectonic assessment: Quantitative-based geomorphometric and morphotectonic analysis at Way Belu Drainage Basin, Lampung Province, Indonesia. *International Journal on Advanced Science, Engineering and Information Technology, 8*(6), 2460–2471. https://doi.org/10.18517/ijaseit.8.6.6089

Gusti, U. K. (2026). Geomorphic units, hazards, and land-use planning in Muaro Kalaban, West Sumatra, Indonesia. *Bulletin of Scientific Contribution: Geology, 24*(1), 73–88. https://doi.org/10.24198/bsc.v24i1.69483

Gusti, U. K., Peace, A. L., & Rimando, J. (2023). Tectonic geomorphology of the Ottawa–Bonnechere Graben, Eastern Canada: Implications for regional uplift and intraplate seismicity. *Canadian Journal of Earth Sciences, 60*(6), 635–652. https://doi.org/10.1139/cjes-2022-0137

Haryanto, I., & Sudradjat, A. (2018). On the Geomorphology and Tectonic Position of Ciletuh-Jampang Area, West Java, Indonesia. *Universal Journal of Geoscience, 6*(2), 47–54. https://doi.org/10.13189/ujg.2018.060203

Huggett, R. J. (2017). *Fundamentals of geomorphology (4th ed.).* Routledge.

Isbahuddin, M., Setiawan, M. A., & Widyastuti, M. (2024). Pemetaan Geomorfologi Detail untuk Analisis Karakteristik Erosi Tebing Sungai pada Sebagian Penggal Sungai Oyo, Kabupaten Bantul, Provinsi DIY. *Jurnal Ilmu Lingkungan, 22*(4), 1017–1023. https://doi.org/10.14710/jil.22.4.1017-1023

Marbun, A. G., Sutriyono, E., & Gusti, U. K. (2025). Tectono-geomorphic evaluation of Sumatran faults in Bengkulu Segment, Indonesia: Implication to seismic hazard. Warta Geologi, 51(1), 18–28. https://doi.org/10.7186/wg511202503

Moore, A. K., Méndez Méndez, K., Hughes, K. S., & Granger, D. E. (2024). Volcanic arc weathering rates in the humid tropics controlled by the interplay between physical erosion and precipitation. *AGU Advances, 5*, e2023AV001066. https://doi.org/10.1029/2023AV001066

Nuriyatman, E., Budhiartie, A., & Amir, L. (2025). Peran Hukum dalam Pengelolaan dan Perlindungan Lahan Gambut. *Jurnal USM Law Review, 8*(2), 753–776. https://doi.org/10.26623/julr.v8i2.11857

Nurwatik, N., Ummah, M. H., Cahyono, A. B., Darminto, M. R., & Hong, J.-H. (2022). A comparison study of landslide susceptibility spatial modeling using machine learning. *ISPRS International Journal of Geo-Information, 11*(12), 602. https://doi.org/10.3390/ijgi11120602

Pratiwi, E. S., Shen, S.-M., & Sartohadi, J. (2024). Understanding the nature of landslides through detailed geomorphological mapping on the Sumbing Volcanic Landscape, Java Island, Indonesia. *Journal of Maps, 20*(1), 2429710. https://doi.org/10.1080/17445647.2024.2429710

Priyayi, M., & Pratiwi, S. D. (2026). Spatial distribution of geomorphological units in the Gunungsungging area, Sukabumi Regency, West Java. *Journal of Geological Sciences and Applied Geology, 9*(1), 1–8.

Sahara, R., Fadhli, M., & Gusti, U. K. (2022). Morphotectonic analysis of South Solok area: Implication for geothermal manifestation and relative tectonic activity. *Journal of Geology Sriwijaya, 2*(1), 90–99.

Suratinoyo, M. S., Permana, A. P., & Kasim, M. (2024). Geologi dan Karakteristik Batupasir di Daerah Bumela, Kecamatan Bilato, Kabupaten Gorontalo. *Geosfera: Jurnal Penelitian Geografi, 3*(2), 66–79.

Van Zuidam, R. A., for Aerospace Survey, I. I., & (Enschede), E. S. (1985). *Aerial Photo Interpretation in Terrain Analysis and Geomorphologic Mapping.* Smits Publishers.

Widyatmanti, W., Wicaksono, I., & Syam, P. D. R. (2016, June). Identification of topographic elements composition based on landform boundaries from radar interferometry segmentation (preliminary study on digital landform mapping). In *IOP Conference Series: Earth and Environmental Science* (Vol. 37, No. 1, p. 012008). IOP Publishing. https://doi.org/10.1088/1755-1315/37/1/012008

Wulandari, S., & Sutriyono, E. (2023). Studi morfotektonik daerah Ereunpalay, Kabupaten Tasikmalaya, Jawa Barat. *Jurnal Universal Technic (UNITECH), 2*(2), 53–66.