Development of Urban Areas in Potential Areas of Natural Disasters in South Bandung, Indonesia

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Abstract. Geological disasters often occur in South Bandung area, one of which is flood problem in the past, which has not been overcome since the Dutch colonial period. This research was conducted to provide guidance in the development of the area around and give suggestions to reduce the impact of flood and landslide in South Bandung area. The research methods is qualitative method by collecting and producing descriptive data, and doing remote sensing analysis using google earth to update the land use in research area. In addition, quantitative methods are employed by performing superimposed manual statistics and weighting methods, and used Microsoft Excel, Arcgis, Global Mapper, and Mapinfo to process data. Research data is used in primary, secondary, and tertiary data by firstly improving the physical properties of rocks, history of natural disasters, soil air condition, the level of movement of the land, slope, drainage, and foundation. Based on the results of the data processing, the land suitability score > 130 is categorized as a very good possibility area to be an urban area, the score 116 - 130 is an area that has many advantages but can still be overcome by engineering. Technique. Score < 116 is a limitation area that is not feasible to be used as an urban area, a variety of ways that can be done to be converted function become conservation area.

1. Introduction
The research area is located in South Bandung, Bandung Regency, West Java. Landuse for urban areas is determined by land suitability, but will be hampered if affected by constraints such as geological disasters, rare groundwater, steep slopes, and low foundation strength [1]. This study was conducted because of the frequent problems in urban areas and previous research in the development of urban areas include residential areas, industry, agriculture, education, and so on in South Bandung [2]. The necessary analysis in development of urban areas in the research area is to examine several important aspects such as the condition of the physical rock, the condition of ground water, the erosion process, the slope, the disaster and conducting rainfall analysis over a certain period [3].

Congestion, floods, landslides, water droughts, etc. are main problems that disrupt urban areas in South Bandung especially when entering the rainy season. According to Bandung District Government Data recorded that floods in the region have occurred during the Dutch colonial period in Indonesia to the present day. In 2017 recorded flood disaster occurred in some areas in Bandung regency, especially the most severe damage occurred in Dayeuhkolot. The occurrence of landslide in 2014 (January - March) in the research area occurred as much as 7 times with the main factors is caused by high rainfall. With these various problems, it is necessary to conduct research to examine the basic aspects of urban development [4].
2. Literature Review

2.1. Physical character of rocks

Physical character of rock characterizes the lithology of a constituent rock, which are permeability, porosity, and strength. The study area is divided into 4 type of rock units that is Aluvial Deposition (Blue) which is dominated by fine-grained material, clay-sized to tuffing pebbles, with impermeable properties, in some places is found in surface water flooding and become flood subscription area throughout the year [1]. Unit Tuf (Purple) is dominated by tuff material, but in some places in the river flow found lava and breccias, it is soft, and has not been well compacted, but has the ability to pass water well. Andesite units (Red) are dominated by andesite stones and found tuff, breccias, and mosaics, it has a high hardness and poor water passing properties, but found a fracture so it can still pass water down the surface. Andesite Units Breccia (Orange) inserts are composed of andesitic rocks with pyroclastic breccia inserts, andesite has impermeable properties, but there is a fracture so it can pass water down the surface, and has very hard physical properties. Breksi has a hard nature is interlocking, so it is very good to be foundation in the building [5]. Maps can be seen in figure 1.

![Figure 1. Physical character of rocks [1]](image1)

2.2. Morphometri

Based on the calculations and grouping intervals slope, area of research is compiled by the slope with a value of 0% -2% (Dark Green) with flat relief, so it will get a value of slope stability is excellent due to the influence of the gravitational force is so small that the area is very good for Done development. Then 3% -7% (Light Green) with relief that the sloped, so it will have a good slope stability with influence small gravitational force. 8% - 13% (Yellow) with sloping relief, so will have medium slope stability with medium gravity effect. 14% -20% (Orange) with relief rather steep so it will have a value of gravity relative rather large and would cause a degree of slope stability has a rather low value. 21% -140% (Purple) with a steep relief so it will have a high gravity effect and will cause the slope stability rate will be low value. And with a steep relief so that it will have a very high gravity influence and cause a very low slope stability rate [6]. Maps can be seen in figure 2.

