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MORALITY BEFORE KNOWLEDGE

Analysis of the risk of landslids in Kebomas, Gresik district

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ABSTRACT
The landslide disaster occurred during the rainy season in Kebomas District, Gresik Regency, which has topography in the form of hills left over from lime mining in 1960-1990. A field survey conducted from December 2021 to March 2022 stated that landslides occurred during the rainy season in Kebomas District and caused damage to surrounding settlements. Land slope, rainfall, rock type, soil type, and land use are factors that influence the occurrence of landslides. The aim of this research is to map the level of landslide vulnerability in Kebomas District using the Geographic Information System. The research results show that there are three levels of landslide vulnerability in Kebomas District, namely, low, medium and high. The low vulnerability class is found in all villages in Kebomas District, most of which are in six villages or sub-districts in the south, west and north, namely; Dahanrejo, Kedanyang, Pambangan, Kembangan, Randuagung, and Segoromadu. The moderate vulnerability class is found in all villages in Kebomas District, most of which are in six villages in the southeast, northwest and north, namely; Randuagung, Pambangan, Dahanrejo, Kembangan, Sidomoro, and Ngargosari. Areas with a high vulnerability class are in the central part of the sub-district

KEYWORD: Gresik; GIS; landslide; overlays; vulnerability

1. Introduction
Indonesia is classified as a disaster-prone country. This is the result of the physical location of Indonesia which is sandwiched between two continents and two oceans, and traversed by mountains that stretch from the eastern tip of the island of Papua to the western tip of Sumatra. Due to its varied topography, Indonesia is an area that is vulnerable to natural disasters (Tjandra, 2018)

Areas prone to natural disasters include areas prone to floods, areas prone to landslides and areas prone to tidal waves, and landslides are one of the most frequent natural disasters in Indonesia (Rijanta & Baiquni, 2018).
(BNPB, 2011) states that a form of natural disaster called a landslide is caused by the movement of masses of soil or rock that have previously emerged from the slope as a result of disrupting the stability of the soil. In most cases, the effects of the geomorphological state of the wave, especially the slope component, are what cause disturbances to occur on the slope. Apart from that, there are several other influences, namely the condition of the rocks

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that make up the slope and the hydrological conditions on the slope. The risk of landslides is the possibility in a certain area and within a certain period of time, causing losses to residents, buildings, infrastructure and services (Fell & Leroi, 2005).

As a result, the risk of landslides is influenced by the overlapping space and time of dangerous areas (where landslides are most likely to occur) and elements that are potentially susceptible to exposure, causing impacts that can cause damage or loss. This can be translated into the form of classical equation calculations (Varnes, 1984).

One of the districts in East Java with many areas prone to landslides is Gresik Regency. Due to the physical features of the area, which includes limestone hills spread throughout the northern region of Gresik Regency, the area is frequently affected by landslides. Five landslide incidents have been reported in 2021, according to Indonesian disaster information data. According to the National Disaster Management Agency (BNPB) of East Java Province, what causes landslides in Gresik Regency is high rainfall, weak soil and slopes that are prone to landslides. Based on data from the East Java Province Regional Disaster Management Agency (BPBD), there are three sub-districts in Gresik which are included in the 50 districts that are prone to landslides. The three sub-districts marked in red by the East Java BPBD are part of landslide-prone areas. These areas include the districts of Ujungpangkah, Sangkapura, and Tambak, both in the Bawean Islands region. The East Java BPBD also marked other areas, namely Gresik District, Kebomas and Panceng Districts as having moderate risk.

To reduce the negative impacts caused by landslides, landslide-prone areas need to prepare well to face landslides. Creating landslide hazard areas is one strategy that can be used (Noor, 2014). It is highly recommended to use GIS (Geographic Information System) as an analysis tool to model landslide-prone areas, because GIS can be used to quickly identify landslide-prone areas (Putri, 2017).

The use of Geographic Information Systems (GIS) is one way in the mapping process, including the preparation of landslide maps which is the main focus of this research. Landslide risk can be identified quickly through GIS by using an overlay method of landslide parameters, such as: land slope, soil type, rainfall, land use and river density. Through the geospatial information system, it is hoped that it can facilitate the presentation of geospatial information, especially those related to determining landslide susceptibility, as well as being able to analyze and obtain new information to identify areas that are often targets of landslides.

