Geoplanology Modeling in The Planning Area of Majalengka, West Java

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ABSTRACT

Based on the geological condition, the study area consisted of carbonate sandstone units (Tmbp), claystone units (Tml), non-carbonate sandstone units (Tpbp), andesitic intrusions (Ia), volcanic breccia units (Qbv), and alluvium (Qal) units. The different types of constituent rocks will affect the innate characteristics or properties of the rock. The regional genetic units explain kinship relations between lithology, morphology, and tectonics. It is used to determine the genetic processes that occur in an area which will later be developed into the smallest units in the geological analysis. In terms of spatial planning, the geological analysis is needed to produce an ideal area in terms of water adequacy, environmental carrying capacity, and disaster. In accordance with Law No. 11 of 2011 concerning the district development plan of Majalengka, then a layout plan emerged that would be applied to the area. Especially in the research area, land suitability covers a possible area that has a value of> 131, spread in the north to the west of the research area, with high to the very high land capability to be developed. The constrained area which has a value of 121-131 is spread in the north to south of the research area, with the ability of the land to be developed. And the limitation area has a value of <121 dominating in the northwest to the southeast of the research area, with low land capacity - very low to be developed. Based on the analysis, there are still some areas that are not in accordance with the pattern of development which should be mainly the development of protected areas.

Keywords: *Regional Genetics, Geology, spatial, Geoplanology*

INTRODUCTION

One of the applications in geology is to provide direction for the development of a regional development both in the sectors of housing, education, agriculture, plantation, industry, etc. in a branch of science called Environmental Geology. Environmental geology is essentially applied geology which is intended as an effort to utilize natural and energy resources efficiently and effectively to meet the needs of human life today and in the future by minimizing the environmental impact that they cause. Directives in the development of the area are needed to support the development of a region, especially in developing cities such as Majalengka.

In accordance with the development directives of Majalengka Regency in 2018 contained in the Regional Regulation of Majalengka District No. 11 of 2011. The development of the Majalengka City area is focused on the industrial sector, especially textiles, Aerotropolis to support the development of BIJB Kertajati, Tourism such as the Construction of Regional Facilities Paragliding, waterfalls, etc. such as road access, buildings, and others, and Ecotourism Areas to support

and maintain local wisdom Majalengka area, namely Gedong Gincu Fruit.

At each stage of development for a particular purpose, problems in the process and after development will surely emerge. Therefore, it is necessary to have an appropriate regional planning stage to produce recommendations for development direction so that the principle of sustainable development is created.

The Research location is administratively located in Majalengka District, Majalengka Regency, West Java Province. Geographically, the study area is at coordinates 108 ° 11'25 "BT to 108 ° 14'07" and -6 ° 29'54 "to -6 ° 52'27" which are illustrated in Figure 1.1.

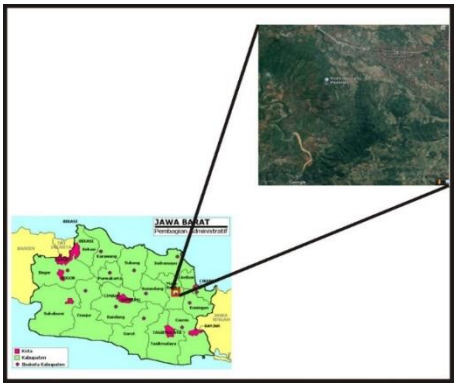

Figure 1.1 Research Area

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The Geological Condition of the Research Area

The geological condition of the study area is as follows:

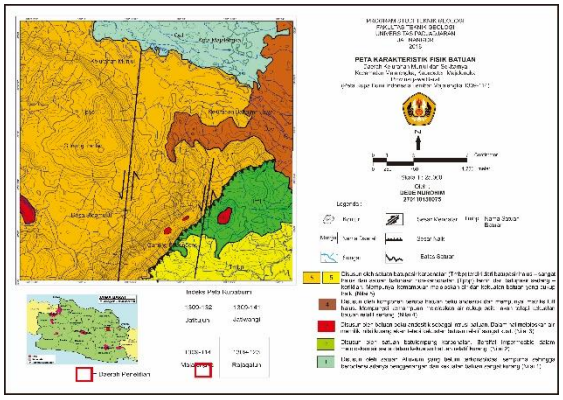

Figure 1.2 Regional Geology of Research (Advanced Geological Mapping, 2018)

a. Results of irreducible (Qyu) young volcanoes

Consisting of breccias, lava is andesite and basalt, tuffaceous sand, lapilli. Derived from Mount Tampomas (in sheet Bandung) and Mount Cereme. Usually, these rocks form low terrain or hills with land that is yellow-gray and reddish (Djuri, 1995).

b. Shale members from the Cinambo (Tomcu) Formation

It consists of flakes with intervals of sandstones and limestones, side sandstone, tuff sandstone, 400-500 m thick (Djuri, 1995).

c. Hornblende andesite (ha)

Shaped plate slabs, cracks with a width of 20-30 m (Djuri, 1995).

d. Citalang Formation (Tpc)

Consisting of light brown tuff sandstones, tuff clay, conglomerates, locally found hard limestone sandstone lenses (Djuri, 1995).