![Figure 2. Morphometri](image2)
2.3. Potential groundwater

Research area is divided into 5 classifications of groundwater potential. Aquifer productive widespread spreading (Old Blue) has good groundwater potential, composed by the sediment material of the lake, groundwater level is between 2 - 5 mbmt. A moderately productive aquifer with wide spread (Old Green) has medium groundwater potential, Prepared by volcanic material of tuff, and breccias, groundwater levels ranging from 4 to 9 mbmt. A moderately productive aquifer, local dispersion (Light Blue) is prepared by fine material - gravel of lake sediment and water flow characteristics through inter grain spaces with groundwater potential between 2-5 mbmt. Productive aquifers, local spread (Young Green) composed by the remaining volcanic eruption of Mount Malabar in the form of lava, and tuff also found a stone [7]. Medium groundwater potential with groundwater depth ranges from 4 - 9 mbmt. The rare groundwater area (Chocolate) is composed by Quarter volcanic material with high hardness and is part of the foot of Puntang Mountain. Characteristics of aquifers are associated with low productivity and rare groundwater. In this area it is not possible to develop residential area, in Mount Pinisan region, the depth of MAT is obtained at 30 m depth, with stable depth at depth 40m, maps can be seen in figure 3 (Peta Hidrogeologi, PU).
2.4. Soil foundation of strength
The carrying capacity of the foundation is a foundation strength (soil) to withstand the load [8]. In the research area there are 3 factors of carrying capacity of foundation soil, namely Low (Red), foundation carrying capacity <3.6 ton / m², Soil (surface material) prepared by organic clay, Silt, and pellet which are alluvium. Medium (old yellow), carrying capacity of foundation 3.6 - 7.2 ton / m², soil (surface material) is composed by silt, clay to silt sandstone. Quarterly volcanic rocks are tuff, lava, and breccias. Good (Green) carrying capacity of foundation 7.2 - 21.6 ton / m², soil (surface material) prepared by sand of lanauan. The bedrock of breccia, tuff, and lava, maps can be seen in figure 4 (Geoling-Metropolitan Map Bandung, ESDM).

2.5. Soil movement
There are 5 classification of soil movement in research area, that is Very Low (Blue), has very low level of vulnerability to exposed soil movement. In this zone rarely or almost never an active land movement occurs. Low (Dark Blue), has a low susceptibility level exposed to ground motion. This zone rarely occurs ground motion, and if there is movement of the old ground the slope will stabilize itself again. Medium (Green), has a moderate degree of vulnerability exposed to ground motion. In this zone can occur land movements, especially in areas adjacent to river valleys, escarpments, road cliffs or if the slopes are impaired. Old soil movements can reactivate due to high rainfall and strong erosion. High (Orange), has a high degree of vulnerability exposed to ground motion. In this zone there is often a movement of land, while the movement of old and new soil is still actively moving, due to high rainfall and strong erosion. Very High (Chocolate), has a very high degree of vulnerability exposed to ground motion. This region are located around the zone of geological structure (cesarean), it has very little possibility for built various infrastructures, because it is very susceptible to damage. So, it is not possible to develop urban area, maps can be seen in figure 5 [1].
2.6. Earthquake hazard areas
In the research area there are 2 factors of earthquake scale, namely Medium Scale (Green), this area potentially occur shaking due to earthquake with scale VI MMI. Potential occurrence of land cracks, liquefaction, landslides on the topography of the hills and the occurrence of land shifts in small dimensions. The speed of the earthquake is in the range of 0.20 - 0.25 G. Generally composed of tertiary rocks, and some of the most commonly transient quarter deposits of structures and depths of intermediate earthquake sources (35 - 90 km). High Scale (Red), This area has the potential to shake earthquake with scale intensity VII-VIII MMI. Potential land cracks, liquefaction, and avalanches on steep topography. Acceleration of the earthquake can occur between 0.25 - 0.30 G. This zone is close to the source of earthquake on land with shallow depth. This zone is composed of Quaternary rocks of alluvium, maps can be seen in figure 6 [1].

2.7. Volcanic eruption
Research area is divided into 2 zones of volcanic eruption that is Safe Zone (Green), In this zone there is no potential damage due to eruption of volcanoes that are around the research area, especially
southern volcano. Factors that affect it because it is far from the source or volcano. Dangerous Zone (Red), In this zone has a high potential eruption of eruption of volcanoes located around the research area. Especially the Southeast region with the existence of Mount Guntur (Alert Zone), and in the South with the presence of Mount Papandayan (Danger Zone 1, II, and III), maps can be seen in figure 7 (Volcanic Map -Sheet Garut).