2. Methods

The method used in processing this research data uses the Overlay method with notations between existing parameters, namely. slope, soil type, rainfall and land use. All these parameters will then be recorded by giving weights and values according to their respective classifications which are then superimposed using ArcGIS 10.4 software.

2.1 Research sites

The location of this research is in Kebomas District, including the sub-districts of: Kedanyang, Pambangan, Gulomantung, Sukorejo, Segoromadu, Tenggulunan, Karangkiring, Indro, Singosari, Sidomoro, Gending, Ngargosari, Kawisanyar, Sidomukti, Giri, Klangonan, Sekarkurung, Kembangan, Dahanrejo, Randuagung, and Kebomas.

Fig 1. Village administration map in kebomas district
(Source: Desacepat.Gresikab.go.id, 2023)

2.2 Data sources and tools

The data sources and tools used in this research are spatial data and non-spatial data as follows: 1) Spatial data, namely shapefile (Shp) of the administrative map of Gresik Regency, Indonesian DEM data, namely shapefile (Shp) of soil type maps of Gresik Regency, and shapefile (Shp) Gresik Regency land use map. 2) The non-spatial data used is CHIRPS (Climate Hazards Group Infra-Red Precipitation with Station) data for Gresik Regency 2021. The equipment used in the research is a laptop, ArcGis 10.4 software, Microsoft Word, and Microsoft Excel.

