Soil Movement Analysis Using Geospatial Information System Method in Gunuang Padang Area Batang Arau Village

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Abstract. Batang arau village is an area that has an area around Gunung Padang. Padang Mountain is a small hill in the south of the Padang city which is directly adjacent to the Indian Ocean. Based on existing history, this area has experienced landslides which caused property losses and the loss of the lives of residents in that location. As a tourist area and a fairly densely populated residential area, knowing the areas prone to land movement is a must, so that people understand the potential for land movement that exists in the location where they live. Geospatial information system is a method that can be used to map the soil vulnerability conditions in the research area. Based on the soil movement model developed by Puslitatanak in 2004, 6 supporting maps are needed to produce a map of soil movement around the research area, namely, regional geological maps, rainfall maps, geomorphological maps, soil type maps, and rock type maps. The six maps are then combined into one to produce a soil vulnerability map in the research location. Based on the results of research, the area of Batang arau sub-district is included in areas with medium-very high soil movement vulnerability. Areas that are included in residential areas are in the medium vulnerability category, while areas that are included in the tourism object of Siti Nurbaya are in the very high vulnerability category.

1. Introduction
Batang Arau Village is located in the Padang Selatan sub-district, Padang city, West Sumatra Province with an area of 0.34 km². Batang Arau Village consists of 4 RW and 19 RT. The total population is 4,391 people (2017).

Batang Arau Village is on a hill that has an altitude of 80m above sea level, which has steep slopes and has the potential for landslides. Based on historical records owned by the city of Padang, the small hill had a quite large landslide, which resulted in casualties and material loss for residents living around Gunuang Padang, Batang Arau Village.

Even though in the last few years, there has been no record of landslides on this hill, the potential for landslides to threaten the lives of people around Gunuang Padang, Batang Arau Village, is added to the status of Gunuang Padang which is currently a Tsunami disaster shelter, which can threaten at any time.

Padang city, which is directly adjacent to the Indian Ocean, and very close to the confluence of the euro-asia and indo-australia plates. As a disaster shelter, this location has to be tested for safety, earthquake activity, rain, and other natural activities can disturb the stability of the slopes of Gunuang Padang, Batang Arau Village.
Therefore mapping of areas prone to land movement is important, as a consideration for the government to issue residential permits and building permits, as well as a guideline for determining which parts are safe to be used as shelters. From this research, it is hoped that participants will be able to Know the potential for movement / landslides and Know which areas have a very light-heavy level of soil movement vulnerability based on the criteria used.

2. Research Methodology
This type of research is mix-methods research, which is a research step by combining two forms of research approaches, namely qualitative and quantitative. Quantitative research is a mathematical model that uses a model that refers to the Bogor Center for Soil and Agro-climate Research (Puslittanak) 2004 as a tool for analyzing information you want to know. While qualitative research is a method that is descriptive or provides a clear picture and is in accordance with the facts in the field.

This research also refers to standard methods or general guidelines, one of the general guidelines used is the Indonesian National Standard (SNI) 13-7124-2005. This guideline is one of the minimum standards for disaster management administrators.

2.1. References
Soil Movement. Movement of land is a natural process that usually occurs in nature, but with the inclusion of the human element with all its activities, its value can turn into a natural disaster. The influence of geology is very large in the process of a ground motion supported by other factors from human activities, animals, water, plants, earthquakes and so on. In general, the causes of ground motion are geological factors (slope angle / slope, river density, lithology, geological structure) and non-geological factors (land use / human culture, rainfall). Some of the causes of landslides are caused by external disturbances and internal disturbances. External disturbances affecting ground motion such as caused vibrations (by earthquakes, explosions, trains), additional loading, loss of lateral resistance, loss of cover vegetation. Internal disturbances that affect ground movement, namely; loss of surface stretch, rising groundwater levels.

Unified Soil Classification System (USCS). The classification system that is often used in the world is the USCS, or unitary classification system. This system may be used based on visual investigation only, or on laboratory test results. The rule of differentiation is the amount of soil grain, so the first step is to place the soil in the coarse or fine soil group. Soil that has a grain smaller than 0.1 mm by more than 50% is included in the fine grained soil group, while soil that has a grain size smaller than 0.06 mm by less than 50% is included in the coarse grained soil group. It should be noted that the 0.06 mm grain size is the smallest grain size that can be measured using a sieve and is also the smallest grain size visible to the naked eye.

Each group is then divided again, but the basis of this group is different, depending on the soil including the group of coarse grained soil or fine grained soil. Since coarse-grained soil properties depend primarily on grain size, this is the only basis for dividing it into two groups, namely gravel and sand (L.D. Wesley, 2006).

