Landslide Vulnerability in Residential Areas for Disaster Mitigation in Sawangan District, Depok City

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Abstract. Disaster occurs due to the interaction of threat factor, vulnerability and inability of the people. The lack of the capacity for decent settlement for the people has extended the use of lands for residential areas in unsuitable zone. Depok city is one of buffer zones of the capital city, Jakarta, with the population growth increasing significantly because of the pressure of the high human migration. The rapid development of an area becomes the trigger of the increasing need for lands. One of the destinations as settlement in Depok city is Sawangan district.

Analyzing data technique that will be used is the descriptive analysis with the spatial approach. Map analyzing using the overlay analysis and classification. Based on the result of the overlay analysis from some maps, it shows that Sawangan district has the bumpy physical condition of an area with the slope rate of 3-8 %, population density rate of 4,001-6,000 inhabitants per km². But it has a potency leads to the land movement that is typically medium. It shows that there is a potency of human activity by building the residential-area with the high population density causes the landslide vulnerability tends to be high.

1. Introduction

Indonesia is a place having various natural disasters. [1] It is because Indonesia is located on the equator so it receives a lot of sunlight and heavy rainfall. Therefore, Indonesia becomes the disaster-prone area for meteorological disaster as well as flood, drought, big ocean waves, etc. The National Agency for Disaster Countermeasure (BNPB) has cited the total of hydro-meteorological disaster that frequently happened in Indonesia was flood which was followed by landslide. [2]

The disaster occurs because of some factors. They are the interaction of threat factors, vulnerability and the inability of the population. [3] The population growth increasing is directly proportional to the need of settlement. The lack of the capacity for decent settlement for the people has extended the use of lands as housing in the inappropriate area. There are a lot of disaster-prone areas used as residential-area. [4] It is strengthened with the geographical environment as the major factor that determines where human live and develop. [5]

Depok city is one of the buffer zones of the capital city, Jakarta, with the population growth which is significant due to the pressure of the high human migration. The rapidly development of an area becomes the trigger for the need of lands. [6] Depok city experiences the growth population which is settled and scattered in each part of the city. One of the places that becomes the destination for residential-area in Depok City is Sawangan district.

The surface area based on its use in Sawangan district in 2016 was 1,535.8 hectares for residential-area from 2,620 hectares of the surface area. [7] With the increasing population growth, the vulnerability
of landslide is greater. Thus, a research about the settlement system is needed to be conducted in order to see the vulnerability landslide disaster happening in Sawangan district, Depok City.

2. Method
2.1. Place
A research is done around the area of Sawangan district, Depok City. This area is one of the areas with the rapidly growth population in Depok City. So a research is needed to be performed along with the analyzing related to the population and the vulnerability to disaster.

2.2. Source of Data
The data which is used is secondary data involving The National Agency for Disaster Countermeasure (BNPB) to see the vulnerability to the disaster, data of population distribution from Central Bureau of Statistics and some of maps which are supported by various sources. The data is strengthened by the review from literatures and the previous researches about the disaster vulnerability in the residential-area.

2.3. Data Analysis Technique
Data analysis technique which is going to be used is descriptive analysis with spatial approach. For the spatial data uses the ArcGis 14 software device include map overlay map technique and the classification from some map data that is gotten, it is RBI map with a scale of 1:25.000 of Depok City to get the map of steepness by using the method of SRTM DEM analysis 30-meter 2014, the map for the prediction for soil movement area in December 2018, soil map RePPProT 1997-1998, the data of population distribution in 2016 in Depok according to BPS.

