

GEOMORPHOLOGICAL ANALYSIS OF THE SUKAMULYA AND SURROUNDINGS AREA, LANGKAPLANCAR AND CIGUGUR DISTRICTS, PANGANDARAN REGENCY, WEST JAVA PROVINCE

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ABSTRACT

Geographically, the Sukamulya and surroundings area, Langkaplancar and Cigugur subdistricts, Pangandaran Regency, West Java Province, are located at 108°30'9.44" E to 108°32'51.343" E and 7°33'42.896" S to 7°36'23.595" S. This study area is located in the South Mountain Zone of West Java, which is characterized by hilly relief and strong tectonic and volcanic influences. This study aims to identify geomorphological conditions and understand their formation processes based on morphographic, morphometric, and morphogenetic approaches. The research methods included spatial analysis or remote sensing using National Digital Elevation Model (DEMNAS) data and validation through geomorphological observations in the field. Several parameters were analyzed, including landform, river flow patterns, slope inclination, lithology, and the influence of geological structures. The results show that the study area is dominated by hills with altitudes between 115 and 436 meters above sea level and slope gradients ranging from 13% to 55%. The drainage patterns that developed were rectangular and subparallel, indicating the control of geological structures and slope inclination on the development of the drainage system. The geomorphological characteristics in the study area were divided into three units, namely the Slightly Steep Structural Hills Unit, the Steep Structural Hills Unit, and the Steep Volcanic Hills Unit. Generally, landscape formation in the study area is controlled by the interaction of endogenous processes such as tectonic activity and volcanism, as well as exogenous processes such as erosion and weathering. This study contributes to the fields of geology and geomorphology, serve as a basis for land use planning, and inform further studies on potential geological hazards such as landslides.

Keywords: geomorphology, Langkaplancar-Pangandaran, morphogenetic aspect, remote sensing, structural geology

INTRODUCTION

Geology is the science that studies the composition of the Earth, its structure, physical properties, history, and formation processes. One of its branches is geomorphology, a science that discusses the Earth's surface and the processes and aspects that influence it (Noor, 2012). It describes the physical and chemical forces that configure any shape, topography, or surface features on Earth (Putri, 2025). Geomorphology includes analysis of the origin, development, distribution of landforms and the interaction of natural processes with constituent materials in the study area (La Habi et al., 2025).

Fadhillah et al. (2021) stated that the Langkaplancar area and its surroundings have

three geomorphological units, namely the Steep Hills, the Gentle Volcanic Hills, and the Steep Denudational Hills. The study covers the analysis of geomorphological aspects, including morphography, morphometry, and morphogenetics.

Sopandi et al. (2020) also conducted a geomorphological study in the Pangandaran area to identify potential land that can be utilized, especially in the tourism industry. This geomorphological identification is not solely about resource potential. Lestari et al. (2023) researched disaster mitigation efforts, such as earthquakes and tsunamis, in the Pangandaran area.

Based on the three previous studies, this study aims to conduct a specific analysis of

one area in Pangandaran, namely Sukamulya and surroundings area, Langkaplancar and Cigugur districts, Pangandaran Regency, West Java Province. The analysis of this area is intended to map and determine geomorphological units and the processes that occur based on morphographic, morphometric, and morphogenetic aspects.

Regional Physiography

According to Van Bemmelen (1949), the Sukamulya and surroundings is part of the South Mountain Zone of West Java. Physiographically, this zone has a variety of landscapes resulting from the interaction of endogenous and exogenous processes, which are also influenced by regional tectonic activity in West Java and intensive denudation processes on steep slopes (Figure 1a).

Morphologically, this zone extends from Pelabuhan Ratu and continues to Nusakambangan Island in the southern part of Segara Anakan with a width of up to 50 km (Zulfi, 2026). The Southern Mountains of West Java are located south of Bandung and the Java Anticline (Priyayi, 2026), which slopes southward toward the Indian Ocean due to a period of contraction (Martodjojo, 2003).

