International Journal of GEOMATE, Dec., 2020, Vol.19, Issue 76, pp. 98–103
ISSN: 2186-2982 (P), 2186-2990 (O), Japan, DOI: https://doi.org/10.21660/2020.76.ICGeo12
Special Issue on Science, Engineering and Environment

HAZARDS AND MORPHOMETRY TO PREDICT THE POPULATION LOSS DUE OF LANDSLIDE DISASTERS IN KOTO XI TARUSAN - PESISIR SELATAN

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ABSTRACT: The purpose of writing this article is to analyze landslide hazards, landslide morphometry and predict the number of populations loss who have the potential to be affected by landslides. The method used is in the form the survey method is used to determine the landslide morphometry and literature studies are used in the form of population data. The results showed that the natural disaster hazards of landslides can be divided into three parts, i.e; low, medium and high natural hazards. The low natural hazard of landslides is generally found in the plains region in the form of alluvial plains and coastal alluvial plains. The hazards of a moderate landslide are generally found in low hilly areas and hilly, while the natural disaster hazard of high landslides is generally found in hilly areas and volcanic mountains that have undergone a weathering process. Landslide morphometry found in the study area was in the form of rotational and translational type landslides. Rotational landslides are natural disasters of landslides that have a sloping plane in the form of a basin and the type of translational landslide has a sloping plane parallel to the direction of the slope. The results of the prediction of the population loss that will be affected by the biggest natural disasters are village Siguntur, which is 3006 people, Kampung Baru Korong Nan Ampek, 1887 people and village Barung-Barung Balantai which is 1775 population.

Keywords: hazard, morphometry, population, pesisir selatan.

1. INTRODUCTION

Indonesia is an archipelago located in the tropics that has the potential to be affected by natural disasters [1]. The geographical location of the State of Indonesia which is located in the tropics causes the State of Indonesia to have high rainfall so that it becomes a trigger for natural disasters such as floods, flash floods and landslides. The morphological condition of the territory of the State of Indonesia in the form of plains to mountains, this causes the territory of the State of Indonesia to have the potential for natural disasters in the area of floods and flash floods and landslides may occur in the foothills of mountains and mountains. Natural disasters that occur in the territory of the State of Indonesia tend to increase, this causes losses caused by a disaster event also increased both the loss of property and human lives [2,3].

Natural disasters, floods, flash floods and landslides are the West Sumatra region located in the western part of the island of Sumatra, i.e the Pesisir Selatan Sub-district, especially in the Sub-district of Koto XI Tarusan. This Sub-district is the area closest to Padang City or this Sub-district is directly adjacent to Padang City. Koto XI Tarusan Sub-district has a lot of natural resource potential, i.e agriculture, marine fisheries, and tourism. The development sector in the tourism sector is the main sector which generates a lot of income for both the local government and the community. Areas that have the potential for the development of the tourism sector in the Koto XI Tarusan Sub-district are Mandeh areas which have tourist attractions in the form of islands, diving, snorkelling, and water rides.

One of the developments of the tourism sector in the Mandeh area is by opening access to land routes which were previously only accessible via sea routes. Making landline in the form of the access road is done by cutting slopes on areas that have steep slopes, this causes natural disasters in the form of landslides which can cause damage to the environment both directly and indirectly. The direct impact is the termination of road access from the Sungai Pisang to the Carocok area, and the impact on settlements that have not been much. The impact of a landslide natural disaster that occurred on the Padang road to Painan resulted in interrupted transportation routes between Padang and Painan.

The impact of this natural disaster of landslides can also indirectly result in the death of coral reefs located on the coast, this is caused by material from landslides carried by water to the coast, so that this material causes the coral reefs to be covered by sediment material, causing death in Coral reefs.

To reduce the suspension caused by a landslide natural disaster, it is necessary to analyze areas that have low, medium, and high landslide hazard levels and analyze the morphometry of the landslide to determine the typology of a landslide in the form of rotational or translational and predict the number of people affected by a natural disaster of the landslide.

2. RESEARCH METHODS

The method used in this study is a survey method carried out to determine the morphometry of landslides in the form of rotational and translational. To determine the level of landslide hazards carried out by Multiple Criteria Analysis (MCA) and Geography Information System (GIS) methods, while predicting the number of inhabitants in areas that have a potential for landslides natural disasters used population data published by the Central Statistics Agency of Pesisir Selatan Regency in 2018 and map of land use in 2018 and satellite imagery (Can be seen on the map of administration in Fig.1).