2.3 Flow diagram

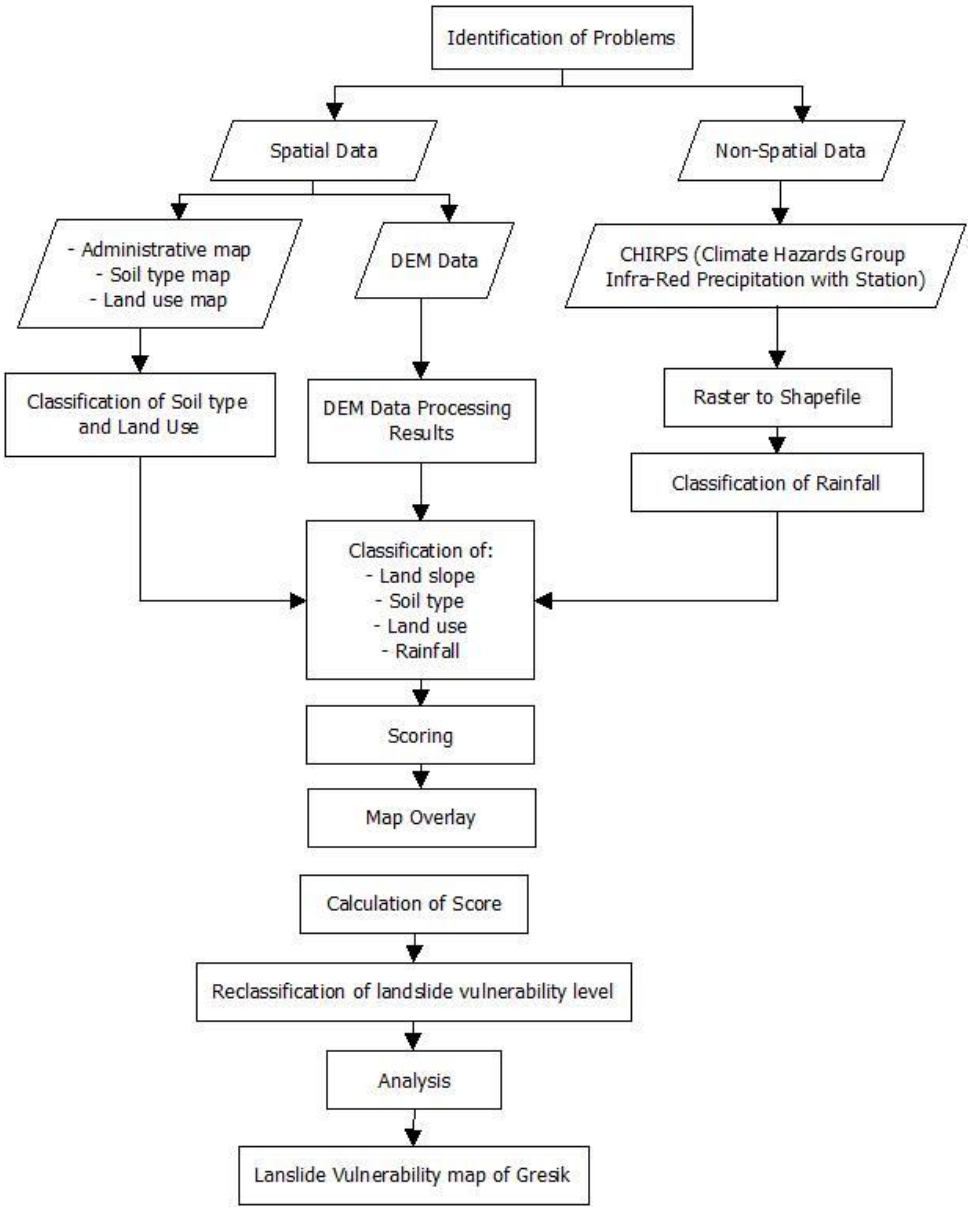

Fig 2. Flowchart of research

3. Results and Discussion

The research object in this paper is Gresik Regency. Astronomically, Gresik Regency is located between 112° to 113° East Longitude and 7° to 8° South Latitude. The administrative boundaries of Gresik Regency to the north border the Java Sea, to the west it borders Lamongan Regency, to the south it borders Sidoarjo Regency and Mojokerto Regency, and to the east it borders Surabaya City. The following is an administrative map of the Gresik Regency area created with ArcGis software.

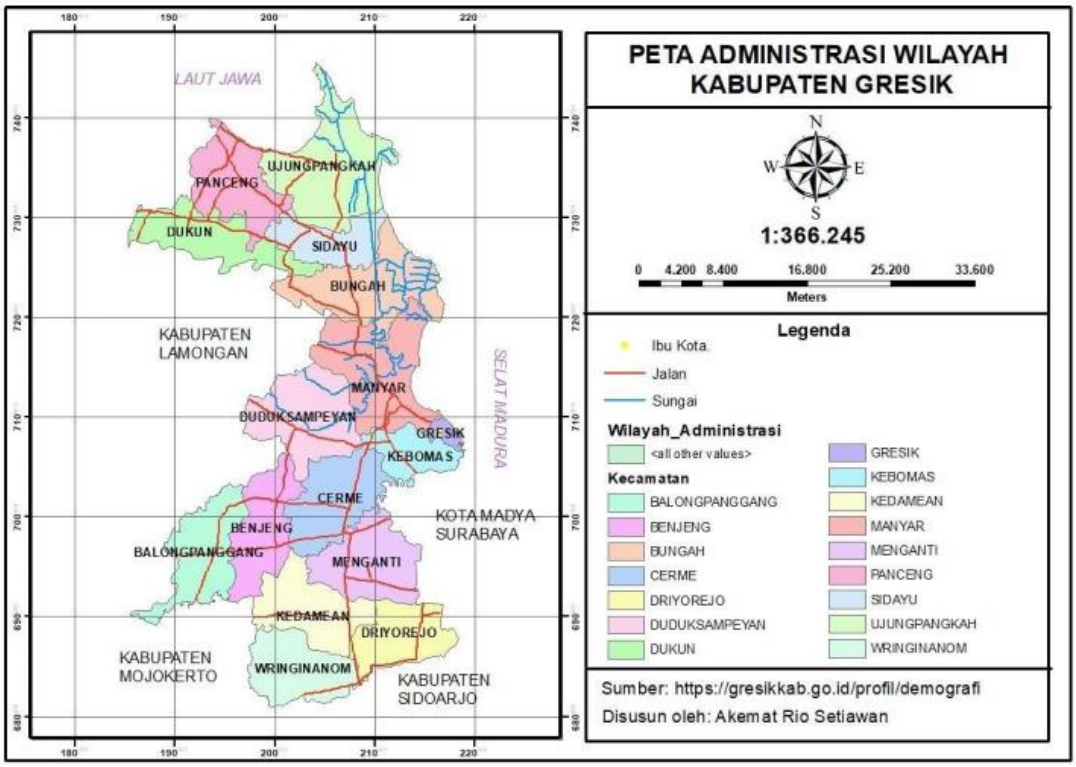

Fig 3. Gresik Regency Administrative Map
(Source: Gresikab.go.id)