RESEARCH METHOD

This study focuses on analyzing the geomorphology of the Sukamulya and

surroundings area, Langkaplancar and Cigugur subdistricts, Pangandaran Regency, West Java Province. Geographically, this area is located at 108°30'9,44" E to 108°32'51,343" E and 7°33'42,896" S to 7°36'23,595" S (Figure 1b). The objects of this study include landforms, slope gradients, and original landforms, which refer to the approach developed by Van Zuidam (1985), as well as river flow patterns identified through classification by Howard (1967). These aspects ultimately became the basis for determining and naming geomorphological units in the study area. In addition, the processing required Digital Elevation Model or DEMNAS data obtained from Badan Informasi Geospasial (2018).

The methods used in this study involved spatial analysis, remote sensing, and direct geomorphological observation in the field (Maulana, 2025; Fibrian, 2026). Remote sensing is a process of obtaining information in the form of objects, areas, and phenomena through spatial data analysis without having to make direct contact with the objects being studied (Lillesand and Kiefer, 1994). Direct observation plays a role in validating the results of remote sensing spatial analysis so that geomorphological units can be obtained accurately. The stages, objects, methods, and results of this study are presented in the research flowchart in Figure 2.

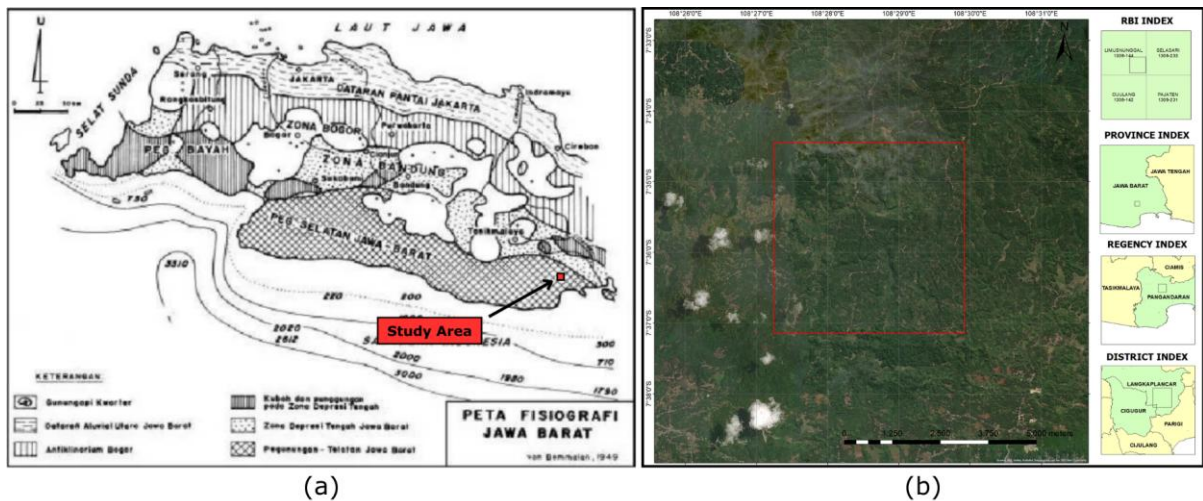


Figure 1. (a) Physiographic Map of West Java (Van Bemmelen, 1949 modified by Martodjojo, 2003); (b) Location of the Research Area