METHOD

The objects focused in this study are to find out the direction of development based on the geological analysis in the Majalengka sub-district by utilizing the principles of environmental geology. The aspects observed are the conditions of rocks and soil, groundwater, disasters, and others.

The field work phase includes geological mapping, engineering geology, and hydrogeology. This stage is a stage that supports the geological aspects of the environment. The method used in data analysis is the assessment and weighting of each of these land capabilities with the weighting and scoring method (Howard and Romson, 1978). The level of ability of the land has a value from 5 to 0 where a large value means that it has a better match, then a superimposed method is carried out so that the value of the ability of each land can be known. From the maps of land capability, a superimpose is carried out which will produce land suit zoning which includes:

- Possible Regions

It is an area that has high to a very high level of land capability to be developed. This area has relatively no physical constraints, it is ready to be developed and built as a development area.

- Constraint area

It is an area that has a level of land capability to be developed and built as a development area. Constraints that this region has developed and built will require additional costs

- Limitation area

An area with a low to the very low level of capability to develop, this area is more suitable to be a conservation area. Areas with high disasters such as floods, land movements, earthquakes, landslides, volcanic eruptions are included in the limitation area.

RESULT AND DISCUSSION

Determination of geoplanology terminology is taken by using physical aspects in the form of analysis of geological, hydrogeological, and geotechnical data which is integrated into environmental geological power in the development planning of the region. The discussion includes the interpretation and analysis in detail of the condition of the land in the research area.

A good residential environment must meet the criteria for physical and non-physical aspects of the settlement and the environment can accommodate the way of life of its inhabitants. One of them was stated in the 1993 GBHN (State Policy Outline) on an area's development with the aim of increasing the harmony of growth rates between regions.

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Physical Characteristics Analysis of Rocks (5)

The patterns of rock distribution, species, and rock properties, age, vertical cross-section, stratigraphy, structure, tectonics, and physiography in the study area are explained in the Geological Map. The characteristics of bedrock affect the carrying capacity of infrastructure development and regional development. The characteristics are composed of carbonate sandstone units (TMBP) consisting of fine sandstones - very fine and non-carbonate sandstone units (Tpbp) consisting of medium - gravel sandstones. Has the ability to pass water and rock strength that is quite good **(Value 5).** Composed by components in the form of andesitic igneous rock and having a smooth tuff matrix. Having the ability to escape water is good but rock strength is relatively moderate **(Value 4).** Composed by andesitic igneous rocks as rock intrusion. In terms of passing water, it has less value but the strength of the rock is relatively very strong **(Value 3).** Composed by carbonate claystone units. It is impermeable in passing water and in rock strength relatively less **(Value 2).** Compiled by Alluvium units that have not been fully consolidated so that there is a potential for very little flooding and rock strength **(Value 1**).

Slope Analysis (5)

This aspect is analyzed from the conditions of morphology, slope (Zuidam, 1985), and vegetation that support the slope aspect data. The characteristics are as follows: Sloping slopes that have a slope of 4 ° - 8 ° with open land conditions. Under these conditions, it does not allow significant ground movement due to sloping slope conditions but is open land **(Value 5).** The slope is very steep which has a slope of 35 ° - 55 ° with the condition of dense vegetation. In these conditions, although it has a very steep slope, it has dense vegetation so that it rarely allows for land movement **(Value 3).** Steep slopes that have slopes of 16 ° - 35 ° with rare vegetation conditions. In these conditions, it is possible to move the land **(Value 2).** The trench slope has a slope of more than 55 ° with the condition of dense vegetation. These conditions can be developed, but engineering is needed to minimize the risk of slope conditions **(Value 1).**

Groundwater Potential Analysis (5)

This aspect was analyzed from the results of hydrogeological mapping, pumping tests, and lithology that supported the data on potential groundwater aspects. Based on the results of the hydrogeological mapping, 11 observation points of wells and 2 points of water were obtained and reflected groundwater flow relatively south-north. In the study area consisted of 3 types of characteristics of potential groundwater, namely: Aquifers with high productivity and wide distribution. Has a discharge of 8.3 l / s with surface lithology of volcanic breccia and part of alluvium **(Value 5).** Local aquifers with moderate productivity. Has a discharge of 7.4 l / s with surface lithology of sandstone and part of alluvium **(Value 3).** Aquifers with low productivity, local means. Has a discharge of 0.23-2.2 l / s with sandstone unit lithology **(Value 2).** The area of groundwater is scarce or meaningless. Found springs that are used as a place to meet the needs of citizens with a discharge of 0.039 - 0.6 l / s with surface lithology of claystone units, sandstones, and igneous intrusion **(Value 1).**