3.1 Overlay method

Table 1. Area of Overlay Results

Class	Wide
Very low	1.996084
Low	42.830307
Currently	134.357697
Tall	5.046906
Very high	0.173116

From the results of overlaying the slope map, soil type map, land use map, and rainfall map, a landslide susceptibility map was obtained. Areas with a low level of landslide vulnerability in the Gresik Regency area are located in the northern area, namely parts of Panggang Sampean District, parts of Manyar District, parts of Bungah District, Sidayu District, Dukun District, Ujung Pangkah District, and Panceng District.

Areas with a moderate level of vulnerability are located in the central to southern part of Gresik Regency, namely parts of Bungah District, Manyar District, Panggang Sampean District, Cerme District, Benjeng District, Balonganggang District, parts of Menganti District, parts of Kedamean District, parts of Driyorejo District, and parts of Wringinanom District.

The areas with the highest level of vulnerability in Gresik Regency are in the high class, namely in the central part of Bungah District, part of Gresik District, part of Kebomas District, part of Menganti District, part of Kedamean District, part of Driyorejo District, and part of Wringinanom District.

The area where a landslide occurred in Gresik Regency is in Kebomas District, precisely in the cliff area of the road leading to Putri Cempo's grave. The area is an area of hills and limestone cliffs. Things like this often experience landslides due to heavy rains that occur in the Kebomas District area.

