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ANALYSIS OF FLOOD HAZARDS IN MAGETAN REGENCY USING DISTANCE SENSING METHOD

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ABSTRACT

Flood is an annual disaster that hits all over Indonesia, and Magetan Regency is one of the affected area . The high regional topography in the western part and the relatively flat topography in the eastern part making it potential for flood to be higher in the eastern part. The DEM (Digital Elevation Model) topography, Landsat maps, and hazard index maps can be identified by remote sensing using regional administration map data, the level of slope slope and vegetation density can be mapped using NDVI method, and the classification of the flood risk level of an area can be done using ArcGIS software. The slope of the slope and the density of vegetation will affect the level of potential flood hazard. There is a low level of potential for flooding on steep slopes because the air will flow and accumulate on the lower plains. Higher vegetation density will provide a good air catchment area. The level of vegetation density is also higher in the western part. Based on the percentage of the affected area, the low flood hazard level reaches 73.3%, so it can be concluded that the flood hazard level in Magetan Regency is low. It is necessary to provide adequate land and channels capable of providing air flow.

Keyword : *Flood, Magetan Regency, Slope, Vegetation*

1. INTRODUCTION

Flood is an annual disaster that occurs in every rainy season because the volume of rainwater exceeds the capacity of absorption area or distribution of water (Khasanah, 2011). This disaster is one of the most common disasters in all regions in Indonesia, one of which is Magetan Regency. Flooding generally occurs in areas with a flat to low slope and a low level of water absorption. Low water absorption can be affected by the level of vegetation density (Septian dkk., 2020). The increasing number of developments can also reduce the level of soil the surrounding area (Khasanah, 2011). Floods of course can cause problems such as damage to houses and the general public as well as disease. Therefore, it is necessary to have a flood-prone area building so that appropriate mitigation can be carried out to reduce the risk of flooding. Magetan Regency is located at the foot of Mount Lawu, in the East side which stretches from South to North with an area of 688.84 km^2. Geographically, it is located between $7^o30'$ North Latitude and $7^o47'$ South Latitude, $111^o10'$ and $111^o30'$ East Longitude.

Administratively, Magetan Regency is bordered by Karanganyar Regency in the west, Ponorogo and Wonogiri Regencies in the South, Ngawi Regency in the North, and Madiun Regency in the East. In general, this area has a topography in the form of weak to strong undulating hills in the west and plain topography to weak waves in the east. The geological condition of Magetan Regency is dominated by the activity of Lawu Mountain where the rocks in the area involve lava, breccia, andesite, tuff, and sandstones types. Soils that make up Magetan Regency are Regosol Gray soil type, 20.06% of the total area and soil types associated with Gray Alluvial and Gray Brown Alluvial 0.90%. Soils of the Regosol Gray type are scattered around the districts of Magetan, Bendo, Maospati, Sukomoro, Nguntoronadi, Takeran, Kawedanan and Ngariboyo. Soil types of Alluvial Gray and Gray Brown alluvial are scattered in Takeran, Kawedanan, and Ngariboyo Districts. Soil types of

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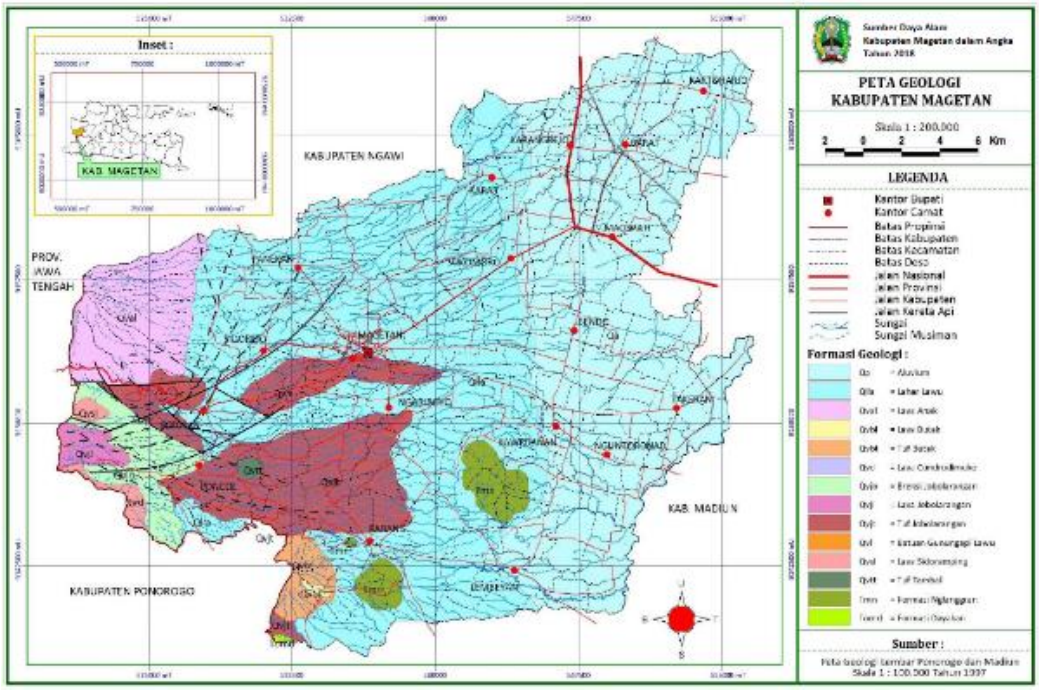