Figure 1.3 Local groundwater observation wells with moderate productivity

Figure 1.4 Springs in rare or insignificant groundwater areas

Potential Analysis of Soil Movement (5)

This aspect was analyzed from slope aspects, soil types, and compositions of erodible rock composers, landslide points, and structural controls that can be known from the analysis of geological mapping. Based on the results of the technical geological mapping, there were 3 landslide points found in the study area. In

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the study area consists of 4 types of potential characteristics of soil movements, namely: Very Low Ground Movement Zone; this zone is rarely or almost no land movement. The sloping area with a slope of 4 ° - 8 ° with open land. The type of soil found in this area is Low-high Plasticity Clay and Pasir **(Value 5).** Low Ground Movement Zone; this zone rarely occurs in ground movements only to the extent that cracks are visible on the road. Sloping areas with a slope of 6 ° - 8 ° with rare vegetation. The type of soil found in this area is a low plasticity clay **(Value 4).** Middle Land Movement Zone; this zone has occurred several times with land movements such as landslides that damaged roads and fields. This area has a slope of 16 ° - 55 °. The soil types found in this area are low-high plasticity clay **(Value 3).** Zone of the High Land Movement; this zone often landslides. This area has a slope of> 55 °. The type of soil found in this area is low-high plasticity clay **(Value 2).**

Picture 1.5 soil cracks and landslides on the Sidamukti road section

Earthquake Hazard Analysis (3)

This aspect is seen from the existence of structural controls that can be known from the analysis of geological mapping. In the study area consists of 1 type of potential earthquake hazard characteristics, namely: Middle Earthquake Zone; This area has the potential to be affected by earthquake shocks with an intensity scale ranging from VII - VIII MMI. Ground cracks, pulses, avalanches on steep hills in small dimensions are still possible. Buildings with designs and construction that are either not damaged or are only experiencing minor damage. Buildings with ordinary structures that are well constructed have mild to moderate damage. Buildings that are not well built with poor structures can experience severe damage. Fencing walls, chimneys, piles of items, monuments can collapse **(Value 3).**

Volcano Hazard Analysis (3)

This aspect is seen from the existence of active volcanoes in the research area. The conditions in the study area are safe volcano zones. In this zone, there is no potential for volcanic eruption around the study area, especially the southern volcano, namely Ciremai Mountain. Safety factors in this area are due to the location far from the source of the volcano **(Value 5).**

Drainage System Analysis (5)

This aspect is seen from the slope, lithology conditions, and tributary branches. The research area consists of 5 types of drainage system characteristics, namely: Very poor drainage system; has a gentle slope (4 ° - 5 °). Little or no deformation so that the tributaries are very few to only order 2 (Howard, 1967)., but are traversed by large rivers (Cijurey River). Water cannot flow properly so that there will be potential for standing water on the surface **(Value 1).** Poor drainage system; has a slope (6 ° - 8 °). Slightly deformed so that the branching of the tributaries is slightly (Order 3) (Howard, 1967). Surface water cannot flow properly so that in this area surface water has the potential to occur **(Value 2).** Medium drainage system; has a relatively steep slope (16 ° - 35 °). Moderate deformation so that there are several branches of tributaries (Order 3) (Howard, 1967). Surface water can flow well, so in this region, there is rarely potential for surface inundation **(Value 3).** Good drainage system; has a very steep slope (35 ° - 55 °). High deformation so that there are several branches of tributaries (Order 4) (H0ward, 1967). Surface water can flow well so that there is no potential for surface inundation **(Value 4).** The drainage system is very good; has a steep slope (> 55 °). High deformation so that there are several branches of tributaries (Order 3) (Howard, 1967). Surface water can flow properly so that in this area there is no potential for surface inundation **(Value 5).**

Bearing Capacity of Soil Analysis (5)

This aspect is seen from the condition of physical and mechanical properties of the soil, lithology conditions, and the value of carrying capacity of the soil. Field conditions successfully charted 43 ground stations and 5

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Undisturbed Sample drilling points. In the study area consisted of 3 types of soil carrying capacity, namely: High, having surface lithology of sandstone and claystone units with characteristics of high-low plasticity clay soils. Has a value of soil carrying capacity of 17.93 t / m2 - 30.9 t / m2 and clay activity value of 0.54 - 0.97 is classified as kaolinite-illite (Das, 1995) **(Value 5).** Intermediate, has a surface lithology of volcanic breccia unit with characteristics of low plasticity clay so well graded sand. Has a carrying capacity of 8.14 t / m2 and the value of clay activity 1.16 is classified as illite (Das, 1995) **(Value 4).** Low, has surface alluvium lithology with characteristics of low plasticity clay so that graded sand is good. Has a carrying capacity of 2.15 t / m2 and clay activity value of 0.43 is classified as kaolinite (Das, 1995) **(Value 3).**