3. Result and Discussion
3.1 Condition
Based on the data that have been collected and processed, the physical condition of Depok City can be seen clearly. It is to know that the suitable area for the settlements The areas are suitable for residential-area should be on the low degree of steepness [8] Sawangan District is included in one of the sub-districts that exists in Depok city with the physical condition with various lands condition starts from the flat area until bumpy with the degree of the highest steepness is 15-25 % . It can be seen clearly in the following figure 1

![Figure 1. Map of Slope Classes in The Study Area of Disaster-Prone Settlements in Sawangan District](image-url)

In Sawangan District, which is signed with the red line, it can be seen that it is still dominated by the light green color with the slope class is 8-15% followed by the green color giving a sign that the area has slope class between 3-8 %, the yellow line with the steepness between 15-25%, and the area that has...
slope class between 0-3 % with the least number. It gives a sign that the area is an area with the bumpy physical condition and a little flat. The criteria of the land refers to cultivation and buffer plants. [9] The condition in the field shows that the use of land in Sawangan District is dominated by the settlements in which they can be seen in the data of Central Bureau of Statistics reaches 1, 535, 8 hectares from 2, 620 hectares of the land use [7] for population distribution, Sawangan District has the even distribution with the level of population density reaches 7, 001-7,549 inhabitants per km2. The further detail is as shown in the figure 2

![Figure 2. Distribution and Density Population Map in Sawangan District](image)

The relief form, sets the layout and character of settlements and thereby naturally contributing to the intense growth and development of settlements. [10] Sawangan District has the characteristic physical condition which tends to be bumpy. But the characteristic of the settlements evenly scatter. The population density in Sawangan District doesn’t show the significantly inequality from one area to another area in the same unit. The population distribution in Sawangan District having the concentration that leads to the southern part with the total of population reaches > 24. 000 inhabitants living in Bedahan Sub-district and Pengasinan Sub-district. But the population density in the both areas haven’t been included as the most heavily populated area. Because the population density reaches 4, 001-6, 000 inhabitants per km2. Meanwhile, the most heavily populated is in the northern, Cinangka Sub-district with the population reaches 7, 001-549

3.2 Landslide Vulnerability in Residential Areas

Landslide or soil movement are defined as downward movement of the soil mass down along the slope rock fragments due to the disturbance of the soil or the rocks itself stability itself [11]. There are a lot of factors which can trigger of the soil movement of landslide. One of the factors of the vulnerabilities of landslide is the slope that considers as the important factor in the process that results landslide. [12] The factor that is able to emerge the landslide besides from the natural factor as well as heavy rainfall, earthquake and the activity of volcanism, it is also triggered by the human activity who clear the land to build some infrastructure. [13] Landslide also can happen due the unstable condition. For example, the increasing of population causing the increasing of the settlement that leads to the instability environment causing the increasing prone to landslide. Based on the overlay and the classification from the topographic map slope, map of prediction for the soil movement, map of the association RePPproT 1997-1998, and the data of distribution people in 2016 in Depok from Central Bureau of Statistics, we get the result as is in the following figure 3
The landslide vulnerability in Sawangan District has variation, low, moderate and high potency. The rate of landslide vulnerability in Sawangan District is in the point of medium potency. Landslide vulnerability with the high potency exists in the Northern, Cinangka Sub-district, with the heaviest populated area. While in the Southern in which it has the highest population approximately 4,001-6,000 and 6,000-7001, has the landslide vulnerability, that is moderate potency. It shows that there is a potency of human activity engages to building the residential area which is heavily populated causes the landslide vulnerability tend to be high too.

4. Conclusion
The result of the analysis of landslide vulnerability in Sawangan District based on the map processing and literature study conclude that:

1. Sawangan District has the characteristic of having a bumpy land. But the characteristic of Sawangan District scatters evenly. The Slope class in Sawangan District is dominated with the light green color with the slope class 8-15%. The most heavily populated area is in Cinangka Sub-district with the total of population reaches 7,001-7,549 inhabitants per km².

2. Landslide vulnerability in Sawangan District has variant, low moderate and high potential. The average of landslide vulnerability in Sawangan District is in the medium potency. Landslide vulnerability with the high potency occurs in the northern, Cinangka Sub-district, with the highest population. It shows that there is a potency of human activity engages to the building of the residential area which is heavily populated causes the landslide vulnerability tends to be high too.

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