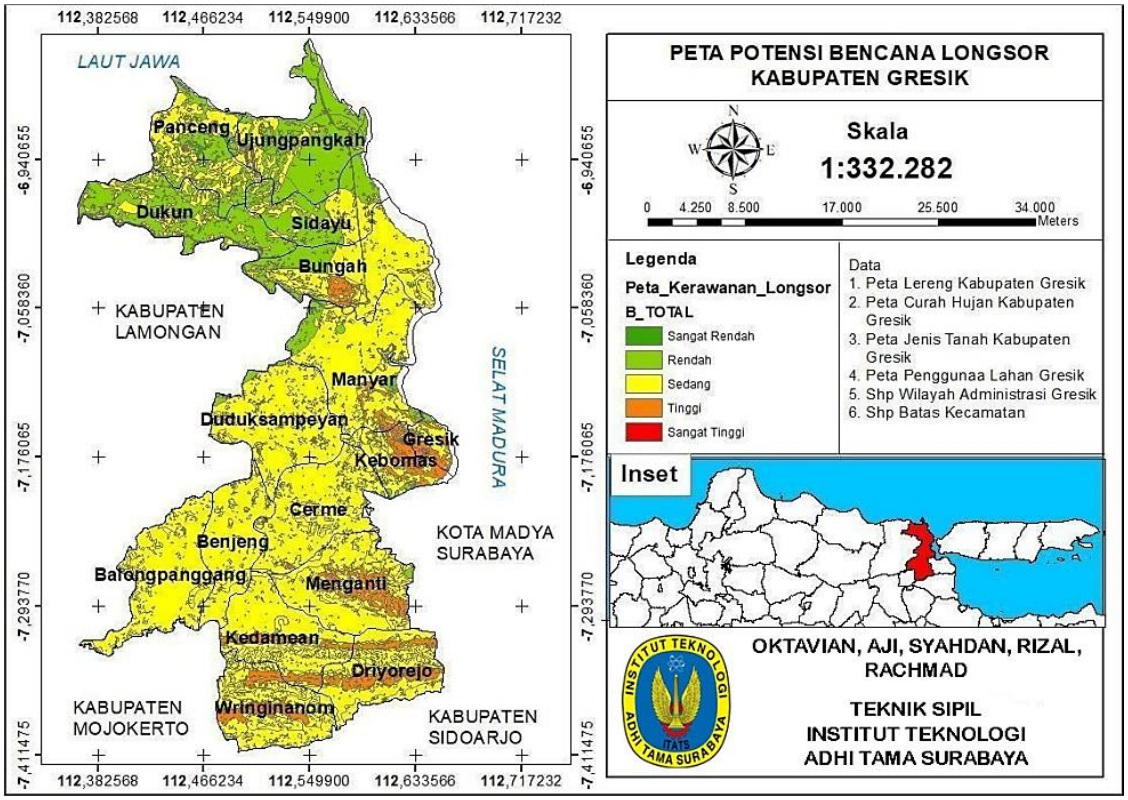

Fig 4. Result of Potential Landslide Disasters Map from data processing

3.2 Classification of land slopes in Gresik Regency

Based on the results of making the slope map, the distribution of the Gresik Regency area shows that the Gresik Regency area is dominated by slopes of 0–2% with a very low class. Gresik Regency is a low-lying area at an altitude of 2 to 12 meters above sea level, except for Panceng District which is relatively higher, namely 25 meters above sea level. The following is the classification of slope parameter scoring.

Table 2. Land Slope Classification

Slope	Score
0 - 2 %	1
2-15 %	2
15-25 %	3
25-40 %	4
>40 %	5

(Source: Puslittanak, 2004)

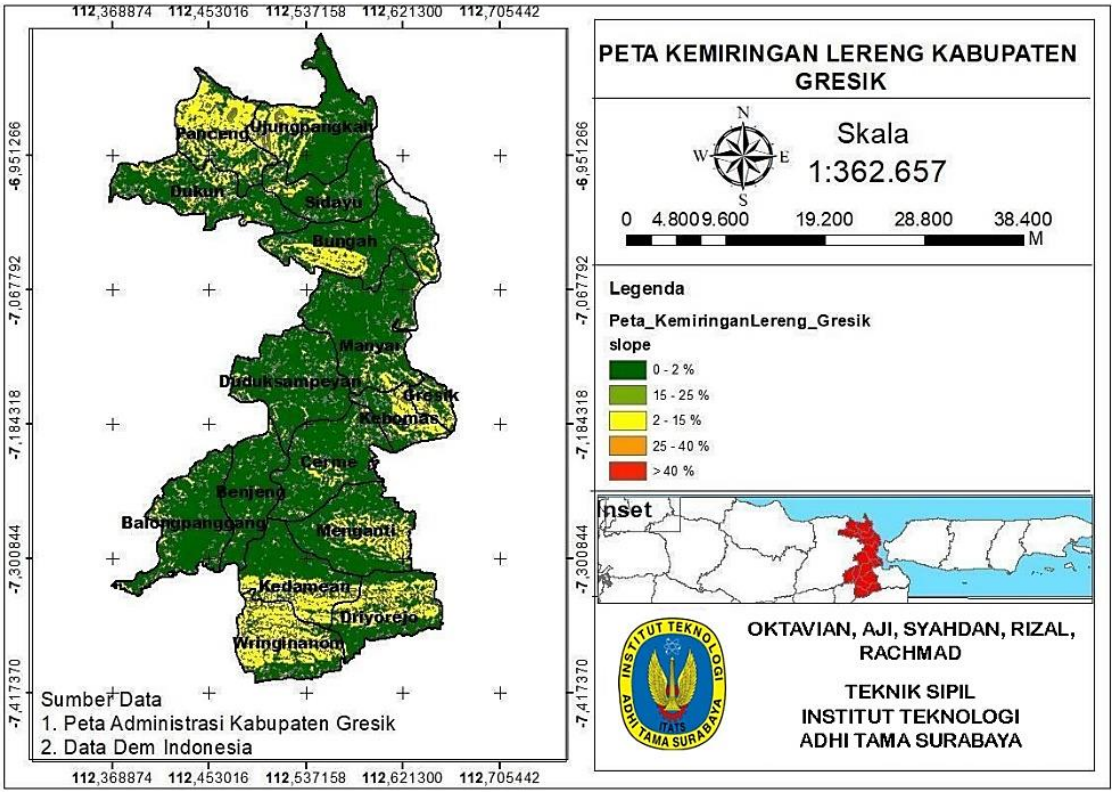

Fig 5. Result of Land Slope Map of Gresik District from data processing

3.3 Soil types of Gresik Regency

The Gresik Regency area is known to have relatively fertile soil. The following are soil type parameters in relation to the threat of landslides. This soil type parameter class refers to the Puslittanak (Center for Soil and Agroclimate Research) classification. The soil type parameter values for Gresik Regency have 2 types of parameters, namely class 1 with alluvial and grumosol soil types which have a slightly sensitive level of vulnerability and class 2 with Mediterranean soil which has a slightly sensitive level of vulnerability. The following are the parameters and scoring of soil types in Gresik Regency.