Land Ability Zone

Based on calculations using statistical analysis, on the ability of land in the development of residential areas, the research area is divided into five areas of land capability with the following scores:

a. The total score is> 141,695, categorized as a region with a very high level of land capability.

b. The total score in the range 131.36 - 141.695, is categorized as an area with a high level of land capability.

c. The total score in the range 121.03 - 131.36 is categorized as an area with moderate land capability.

d. The total score in the range 110.7 - 121.03 is categorized as an area with low land capability.

e. The total score of <110.7 is categorized as a region with very low land capability

Land Suitability Zone

The research area is divided into 3 land suitability regions with the following scores:

- Areas of possibility

This region has a value of> 131, spread in the north to west of the research area, with high to the very high land capability to be developed. This is very good aspects of rock and soil physical characteristics, the potential for natural disasters is very low, the potential for the presence of groundwater is quite good.

- Constraints area

This area has 121 - 131 numbers scattered in the north to south of the research area, with the ability of the land to be developed. This is based on various obstacles that may occur, but these obstacles can still be overcome by engineering and the costs that are not too high to minimize obstacles occur. These constraints include the physical characteristics of rocks and poor soil, rare groundwater, poor drainage, the slope of slopes is too steep and the potential for disasters that may occur.

- Limitation area

This area has a value of <121 dominating in the northwest to the southeast of the research area, with low land capacity - very low to be developed. This is based on various obstacles that occur, with engineering capabilities such as in the Central Region with steep to steep slopes can be used as protected areas. Active fault areas also influence this region as an obstacle. Besides these obstacles such as ground movement, steep slopes, rare groundwater conditions are a number of problems in this area

Solutions and Directives

The analysis was carried out by comparing the geoplanological models produced with the current spatial conditions and regional spatial plans for 2011 - 2025.

a. West - North

In the west - north area, based on the Regional Space Pattern Map, the area is an urban settlement, wetland agriculture, river borders, community forests, and tourist areas. The river border area listed in Law Number 38 the Year 2011 (Article 12) states that "Underside border lines outside urban areas are determined to be at least 5 meters from the outer edge of the embankment along the river channel". Current conditions along the river channel are still settlements that are developing in this area. the results of the geoplanology model show that this area is a region of possibilities, constraints, and limitations to be developed

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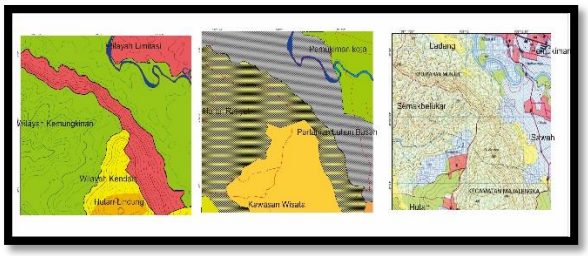


(a) (b) (c)

Figure 1.6 Comparison of geoplanology results (a) with the regional spatial plan map (Dep. PU, 2011) (b) and the current land use map (Bakosurtanal, 1990) (c) west - north.

b. North - East

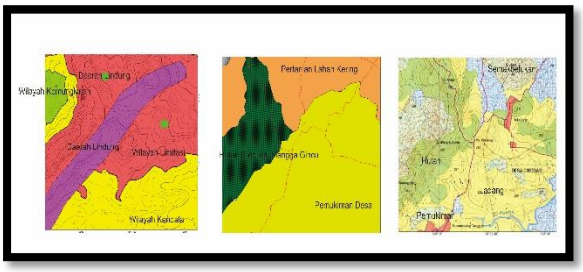
In the North-East region, based on the Regional Space Pattern Map, the area is urban settlements, education, river borders, government, wetland agriculture, dry land agriculture, and forest production of mango gincu. Current conditions along the river channel are still settlements that are developing in this area. in addition, the education area is in an area of limitation where the education area requires very high groundwater productivity. The results of the geoplanology model show that this area is a region of possibilities, constraints, and limitations to be developed.

(a) (b) (c)

Figure 1.7 Comparison of geoplanology results (a) with the regional spatial plan map (Dep. PU, 2011) (b) and the current land use map (Bakosurtanal, 1990) (c) north-east part.

c. Southeast

In the east - south area, based on the Regional Space Pattern Map, this area is a village settlement, dry land agriculture, and the production of mangoes is thick. Current conditions indicate that there are still settlements that stand inactive fault protected areas. Whereas in Law No. 38 of 2011 that the zoned Active Fault Protected Area Line is determined to be at least 250 meters from the outer edge ". In addition, residential areas are in areas of limitation where residential areas require very high groundwater productivity. The results of the geoplanology model show that this area is a region of possibilities, constraints, and limitations to be developed.