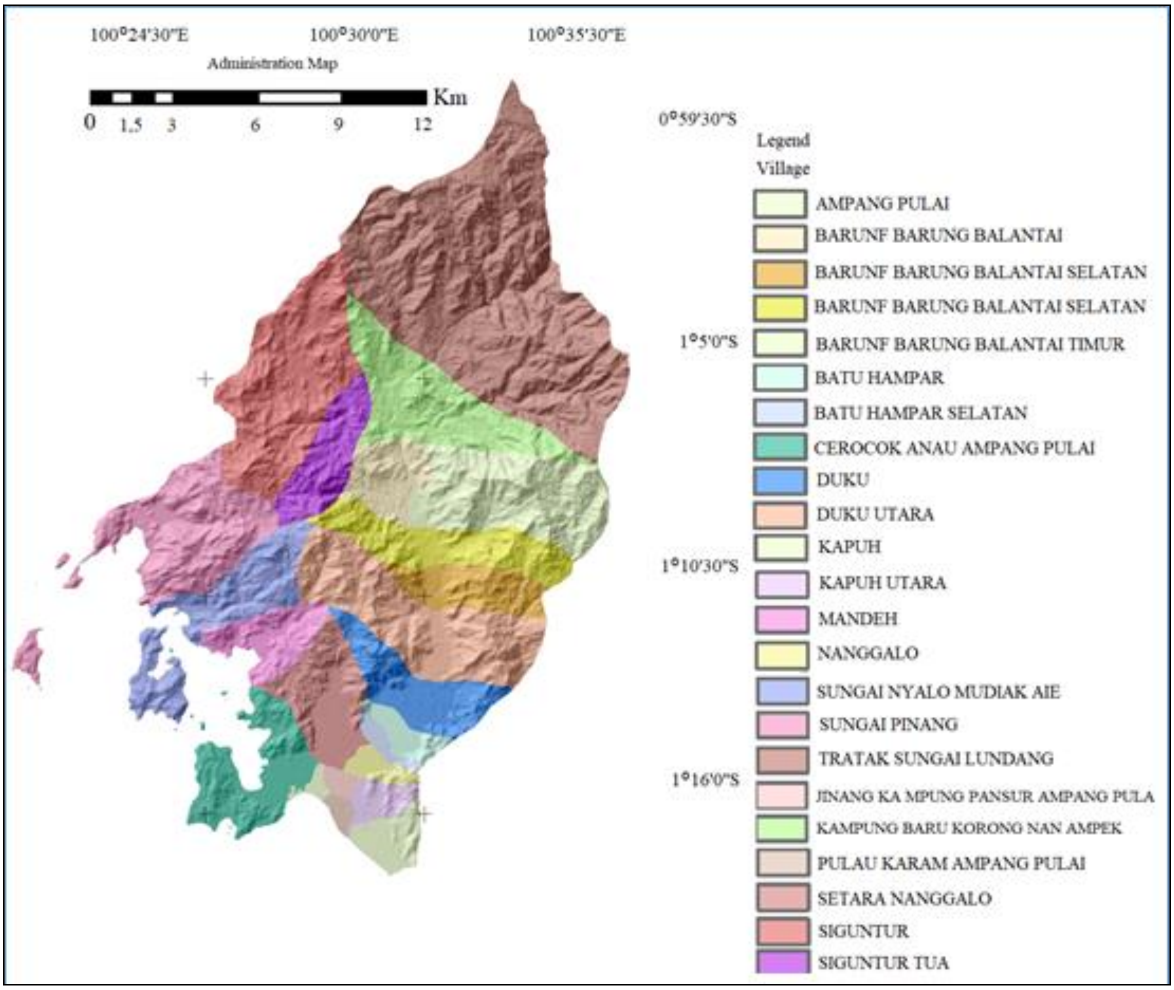

Fig.1 Administrative Map of Koto XI Tarusan Sub-District, Pesisir Selatan Regency

To determine the level of landslide hazards found in Koto XI Tarusan Sub-district using the following formula.

*Hazard= (0.3*slope)+(0.2*geology)+0.2* geomorphology)+(0.2*soil type) +(0.1*land use)*

To determine the morphometry and typology of the landslide [Fig 2], it was carried out using a formula that was found [4]. To predict the number of inhabitants in areas that have the potential for moderate and high landslides natural disasters, residential area data obtained from land-use maps and satellite imagery as well as Koto XI Tarusan Sub-district data obtained from the Central Statistics Agency of the South Coastal Regency in 2018.