Figure 1. Geological Map of Magetan Regency (Sumber Daya Alam Kabupaten Magetan, 2018).

Alluvial Gray and Gray Brown alluvial are scattered in Takeran, Kawedanan, and Ngariboyo Districts. The distribution of lithology types in Magetan Regency can be seen on the Geological Map of Magetan Regency in **Figure 1** (Sumber Daya Alam Kabupaten Magetan, 2018).

Flood is a flow of runoff that flows through a river into a puddle. The runoff is water that flows on the ground caused by rainfall (Hadisusanto, 2011). The flood is a puddle on normally dry land such as settlements, city centers, and agricultural land. Flooding can also be caused by overflowing drainage channels where the volume of flowing water exceeds the capacity of the river itself. The high level of rainfall in an area can be used as one of the driving factors for flooding. A high level of rainfall that is not balanced with good drainage channels and infiltration areas, the water that falls will become a puddle. Water will flow and accumulate in the lowlands to flat so that the lowland areas will be more prone to potential flooding than those in the highlands. The level of the slope can be classified into several classes based on the Guidelines for Preparation of Land Rehabilitation and Soil Conservation Patterns, (1986) in Matondang J.P., (2013) as shown in **Table 1.**

Table 1. Slope Classfication

Slope Classfication	Class	Value
0-8%	Flat	5
8-15%	Sloping	4
15-25%	Slightly Steep	3
25-45%	Steep	2
>45%	Very Steep	1

In addition to the level of slope, the level of vegetation density in an area can also affect the level of vulnerability to potential flooding. Mapping the level of vegetation density can be done based on a geographic information system using the NDVI method, where the Normalized Difference Vegetation Index (NDVI) is a description of the level of vegetation density. The level of greenery of plants where photosynthetic vegetation will absorb some of the red waves of sunlight and reflect the near red waves is higher while dead vegetation

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reflects more of the red waves and less of the near red waves. According to (Wahyunto, 2003) the greenness level of a vegetation can be classified into several classes as in **Table 2.**

Table 2. NDVI Classification

Class	NDVI Value	Range Vegetation
1	-1<NDVI>-0.03	Very Low
2	-0.03<NDVI>0.15	Low
3	0.15<NDVI>0.25	Medium
4	0.25<NDVI>0.35	High
5	0.35<NDVI>1	Very High

The level of vegetation density can be related to the potential for water infiltration, with a high level of vegetation density generally consisting of dense forests which can cause the water to seep into the ground and not become a surface puddle.

Based on remote monitoring that has been carried out by (Any Zubaidah et al, 2013) the Magetan area has the potential for low to moderate levels of flooding when compared to other districts in East Java, where the areas most affected by flooding are several sub-districts such as Kartoharjo, West, Takeran Districts. , and Bendo. However, in December 2020 there was a flash flood that hit several sub-districts in a high topography, this was caused by the shallow waterways in the area (BPBD Magetan, 2020).

In general, floods can cause social, economic and health losses. Floods can damage residents settlements and public facilities, in addition to the emergence of diseases that attack the affected communities to the emergence of fatalities. There needs to be a mitigation to reduce the risk of the flood event. In addition to the government's role, there is a need for community participation in reducing disaster risk. This study aims to map the level of flood hazard in Magetan Regency using remote sensing methods by classifying the slope parameters and vegetation density.

2. METHODOLOGY

In this study, remote sensing is used to analyze the level of vulnerability to flooding in Magetan Regency. To find out flood-prone areas in Magetan Regency, an administrative map of the Magetan Regency area is needed which is obtained from Ina-Geoportal, a Digital Elevation Model (DEM) topographic map from DEMNAS Geospatial Information Agency Landsat data that can be obtained from the USGS website, as well as a map of the Flood Hazard Index. Then, the data processing is carried out in ArcGIS to obtain slope maps, vegetation density, and flood-prone maps.