Table 3. Soil Type Classification

Type of soil	Score
Alluvial Gray	1
Dark Gray Alluvial	1
Hydromorphic Alluvial	1
Dark Gray Grumusol	1
Mediterranean Sorrel and Litosol Complex	2
Mediteran Red and Litosol Complex	2

(Source: Puslittanak 2004)

a) Alluvial Soil

Alluvial soil has a slightly gray color and it is also known that some of this soil is brown. This gray color is generally owned by alluvial soil with land use, namely rice fields or plantations. Meanwhile, alluvial soil outside plantation areas tends to be brown in color.

b) Grumosol Soil

Grumusol soil is formed from weathering processes that occur in limestone rocks and volcanic tuffa. This soil is brown to black in color. The organic content in Grumosol soil is relatively low because it comes from limestone rock content. It can be concluded that

grumusol soil is not fertile, so it is not suitable for planting plants. The texture of this soil is relatively dry and breaks easily, especially during the dry season.

c) Mediterranean Complex Land

Mediterranean soil is characterized by the form of calcareous igneous rocks, contains many carbonate compounds, and has a yellowish red to gray color. This soil was formed due to the weathering process that occurs in limestone rocks, resulting in a fairly poor fertility level.

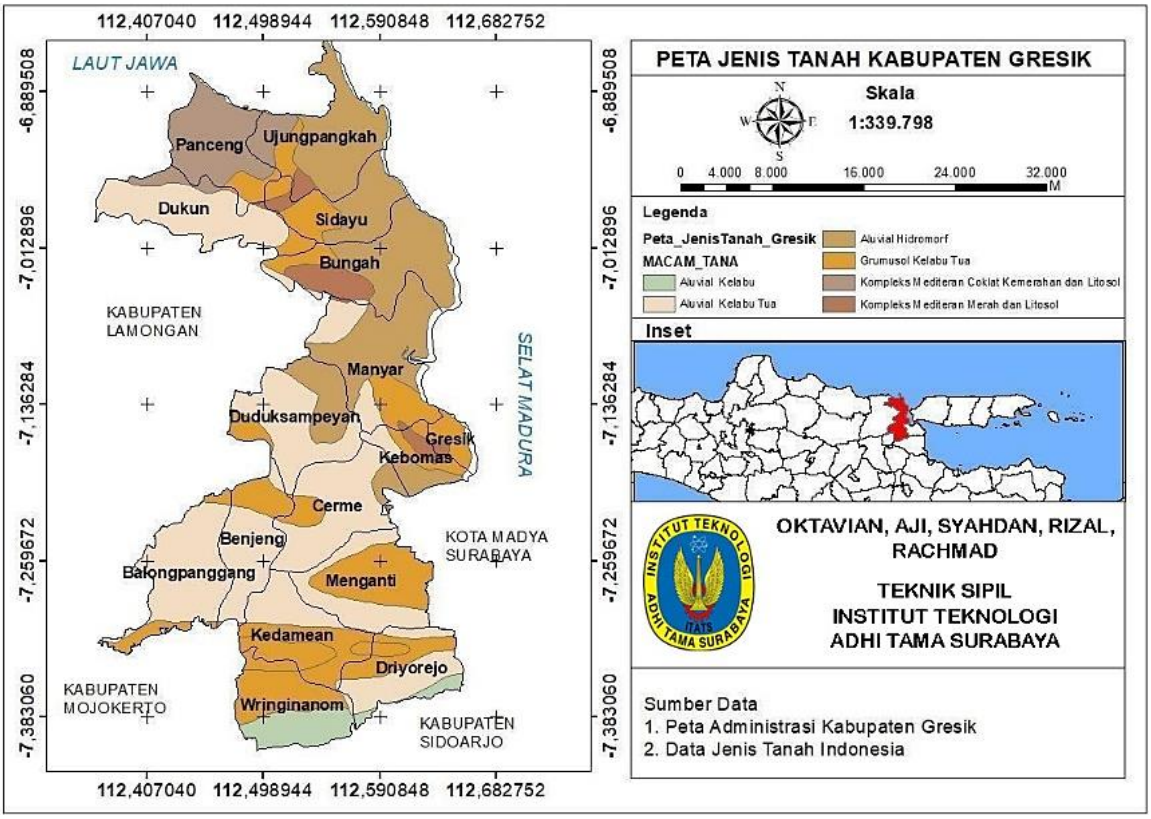

Fig 6. Results of Soil Type Map of Gresik District from data processing

3.4 Gresik Regency land use classification

Land use parameters are parameters for dividing soil types based on the function of the land by influencing the load capacity of the soil and the level of stability in the area. Land Use Management is used to determine the extent of land use in a particular area. The following is a scoring of land use parameters. The following are the parameters and scoring of land use in Gresik Regency.

Table 4. Land use classification

Description	Land Score
Water body	1
Airport / Harbor	1
Thicket	2
Swamp Thicket	2
Secondary Dryland Forest	3
Primary Mangrove Forest	3
Secondary Mangrove Forest	3
Plantation Forest	3
Settlement	5
Mining	5
Dryland farming	4
Mixed Dry Land Agriculture	4

Ricefield Pond	1

(Source: Puslittanak 2004)

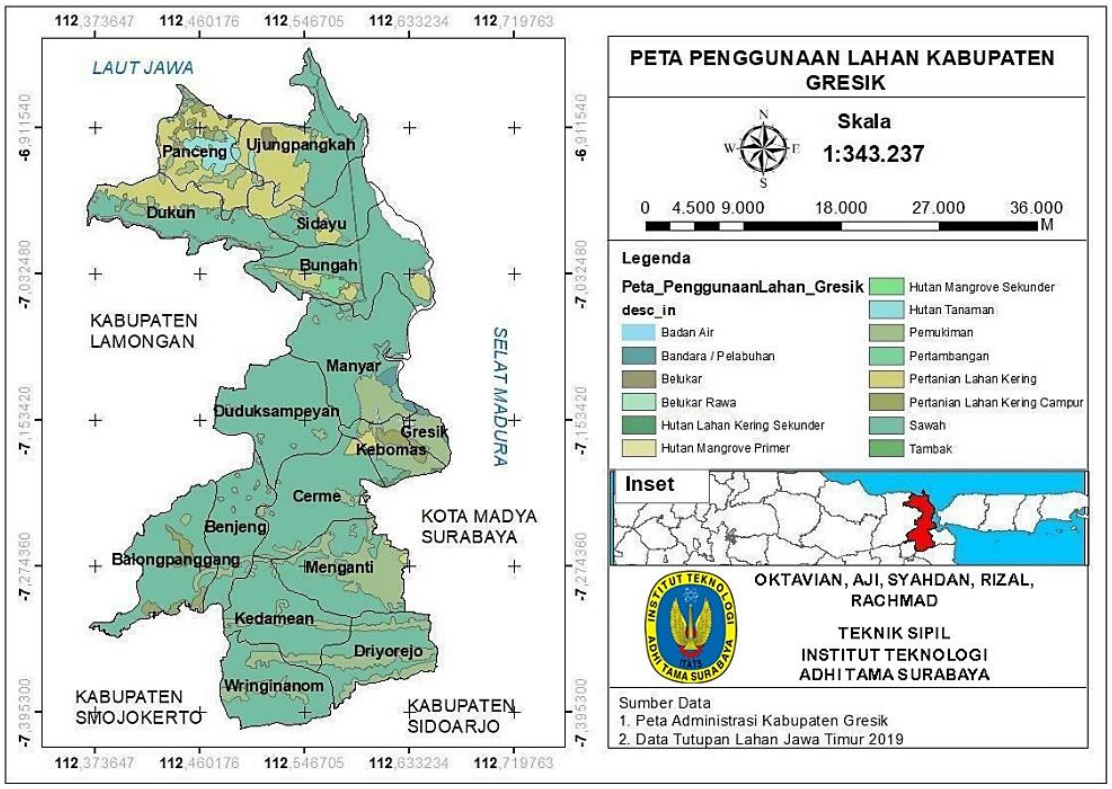

Fig 7. Results of Land Use Map of Gresik District from data processing

3.5 Gresik Regency rainfall classification

Rainfall in the research area is one of the determining factors in the potential level of landslide danger. With the increasing value of rainfall, it can be concluded that this area is one of the areas with a high potential for landslides. The following is a scoring of rainfall parameters.