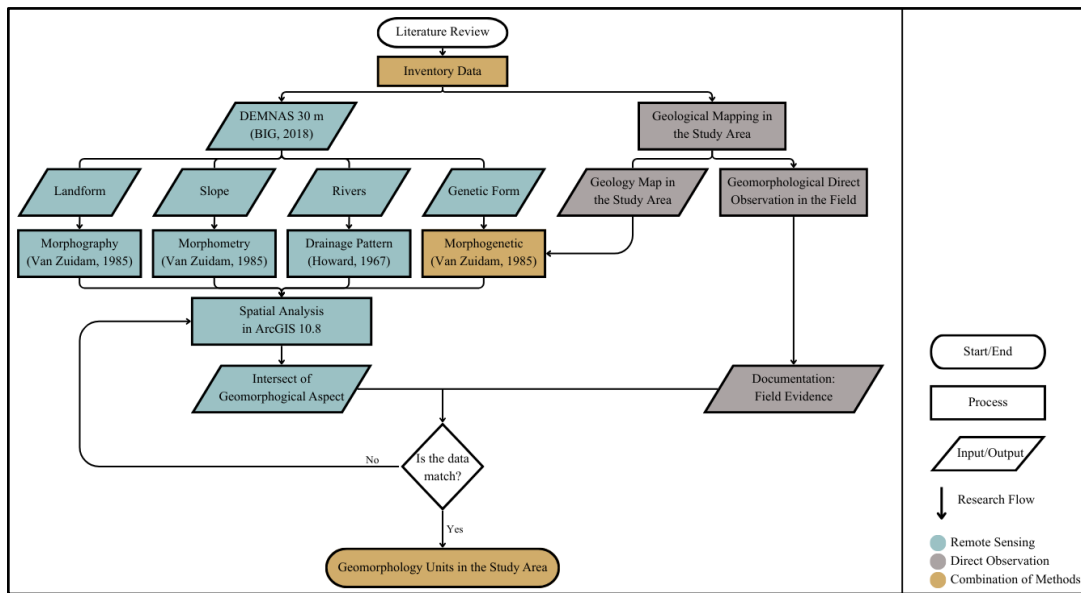


Figure 2. Research Flowchart

RESULT

The mapping area is located at an altitude of 115 – 436 meters above sea level (masl). The landform classification in the mapping area can be classified into hilly areas (100 – 500 masl) based on Van Zuidam's classification (1985) without interpreting it into low or high relief. These hills cover the mapping area with an area of 25 km² or 100%, as indicated by the dark green color (Figure 3).

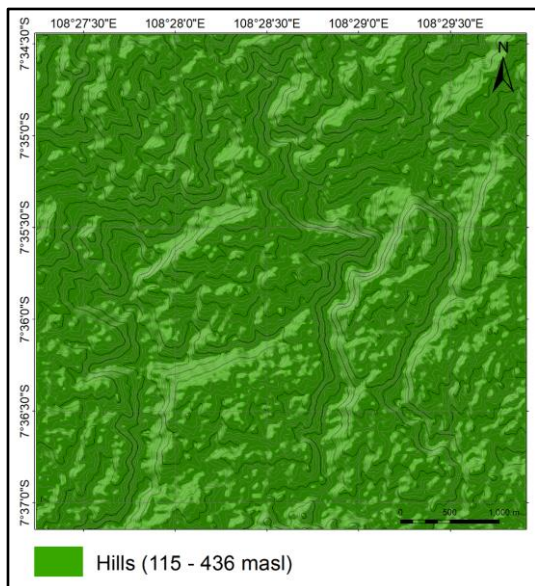


Figure 3. Morphography Map of Study Area

Through morphometric analysis using Van Zuidam's slope classification (1985), the mapping area is classified as slightly steep and steep slopes (Figure 4). Slightly steep slopes have a slope value of 13 - 20% with an area of approximately 10,18 km², or 40,72% of the total mapping area. This class is marked in

dark yellow and dominates the entire mapping area. Steep slopes have a slope value of 20 - 55% with an area of approximately 14,82 km² or 59,28% of the total mapping area. This class is marked in orange and dominates the northern part and extends to the south, northeast, northwest, east, and west. This class is highly developed along perennial or main river valleys in the mapping area.

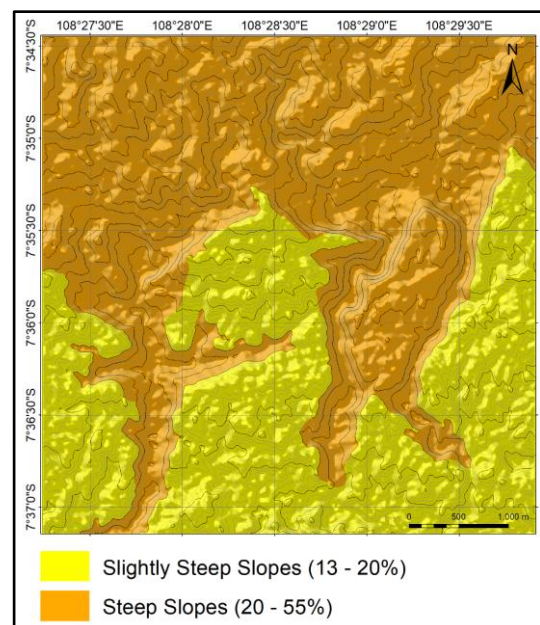


Figure 4. Morphometry Map of Study Area

Rivers in the mapping area are main rivers or perennial rivers, which flow continuously throughout the year. Temporary or intermittent rivers are rivers that only flow during the rainy season. Drainage patterns

are formed by erosion and tectonic activity, which create valley shapes as places for water to flow. The drainage pattern analysis was conducted based on topography, which was then compared with the patterns identified by Howard (1967). The drainage patterns that developed in the mapping area consisted of two types, rectangular and subparallel (Figure 5).