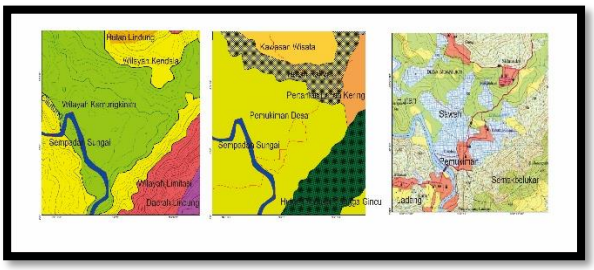


(a) (b) (c)

Figure 1.8 Comparison of geoplanological results (a) with the regional spatial plan map (Dep. PU, 2011) (b) and the current land use map (Bakosurtanal, 1990) (c) east – south.

d. South - West

In the south-west area, based on the Regional Spatial Pattern Map, the area is village settlements, river borders, dry land agriculture, Tourist Area, and community forests. In this condition, the ideal parameter is to build a village settlement because it is in a limitation area that is still able to meet the needs of the community. However, along with the river channel, there are still settlements that have developed in this area.



(a) (b) (c)

Figure 1.9 Comparison of geoplanology results (a) with the regional spatial plan map (Dep. PU, 2011) (b) and the current land use map (Bakosurtanal, 1990) (c) south-west part.

CONCLUSION

The research area is divided into 3 land suitability regions with the following scores:

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• Areas of possibility

This region has a value of> 131, spread in the north to west of the research area, with high to the very high land capability to be developed. This is very good aspects of rock and soil physical characteristics, the potential for natural disasters is very low, the potential for the presence of groundwater is quite good.

• Constraints area

This area has a value of 121 - 131 spread in the north to south of the research area, with the ability of the land to be developed. This is based on various obstacles that may occur, but these obstacles can still be overcome by engineering and the costs that are not too high to minimize obstacles occur. These constraints include the physical characteristics of rocks and poor soil, rare groundwater, poor drainage, the slope of slopes is too steep and the potential for disasters that may occur.

• Limitation area

This area has a value of <121 dominating in the northwest to the southeast of the research area, with low land capacity - very low to be developed. This is based on various obstacles that occur, with engineering capabilities such as in the Central Region with steep to steep slopes can be used as protected areas. Active fault areas also influence this region as an obstacle. Besides these obstacles such as ground movement, steep slopes, rare groundwater conditions are a number of problems in this area.

Development recommendations must be examined in advance between the Land Suitability Map and the District Spatial Map. Majalengka and the current land use map. Based on the analysis, there are still some areas that are not in accordance with the pattern of development which should be mainly the development of protected areas. Regulations regulating the river border area must be at least 5 meters from the settlement and the active tectonic area is 250 meters from the settlement. Some settlements have been and are planned to be built in the constraints area, where the area will not be able to meet human needs in terms of groundwater, soil carrying capacity, and disaster.

SUGGESTION

The research area has diverse characteristics both from the aspects of lithology, morphology, tectonics, groundwater, physical characteristics of the soil, disasters, etc. All of these aspects must be utilized properly. The suggestions from the authors are as follows:

1. The pattern of development that must be applied to residents should not follow the National Road pattern with an elongated pattern. But it spreads to the south due to the good condition of the land and is still empty.