Application of Geographical Information Systems (GIS) and Remote Sensing in Landslide Vulnerability Zone Mapping Studies. At present, GIS has been widely used in various fields of science such as planning, population, environmental and monitoring and so on. Landslide hazard map analysis is done after thematic maps of parameters, namely rainfall maps, soil type maps, geological maps, slope maps of the area are available and ready in the form of digital maps. Each type of map is classified based on the score and given a weight then the scores are grouped and analyzed. The mapping is done using ArcGIS software. In the mapping process, each parameter has a score classification multiplied by the weight of each parameter according to the model which refers to the 2004 Soil and Agro-climate Research Center (Puslittanak), (Riki Rahmad, 2018). The zone of ground movement vulnerability can be divided as much as possible into four, namely: High ground motion.
susceptibility zone, medium soil movement susceptibility zone, low ground motion susceptibility zone, very low ground motion susceptibility zone.

2.2. Research Stages
In the study, there were 3 stages of activities carried out, namely primary data collection, secondary data collection and laboratory testing. Primary data obtained in the research location is the geometric measurement data of landslides, strikes and dips along with the coordinates of the landslide locations in the field, and soil sample data at 4 location points using hand drill equipment.

![Figure 1. Sample collection process in RW 1 RT 1 Batang Arau village](image)

Secondary data used in this study are geological maps, topographic maps, slope maps, rock type maps, soil type maps. After obtaining primary data from the field, the sample will be tested in the laboratory by testing the atterberg limit in which there is a liquid limit and a plastic limit as well as a soil shear test.

The next stage is sample testing at the Laboratory. Sample testing was carried out at the Mining Laboratory of Padang State University. The test carried out is a test to determine the soil classification, namely the Liquid Limit and Plastic Limit tests.

![Figure 2. Liquid Limit Test](image) ![Figure 3. Plastic Limit Test](image)

In addition to using the liquid limit test, plastic plastic testing is also carried out to find out other soil parameters. To complement secondary data in the process of limiting the soil movement map, additional data is needed in the form of geological maps of the research area, topographic maps, rock type maps, soil type maps and slope maps of the Regional Geological Map of the South Padang District Region. It can be seen in Figure 7, 8, 9, 10, 11.
Figure 4. Regional Geological Map of Batang Arau Village

Figure 5. Topographical Maps of Batang Arau Village
Apart from regional geological conditions, it is also necessary to have topographical conditions around the study area which are depicted on the following topographic maps. The next map shows the types of rock around the research location, this map will tell us about the variety of rock in research area. The next map needed is the geomorphological state of the study area, this map contains the steepness of the slopes around the research location.

![Figure 6. Rock Type Map Around Batang Arau Village](image1)

![Figure 7. Geomorphological Map of Batang Arau Village](image2)
3. Result and Discussion
In this study, two main activities were carried out which resulted in two different outcomes. The first activity is taking samples in the field to get the conditions and types of soil in the research location. Data collection was carried out at 4 different locations that represented the condition of the soil type in the area of Batang Aru village as a whole. Furthermore, laboratory testing is carried out to obtain a map of soil types in the research location.

From the rock type map, Batang Aru Village is located on volcanic rocks. From the soil type map, the research location in Batang Aru Village has alluvial soil types and a red-yellow podsolic complex. The slope angle of the research location is between 21 - 55%. Based on the results of combining the five existing maps, then the soil vulnerability map is obtained in the area of Batang arau village, which is described in Figure 9.

![Figure 8. Soil Type Map of Batang Arau Village](image)

![Figure 9. Map of Soil Vulnerability in Batang Arau Village](image)
Based on the resulting soil vulnerability map, it can be seen that the kelurahan of Batang arau is in an area with medium-very high soil movement vulnerability. The area occupied by residents is in the medium-high category, while the area around the Siti Nurbaya tourist attraction is included in the very high category of land vulnerability.

4. Conclusion

Based on research conducted in the area of batang arau village, it can be identified that there are 3 types of soil found in the study area, namely alluvial soil, red soil, and regosol soil. This classification is obtained based on the results of testing the type of soil in the laboratory. Soil movement vulnerability maps are obtained by combining 6 maps, namely, rainfall condition maps, regional geological maps, geomorphological maps, rock type maps, soil type maps, and topographic maps of the research area. The result of combining these six maps produces a map of soil movement vulnerability. Based on the vulnerability map of soil movement, it is known that the research area is included in the medium-very high category, meaning that around the research area there is still potential for soil movement.

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