2.8. Drainage
Drainage will drain the water downstream at relatively fast speed so as not to trigger erosion and have a chance to absorb water and not drain water very slowly (relatively immobile) so that it will trigger a river overflow [9]. Excellent Drainage System (Old Green), with steep slopes up to steep (> 20%), has very high deformation so that very many branching branches are found. The surface water can be drained very well, so in this region there is no potential surface water puddle. The Good Drainage System (Green), with a steep sloping slope (13% -20%), is highly deformed to the extent that rivers are found to be relatively large. Surface water can be well drained, so in this area there is no potential water puddles on the surface. Medium Drainage System (Dark Blue), with a relatively sloping slopes slope (8% -13%), suffers from moderate deformation resulting in branching branches. Surface water can be well drained, so in this region there is no potential surface water puddle. Bad Drainage System (Old Blue), with slope slightly sloping (2% -8%), Slightly deformed so that branching of the creek a little. Surface water cannot be drained properly, then in this region there is potential water puddles on the surface. Very Bad Drainage System (Young Blue), with slope of relatively flat (0% -2%), Little or not yet deformed so that river branching is very small, but traversed by big river (Citarum River). Water cannot be drained properly, so there will be potential water puddles on the surface, maps can be seen in figure 8 [1].
2.9. Rainfall
Rain Type Calculation (Q) can be done by determining the number of wet months, and dry months first [10]. Then the number of wet months is averaged, and the number of dry months is averaged. And then used the calculation to get the value of Q 0.179478 (Wet) based on Schmidt and Ferguson classification.

2.10. Flood area
This Flood Map is used to analyze the influence of the most flooded areas and to result the land suitability maps from the supporting aspects of urban areas [7], maps can be seen in figure 9.

2.11. Land suitability based on land closure
Land use in the research area needs to be analyzed based on land suitability level. This needs to be done in reducing the risk that can occur due to nonconformity in land use.
Table 1. Assessment and weighting aspects of land capability

| No | Land Capability                      | Weight | Value | Total |
|----|--------------------------------------|--------|-------|-------|
| 1  | Physical Character of Rock           | 5      |       |       |
|    | Andesit insert Breccia unit          | 5      | 25    | 125   |
|    | Andesite unit                        | 4      | 20    | 80    |
|    | Tuf unit                             | 3      | 15    | 45    |
|    | Aluvium unit                         | 1      | 5     | 5     |
| 2  | Morphometry                          | 5      |       |       |
|    | 0% - 2%                              | 5      | 25    | 125   |
|    | 3% - 7%                              | 4      | 20    | 80    |
|    | 8% - 13%                             | 3      | 15    | 45    |
|    | 14% - 20%                            | 2      | 10    | 20    |
|    | 21% - 140%                           | 1      | 5     | 5     |
|    | >140%                                | 0      | 0     | 0     |
| 3  | Potential Ground Water               | 5      |       |       |
|    | A wide-ranging aquifer               | 5      | 25    | 125   |
|    | Productive aquifers are broad        | 4      | 20    | 80    |
|    | A moderately productive              | 3      | 15    | 45    |
|    | aquifer local                        |        |       |       |
|    | Local productive aquifers            | 2      | 10    | 20    |
|    | Groundwater areas are scarce         | 0      | 0     | 0     |
| 4  | Soil Foundation Strength             | 5      |       |       |
|    | High                                 | 5      | 25    | 125   |
|    | Medium                               | 4      | 20    | 80    |
|    | Low                                  | 3      | 15    | 45    |
| 5  | Soil Movement                        | 5      |       |       |
|    | Very Low                             | 5      | 25    | 125   |
|    | Low                                  | 4      | 20    | 80    |
|    | Medium                               | 3      | 15    | 45    |
|    | High                                 | 2      | 10    | 20    |
|    | Very High                            | 1      | 5     | 5     |
| 6  | Earthquake                           | 5      |       |       |
|    | Medium scale                         | 3      | 15    | 45    |
|    | High scale                           | 2      | 10    | 20    |
| 7  | Volcanic Eruption                    | 5      |       |       |
|    | Safe zone                            | 5      | 25    | 125   |
|    | Danger zone                          | 0      | 0     | 0     |
| 8  | Drainage                             | 5      |       |       |
|    | Very Good                            | 5      | 25    | 125   |
|    | Good                                 | 4      | 20    | 80    |
|    | Medium                               | 3      | 15    | 45    |
|    | Poor                                 | 2      | 10    | 20    |
|    | Very poor                            | 1      | 5     | 5     |

(Source [1])