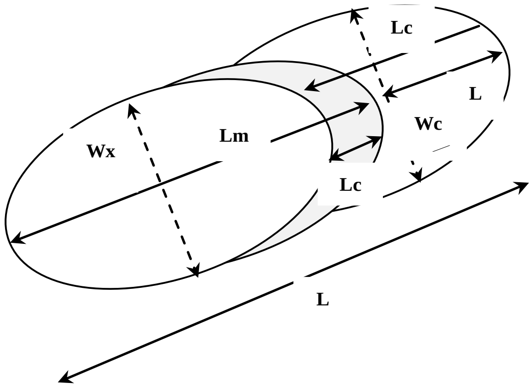

Fig.2 Model of Landslide Morphometry/Typology

Information:
D = total depth of landslide or depth
L = total length of the landslide
Lm = length of displaced material
Lc = length of a convincing part
Wx = width of the convex part
Wc = width of the concave part
Lr = length of the surface of rupture

3. RESULTS AND DISCUSSION

3.1 Landslides Hazard

Landslide hazards indicate the threat or potential for natural disasters of landslides that occur in an area [5]. The hazard of landslides is influenced by several factors such as; geological conditions, geomorphology, slope, soil type, rainfall, and land use. Based on the analysis of landslide hazards found in the Koto XI Tarusan Sub-district, Pesisir Selatan Regency can be seen in the following Table 1 dan Fig 3 below.

Table 1 Landslide Hazards in Koto XI Tarusan Sub-district, Pesisir Selatan Regency

Village	**Low**	**(%)**	**Medium**	**(%)**	**High**	**(%)**	Total Ha
Ampang Pulai	117.02	19.18	493.12	80.82	0.00	0	610.14
Barung_Barung Balantai	232.91	23.03	778.48	76.97	0.00	0	1011.39
Barung_Barung Balantai Selatan	204.6	15.50	493.12	37.37	622.02	47.13	1319.74
Barung-Barung Balantai Tengah	226.42	10.83	843.49	40.36	1019.84	48.80	2089.74
Barung_Barung Balantai Timur	133.36	4.02	938.24	28.30	2243.60	67.68	3315.20
Batu Hampar	256.21	53.47	222.93	46.53	0.00	0.00	479.14
Batu Hampar Selatan	124.01	49.13	128.38	50.87	0.00	0.00	252.39
Carocok Anau Ampang Pulai	362.59	17.85	798.12	39.30	870.14	42.85	2030.85
Duku	643.93	36.33	1121.75	63.29	6.84	0.39	1772.51
Duku Utara	407.21	10.76	2560.48	67.68	815.77	21.56	3783.47
Jinang K. Pansur Ampang Pulai	169.63	100.00	0.00	0.00	0.00	0.00	169.63
K. Baru Korong Nan Ampek	0	0.00	2308.76	76.20	721.10	23.80	3029.86
Kapuh	544.39	78.03	153.32	21.97	0.00	0.00	697.71
Kapuh Utara	349.24	71.77	137.36	28.23	0.00	0.00	486.60
Mandeh	260.44	22.04	921.36	77.96	0.00	0.00	1181.80
Nanggalo	216.04	61.03	137.91	38.96	0.04	0.01	353.99
Pulau Karam Ampang Pulai	160.71	100.00	0.00	0.00	0.00	0.00	160.71
Setara Nanggalo	302.24	16.08	1576.92	83.91	0.14	0.01	1879.30
Siguntur	0.6628	0.02	3392.22	77.91	961.37	22.08	4354.25
Sguntur Tua	0	0.00	942.80	65.97	486.33	34.03	1429.13
Sungai Nyalo Mudik Aie	208.7	8.79	1931.66	81.31	235.17	9.90	2375.54
Sungai Pinang	24.237	0.70	3372.31	96.91	83.31	2.39	3479.85
Taratak Sungai Lundang	0	0.00	2896.20	25.21	8590.17	74.79	11486.37

Source: Data Analysis,2019.