Rectangular developed in the western part of the area with an area of 11,10 km² or 45,2% of the total mapping area. The rivers that form this flow pattern are the Ci Ranta and Ci Dalima Rivers. Meanwhile, Parallel developed in the northern part of the area with an area of 13,46 km² or 54,8% of the total mapping area. The rivers that form this drainage pattern are the Ci Situ and Ci Julang Tengah rivers.

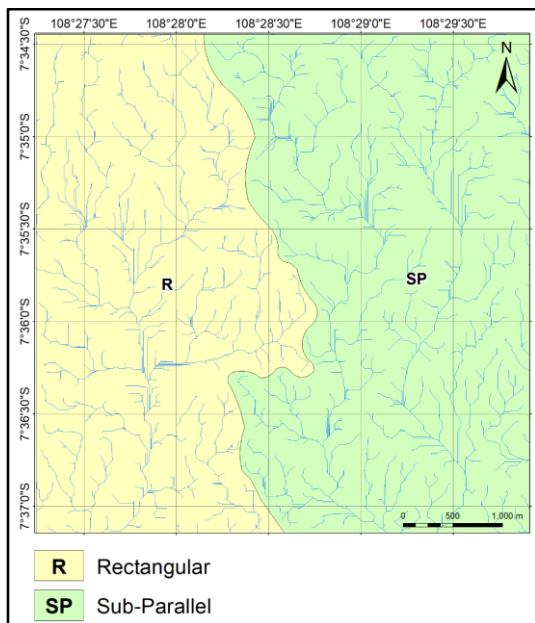


Figure 5. Drainage Pattern of the Study Area

In the morphogenetic analysis of the mapping area, the geomorphological processes that occur (exogenous and endogenous) and the constituent materials or lithology that have been divided into rock units are reviewed. These lithological units are in the form of geological maps of the mapping area obtained based on geological mapping and are used as a reference in interpreting the morphogenetics of the study area (Figure 6).

The findings in this direct observation show the supporting elements of morphogenetics, such as exogenous and endogenous processes, structural features, and constituent materials. Exogenous processes in the form of erosion and weathering play a role in the formation of the study area's landscape. The presence of erosion is characterized by

the outcrops in rivers and on land, as well as the appearance of perennial rivers with wide river profiles (horizontal erosion) and deep valleys (vertical erosion). Meanwhile, weathering processes are marked by physical changes such as color or hardness in rocks.

DISCUSSION

Endogenous processes that play a role are tectonic and volcanic. Tectonic activity in the mapping area has resulted in fractures with indications of slip faults, the discovery of four slickensides, and six folds based on the reconstruction of the stratification pattern. Meanwhile, volcanism has resulted in magmatism and volcanic activity, producing volcanic breccia and tuff lithology. Based on its lithological distribution, this area is composed of five rock units. The lithology consists of volcanic breccia, tuff, sandstone, and limestone.

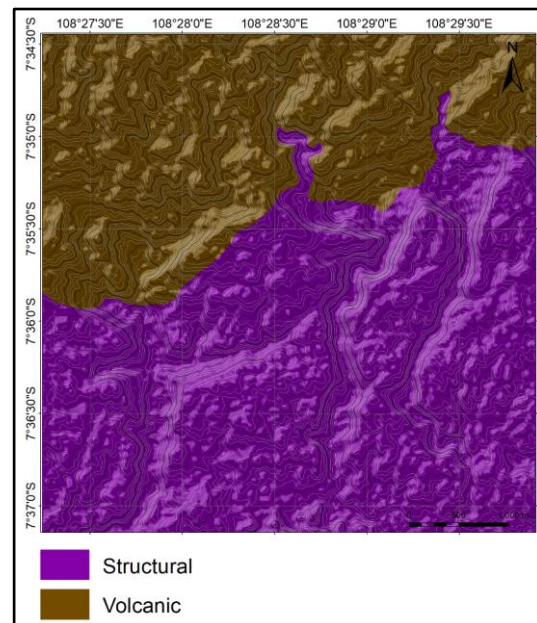


Figure 6. Morphogenetic Map of Study Area

Geomorphology

Based on the analysis conducted on the topographic map and supported by the analysis of morphographic, morphometric, drainage pattern, and morphogenetic aspects, the geomorphological units of the mapping area are divided into three (3) units as follows (Table 1 & Figure 7).