2. The pattern of settlements in the fault zone should be moved to areas that have the high land capability.

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Appendix

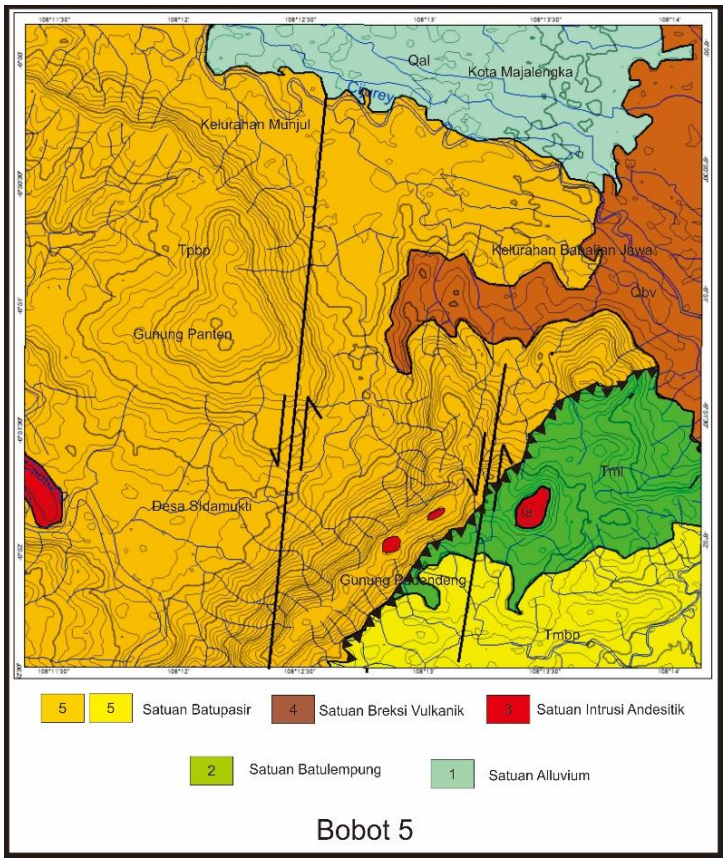

Figure 1.10 Physical Characteristics Analysis of Rocks

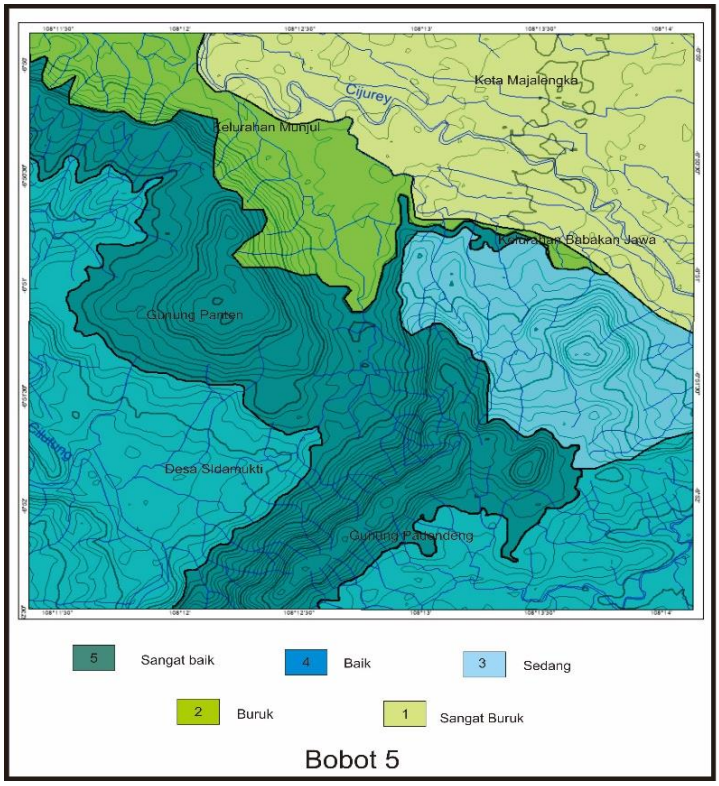

Figure 1.11 Drainage System Analysis

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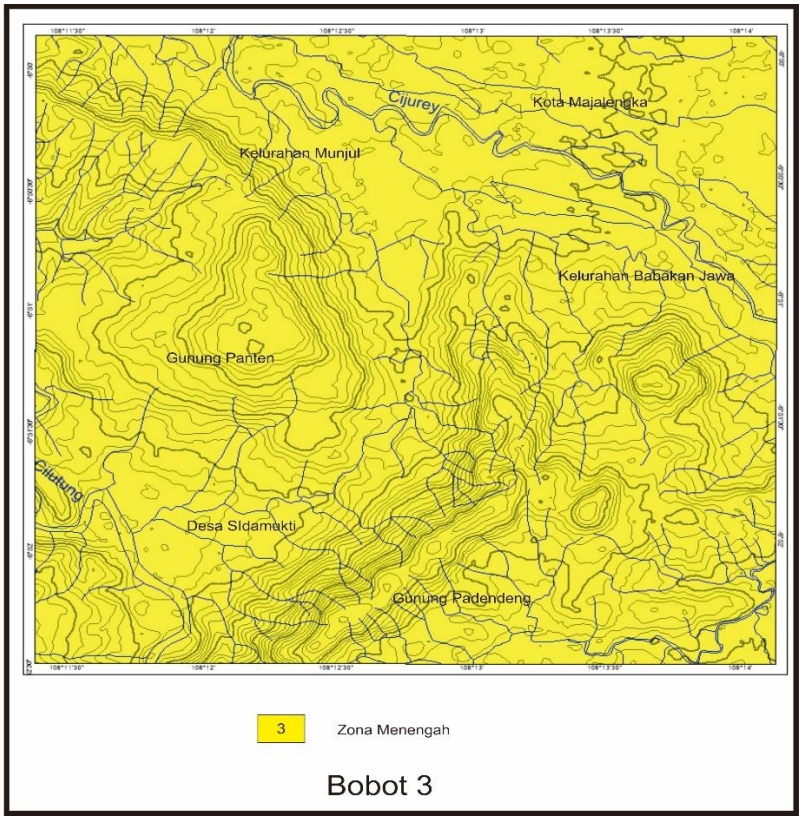