Based on the DEM topographic map, Spacial Analysis Surface processing can be carried out to determine the slope, it is necessary to classify the slope class based on **Table 1**. Therefore, the slope map and slope level information can be obtained.

Based on Landsat image data, it can be processed using the NDVI method to determine the level of vegetation density. By using the calculation of Band 4 and Band 5 according to the equation, the vegetation density can be obtained. It is possible to classify the level of vegetation density using **Table 2**. The data can be associated with the slope height which can be obtained from DEM topographic data.

By using a flood hazard index map obtained from the Inarisk website, then it is used to create a map of the potential flood hazard in the Magetan Regency area and then classification is carried out based on the class of flood potential on the Inarisk website, namely low, medium, and high classes. Furthermore, slope and hillshade as well as regional administrative boundaries and river flow information are added.

3. RESULTS AND DISCUSSION

Flood is a puddle of water in an area with the vulnerability level of of an area towards potential flooding can be influenced by several factors. The level of the slope can affect the potential

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vulnerability of the area to flooding as shown in the picture showing the level of slope in Magetan Regency.

The slopes can be classified based on **Table 1** where the green color indicates the level of the flat-sloping slope, the yellow color indicates the slightly steep slope, and the orange-red color indicates the steep-very steep slope.

Based on **Figure 2**., the steep-to-very steep slope is in the west where the area is a mountainous area with a high topography such as Karanganyar District, and parts of Plaosan and Panekan Districts. Where the more to the east, the slope will be more gentle. The central part of Magetan Regency has a moderate-sloping slope, and the eastern part has a gentle-flat slope.

Table 3. Area Based on Slope Level

Slope	Wide (Ha)	%
Flat	48496,5	67,5
Sloping	13682,7	19,05
Slightly Steep	6522,2	9,08
Steep	2572,5	3,58
Very Steep	542,2	0,79

Associated with flooding, then in areas with steeper slopes, the potential for flooding will be lower due to high topography, the rainwater that falls will flow towards lower plains and accumulate there. Therefore, the lower plains will have a higher level of potential for flooding. The eastern part of Magetan will have a higher level of potential for flooding than the western part.