Slightly Steep Structural Hills

This unit has an area of 9,93 km² or 39,72% of the total mapping area, filling the central part from east to west. Morphographically, the landform consists of hills with heights ranging from 115 to 300 meters. Morphometrically,

the slope gradient ranges from 13 to 20% and is classified as Slightly Steep (Van Zuidam, 1985).

This unit has U-shaped and V-shaped valleys scattered with developed drainage patterns, namely rectangular and subparallel. The exogenous processes at work are erosion and weathering which have a minor influence, while the endogenous processes occurring are strongly controlled by geological structures in the form of fractures, folds, and faults, which are present in tertiary rocks with tuffaceous sandstone, sandstone, and limestone lithology.

Steep Structural Hills

This unit has an area of 5,43 km² or 21,72% of the total mapping area, which dominates the southern and central parts of the east-west. Morphographically, the landform consists of hills with heights ranging from 115 to 300 meters. Morphometrically, the slope ranges from 20 to 55% and is classified as steep (Van Zuidam, 1985).

This unit has a scattered V-shaped valley with a developed drainage pattern, namely Rectangular and Subparallel. The exogenous processes at work are erosion and weathering which have a minor influence, while the endogenous processes occurring are strongly controlled by tectonic activity in the form of fractures, folds, and faults, which are present in tertiary rocks with tuffaceous sandstone and sandstone.

Steep Volcanic Hills




This unit has an area of 9,19 km² or 36,76% of the total mapping area, covering the northern and central parts of the east-west. Morphographically, the landform consists of hills with heights ranging from 175 to 436 meters. Morphometrically, the slope gradient ranges from 20 to 55% and is classified as steep (Van Zuidam, 1985).

This unit has scattered V-shaped and U-shaped valleys with developed rectangular and subparallel drainage patterns. The exogenous processes at work are erosion and weathering, while the endogenous processes occurring are strongly controlled by volcanic activity in the form of tertiary volcanic rocks with volcanic breccia and tuff lithology.

Geomorphological Field Evidences

Direct observations in the field mapping area showed several documents taken. There are six geomorphological photos that have been observed with codes, coordinates, azimuth, and elevation. G-01 is located at 108°27'57,3" E 7°36'18,0" S with an azimuth of N306E and an elevation of 176,85 masl (Figure 8a). G-02 is located at 108°29'30,5" E 7°36'41,2" S with an azimuth of N010E and an elevation of 142,12 masl (Figure 8b). G-03, located at 108°29'28,1" E 7°35'32" S with an azimuth of N025E and an elevation of 254,30 masl (Figure 8c). G-04 located at 108°29'03,4" E 7°34'53,9" S with azimuth N205E and elevation 307,13 masl (Figure 8d). G-05 located at 108°29'07,2" E 7°35'05,9" S with azimuth N139E and elevation 251,89 masl (Figure 8e). G-06, located at 108°29'09,8" E 7°35'09,8" S with an azimuth of N202E and an elevation of 229,91 masl (Figure 8f).

Table 1. Geomorphological Unit Explanations

Geomorphology Unit	Symbol	Geomorphological Characteristics								
		Morphography			Morphometry			Morphogenetic		
		Land Form	Drainage Patterns	Valley Shape	Elevation (masl)	Gradient Slope (%)	Slope Class	Endogenic	Exogenic	Lithology
Slightly Steep Structural Hills		Hills	R, SP	U - V	115 - 300	13 - 20	Slightly Steep	Tectonic	Erosion & Weathering	Tuff Sandstone, Sandstone, Limestone.
Steep Structural Hills		Hills	R, SP	V	115 - 300	20 - 55	Steep	Tectonic	Erosion & Weathering	Tuff Sandstone, Sandstone.
Steep Volcanic Hills		Hills	R, SP	V - U	175 - 436	20 - 55	Steep	Volcanism	Erosion & Weathering	Volcanic Breccia, Tuff.