Figure 1.12 Earthquake Hazard Analysis

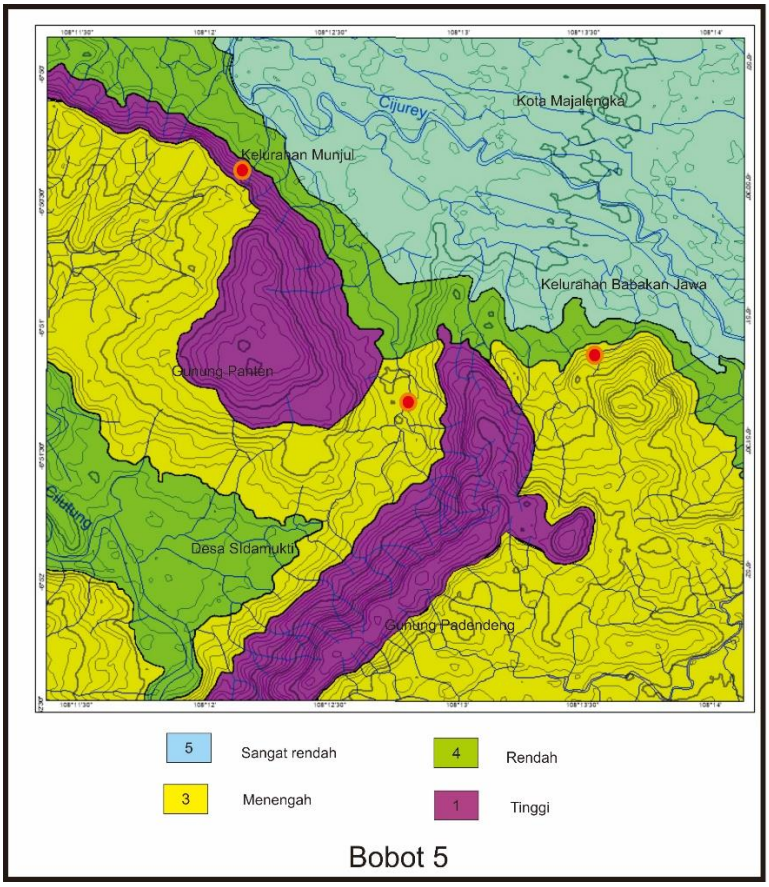

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Figure 1.13 Potential Analysis of the Soil Movement