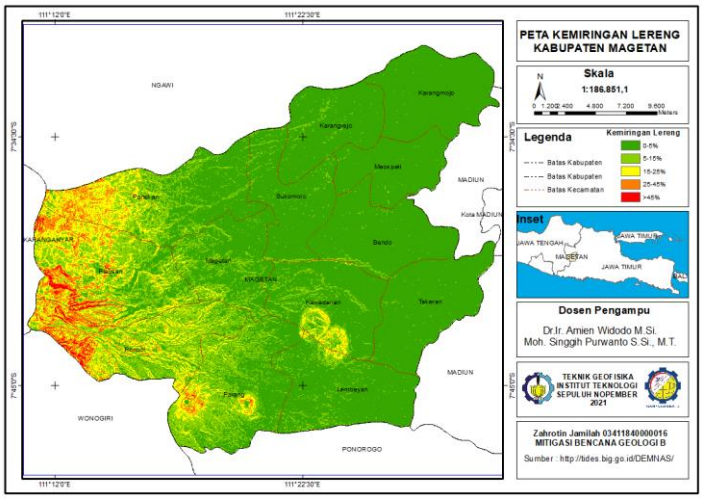

Figure 2. Slope Map in Magetan Regency

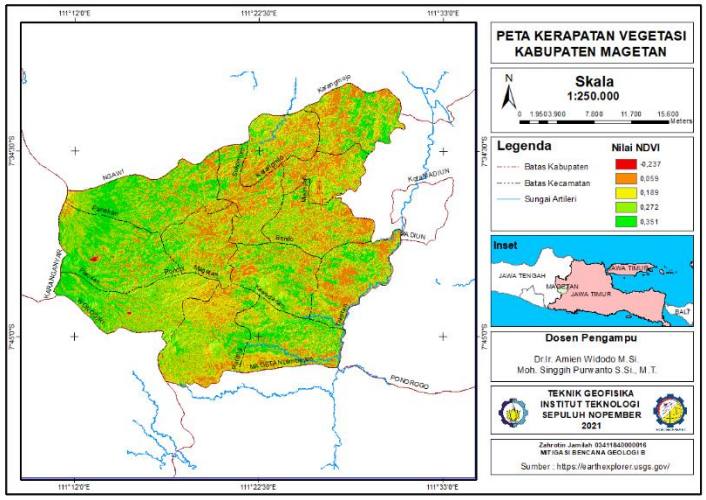

Figure 3. Vegetation Density Map in Magetan Regency

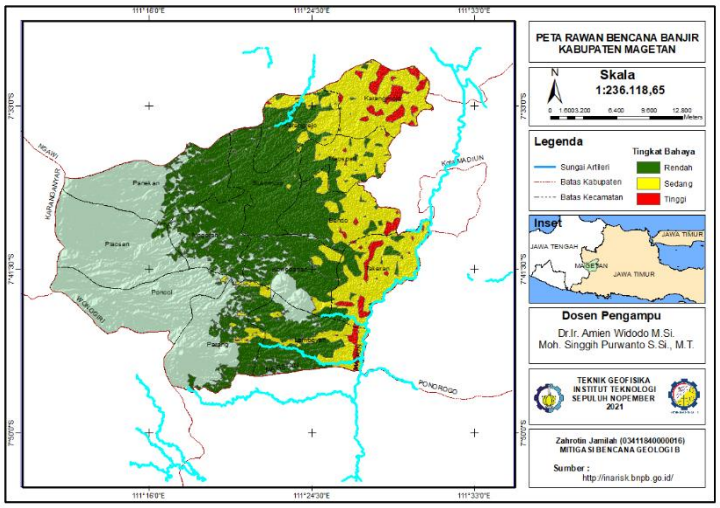

Figure 4. Flood Hazard Map in Magetan Regency

Based on **Figure 3**, the level of vegetation density can be classified according to **Table 2.** The level of vegetation density is very low with a negative value, it can be indicated that the area is a fairly large pool of water such as a reservoir or lake where there is no vegetation in the area. Very low density levels are shown in red on the map. The orange color on the map with a value of 0.059 has a low level of vegetation, it can be indicated that it is a building, water area, or rice field. The yellow-green color has a medium density level with a value of 0.189-0.272 where the area can be indicated as an area with a less dense vegetation density such as

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plantations, while a density with a value > 0.35 can be classified as high density depth which is indicated as dense forest.

Based on the map in the picture, it can be seen that the western part of Magetan is dominated by high-very high vegetation density, dense forest vegetation, while in the eastern part it is dominated by low-moderate vegetation density in the form of buildings, plantations, rice fields, and waters. Therefore, the western part of Magetan will have a high water absorption capacity when compared to the eastern part so that when it is associated with flooding, the eastern area will have more potential due to water not being able to absorb properly. Associated with the lithology that composes the area, the eastern part of Magetan is composed of lithology in the form of alluvium Figure 1. where alluvium has a high level of porosity and permeability. However, in this area most of the land is used for buildings, rice fields and waters so that the absorption capacity of the soil will be reduced. In addition, there are rivers that border the Districts of Takeran, Lembeyan, Kartoharjo, and Bendo. By using the flood hazard index information from inarisk.bnpb.go.id, a map of the distribution of flood hazard in the Magetan area can be obtained in **Figure 4**.

On the map in **Figure** 4, the low levels of danger to potential flooding are marked in red, medium levels are marked in yellow and low levels are marked in green. Areas with a high level of danger are in the east. This can be related to the level of the slope, the height of the slope, and the density of vegetation as well as the type of soil. The extent of the affected area based on the level of hazard can be shown in **Table 4.**

Table 4. Area of Affected Area by Hazard Level

Hazard Level	Wide (Ha)	%
Low	52647,02	73,3
Medium	17139,89	23,6
High	2029,198	3,1

Based on the affected areas as shown in **Table 4**, it can be concluded that the level of flood hazard in Magetan Regency has a low category where the potential for flooding only occurs in the eastern part with flat slopes and low-medium density levels. Therefore, as shown in **Figure 4**. where the potential for flooding occurs in areas with indications of residential residents, so as to reduce the risk of flooding, joint mitigation between the government and the community can be carried out. It is necessary to rearrange such as providing sufficient infiltration land and making waterways that can accommodate maximum water discharge.

4. CONCLUSIONS

Based on the slope, the western part of Magetan Regency has a high topography compared to the eastern part which has a low topography. The level of vegetation density varies from high vegetation in dense forest areas such as the western part, the middle part is dominated by a fairly dense vegetation level, while the eastern part is dominated by moderate vegetation levels in the form of rice fields or housing. By using a flood hazard map from Inarisk and associated with the slope and height, it can be seen the level of flood hazard where the Regency is included in the low category so that there is a need for rearrangement such as providing sufficient infiltration land and water channels that are able to accommodate water discharge.

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