3. Methods
The method is used in this research is qualitative and quantitative method. Qualitative methods by conducting descriptive data collection on flood and landslide disaster information to the community in research area and doing landsat image analysis using google earth. Then performed quantitative method in the form of statistical analysis with superimposed manual method and do the weighting manually to
supporting aspects of urban area [1]. In the statistical analysis using the superimposed method, the assessment is based on the level of suitability, with the minimum to maximum value of 0 to 5 the higher the value, the higher the level of land suitability for urban area, and weighted the land capability aspect based on the importance level with the value minimum to maximum of 0 to 5 and the greater the weighting value the more important it is to develop urban areas. Of all elements in the planning of land done superimposed method so that can know the value of land ability in the research area. In the classification of land capacity used statistical methods, namely:

- Total skor ($\sum x$), Calculated from the sum of the overall total score.
- Average of total score ($\bar{x}$), Calculated from the total overall score divided by the number of scores, used the formula:

$$\bar{x} = \frac{\sum x}{n}$$  \hspace{1cm} (1)

Information:
- $\bar{x} =$ Average of total score
- $\sum x =$ Total skor
- $n =$ Amount of data
- Standard Deviation

$$\delta = \sqrt{\frac{\sum (x-\bar{x})^2}{n-1}}$$  \hspace{1cm} (2)

Information:
- $\delta =$ Standard Deviation
- $\bar{x} =$ Average of total score
- $\sum x =$ Total score
- $n =$ Amount of data

Finally, an analysis of floods, landslides, and rainfall for urban area development is carried out.

4. Results and Discussion

Determination Classification of land suitability is done by using statistical methods, namely determination of total score, average score of overall data capability, and standard deviation to determine the land suitability classification range (see table 2 and figure 10).
- From the calculation results obtained a total score of 117730.
- From the calculation result got total score average 123.2.
- From the results obtained calculation value of Standard Deviation 12.971.

| Land Capability Class | Criteria | Score |
|------------------------|----------|-------|
| Very High              | $> \bar{x} + \frac{1}{2}\delta$ | $>144$ |
| High                   | $\bar{x} + \frac{1}{2}\delta - \bar{x} + \frac{1}{2}\delta$ | $133 - 144$ |
| Medium                 | $\bar{x} - \frac{1}{2}\delta - \bar{x} + \frac{1}{2}\delta$ | $116 - 130$ |
| Low                    | $\bar{x} - \frac{1}{2}\delta - \bar{x} - \frac{1}{2}\delta$ | $102 - 116$ |
| Very Low               | $< \bar{x} - \frac{1}{2}\delta$ | $<102$ |
Based on calculations using statistical analysis, on the ability of land in the development of residential areas, the study area is divided into five areas of land capacity with the following scores:

- Total score score > 144, categorized as area with very high land capability level.
- Total score scores in the range 130 - 144 are categorized as areas with high land capability.
- Total score scores in range 116 - 130, categorized as areas with moderate level of land capability.
- Total score scores in the range 102 - 116 are categorized as areas with low land capability.
- Total score < 102, categorized as a region with very low land capability.

Wet rainfall indicates that the research area has abundant water reserves to meet the needs of life, but can cause natural disasters, especially floods and landslides. The land suitability score > 130 is categorized good for urban development, then score 116 - 130 is a constraint area that has various constraints such as availability of available water with a number that is not too high, potential disasters that can still occur, the strength of the foundation not too good and other obstacles, but still can be overcome by engineering. Score < 116 is a limitation area that is not feasible for urban development, the condition of this region has a steep slope, the condition of relatively hard constituent rock is composed by andesite stone so it will be difficult to drill in getting ground water if it will be made urban area, and rare groundwater conditions making it very difficult to obtain groundwater to meet daily needs. Various efforts to reduce the constraints are impossible to do, could be done but require a very high cost.

5. Conclusions
This region is scattered in the middle (East and West) areas of research, with high land capability to very high for urban areas development. It is based on the very low potential aspects of natural disasters (Flood and Landslide), the potential for good ground water availability, and the carrying capacity of the soil good. This area is scattered in the northern, central, and southeastern regions, with the ability of land being developed for urban. This is based on various constraints that may occur, but these constraints can still be overcome by engineering techniques to minimize and prevent these constraints occur include flood and landslide. This region dominates in the southern and central part of the research area, but also in the middle of the research area, with poor land capability to very poorly developed urban areas. This
is based on various obstacles that may occur, with engineering capabilities that are still limited as an example of floods that occur in the northern region of research has occurred in the Dutch colonial period, so that this area needs to be converted function to conservation land. Southern region can be utilized as a protected forest area. Constraints that can occur are in the form of floods, steep slopes, volcanic eruptions, landslides, rare earth water conditions, etc.

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