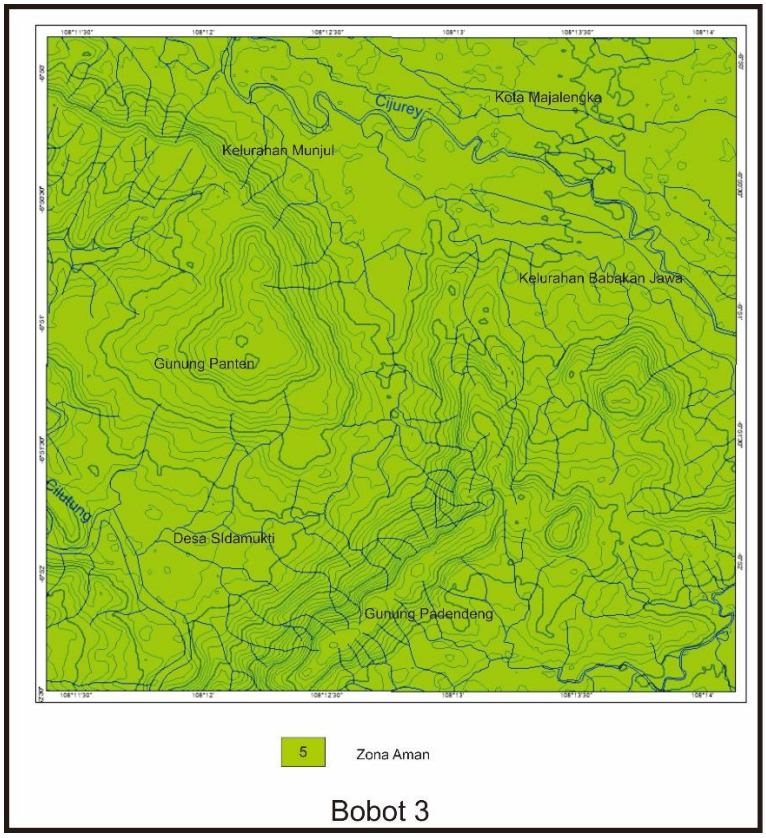

Figure 1.14 Volcano Hazard Analysis

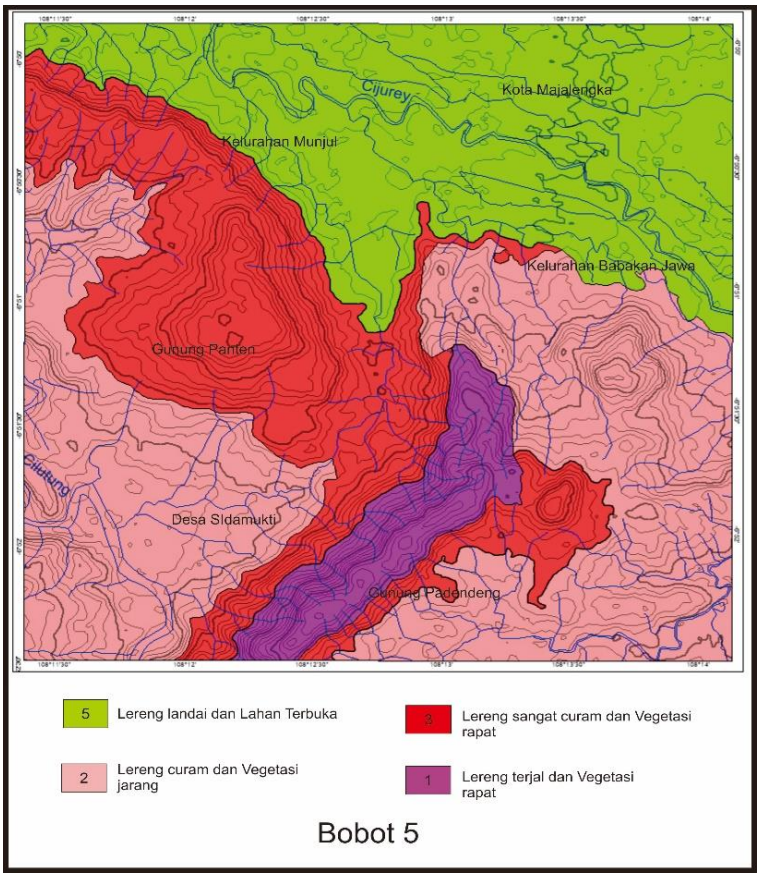

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Figure 1.15 Slope Analysis

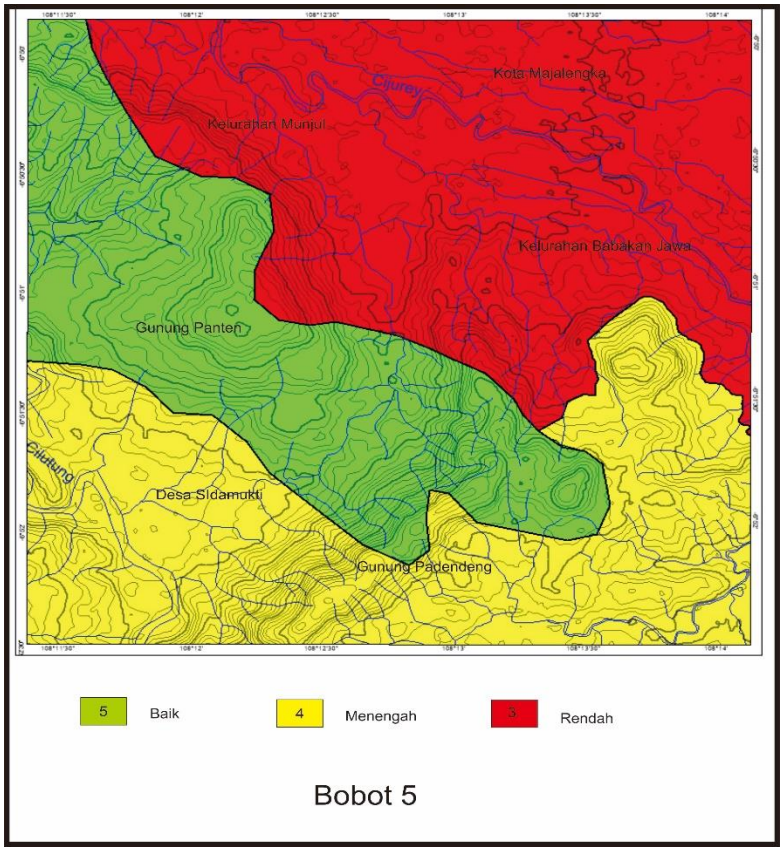

Figure 1.16 Bearing Capacity of Soil Analysis

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