Table 5. Rainfall Classification

CH	CH Score
1500-2000	3
1500-2000	3
1500-2000	3
>2500	5
2000-2500	4
<1000	1
1000-1500	2
1000-1500	2
1000-1500	2
2000-2500	4
1500-2000	3

Source: Puslittanak 2004

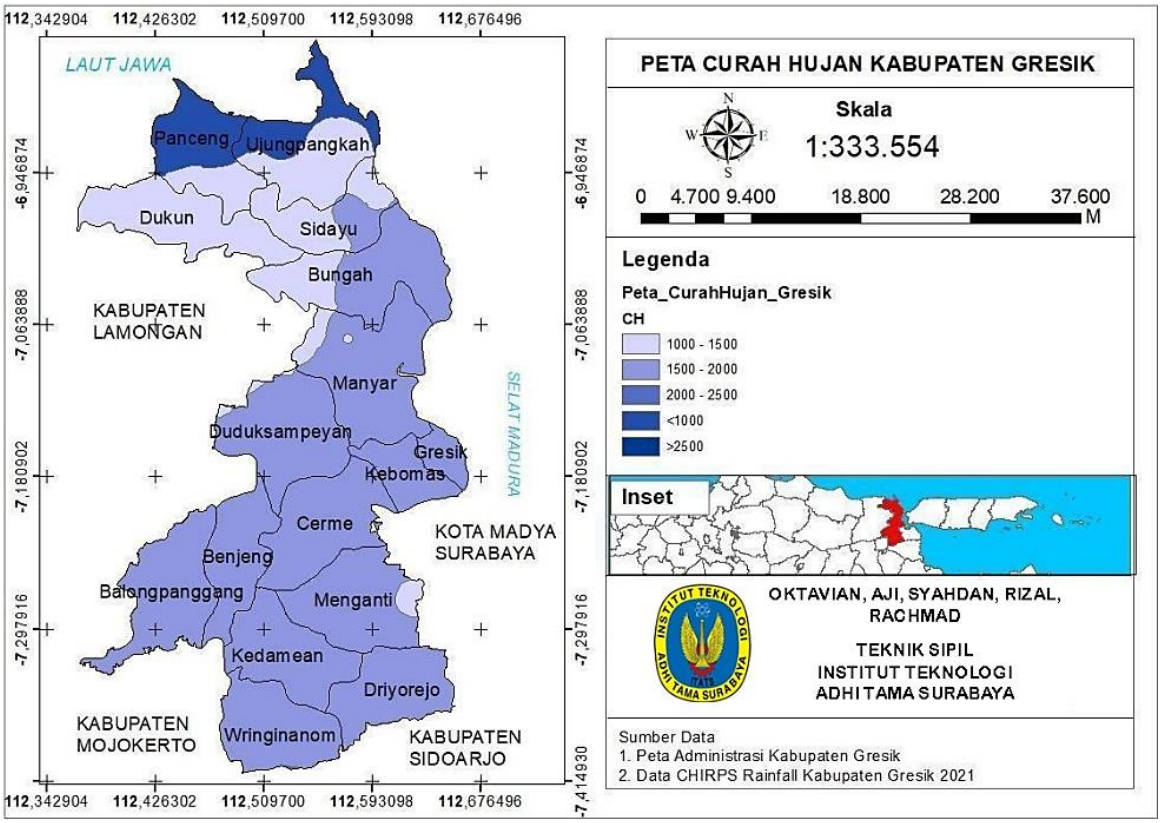

Fig 5: Results of rainfall map of Gresik District from data processing

4. Conclusions

From the results of research on analysis of landslide-prone areas in Gresik Regency using the Geographic Information System, it can be concluded that landslide zones are divided into 5 classes, namely very low vulnerability zones with an area of 1.9 km2, low vulnerability zones with an area of 42.8 km2, the medium vulnerability zone has an area of 134.5 km2, the high vulnerability zone has an area of 5.04 km2, and the very high vulnerability zone has an area of 0.17 km2. The areas with the highest level of vulnerability in Gresik Regency are spread across the central part of Bungah District, part of Gresik District, part of Kebomas District, part of Menganti District, part of Kedamean District, part of Driyorejo District, and part of Wringinanom District.

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