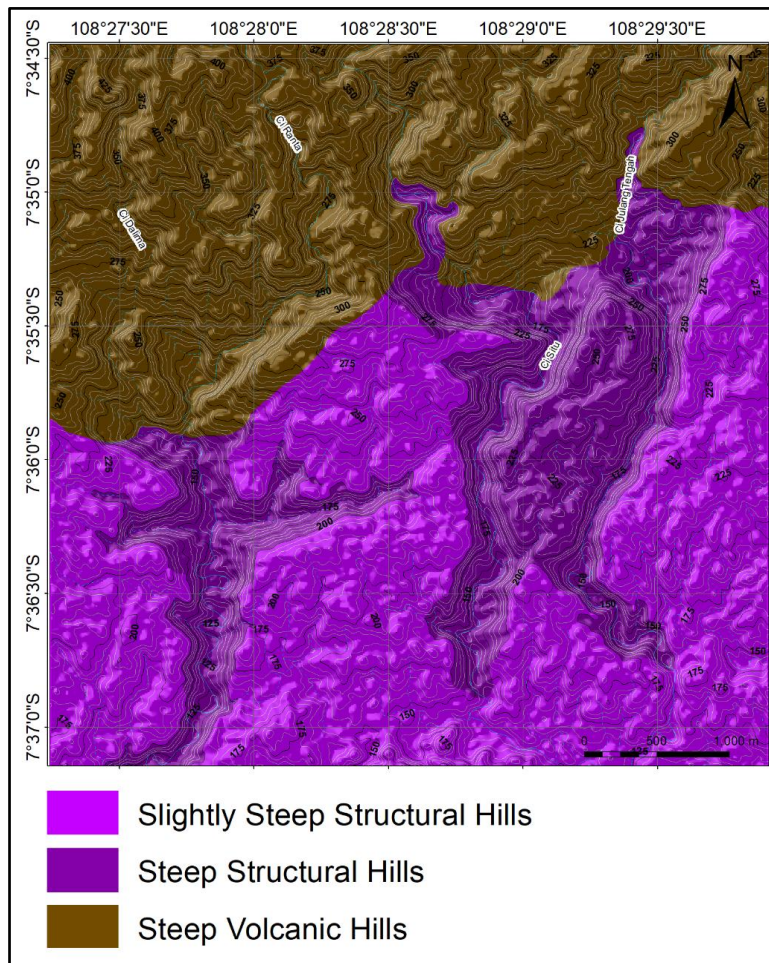


Figure 7. Geomorphological Map of Study Area



Figure 8. (a) Slightly Steep Structural Hills & Steep Structural Hills on G-01; (b) Steep Structural Hills on G-02; (c) Slightly Steep Structural Hills on G-03; (d,e,f) Steep Structural Hills & Steep Volcanic Hills on G-04, G-05, and G-06

CONCLUSION

The Sukamulya and surroundings area are categorized into three geomorphological units, namely the Moderately Steep Structural Hills Unit (39.72%), the Steep Structural Hills Unit (21.72%), and the Steep Volcanic Hills Unit (36.72%). The characteristics of this area are dominated by elevations between 115 and 436 meters above sea level, with slope gradients ranging from 13% to 55%. The river flow patterns that have developed are rectangular and subparallel, controlled by geological structures and slopes.

Geomorphological analysis has been conducted in depth in the study area through the integration of remote sensing methods using DEMNAS data and direct field observation validation. This includes aspects of morphography, morphometry, and morphogenetics, providing a comprehensive picture of the landscape and the processes that shape it.

This study contributes to the understanding of the interaction between endogenous processes (geological structures and volcanism) and exogenous processes (weathering and erosion) in the South Mountain Zone of West Java. Findings on geological structures such as strike-slip faults, folds, and the distribution of lithology such as volcanic breccia, tuff, sandstone, and limestone enrich the regional geological data in the Pangandaran area.

The results of this geomorphological mapping can be used as a basis for consideration in land use planning and regional development in the Langkaplancar and Cigugur subdistricts. For further research, it is recommended to conduct a more specific analysis of geological disaster risks, such as the potential for landslides or ground movement, given the dominance of steep slopes accompanied by geological structure control in most of the study area.

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