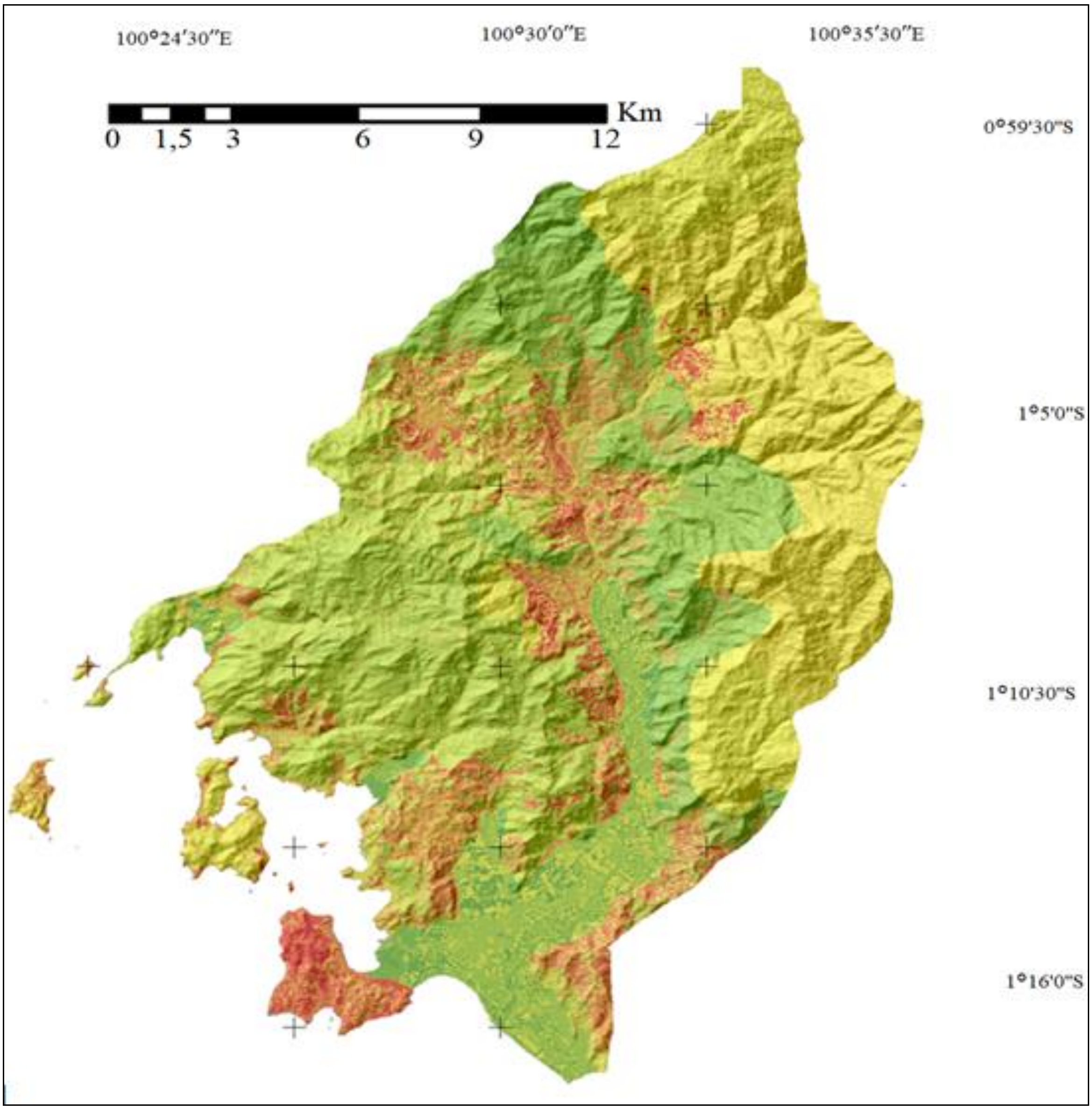

Fig.3 Map of The Landslide Hazard in Koto XI Tarusan Sub-district, Pesisir Selatan Regency

Based on the landslide hazard table, it can be seen that the landslide hazards that occur in Koto XI Tarusan Sub-district, Pesisir Selatan Regency can be divided into three parts, i.e low, medium and high landslide hazards. The widest low landslide hazard is found in Nagari Duku which is 643.93 ha and the widest moderate landslide hazard is Nagari Siguntur which is 3,329.22 ha and the widest high landslide hazard is found in Nagari Taratak Sungai Lundang which is 8,590.17 ha.

Areas or *nagari* that have moderate and high landslide hazards are generally found in hilly and mountainous areas, this causes the easy material to decay down the slope due to gravity forces [7-9]. High rainfall and the intensity of sunlight throughout the year causes high levels of rock weathering which can cause soil and rocks to ease down the slope [10-13].

3.2 Morphometry and Typology

Morphometry shows the shape and size of soil and rock material that experienced landslides in the form of depth, length of the landslide section, length of the basin, and width of the basin [2, 3, 11]. The typology of a landslide shows the type of landslide that occurs based on the type of movement and the material that became the landslide. The results of morphometric analysis and typology of landslides in the Koto XI Tarusan Sub-district can be seen in the following Table 2 below.

Table 2 Morphometry and Typology of Landslides

D	L	Lm	Lr	Lc	Wc	Wx	D/L*100%	Lm/Lc	Wx/Wc	Lr/Lc	(Wx/Wc1) (Lm/Lc) x 100%	Landslide Typology (slide)
1.2	7.3	2.1	3.5	0.8	6.8	7.8	16.4	2.6	1.1	4.4	38.6	Planar
1.4	8.2	2.4	4.3	0.7	7.2	8.4	17.1	3.4	1.2	6.1	57.1	Planar
1.6	7.3	2.2	3.7	0.6	7.8	10.1	21.9	3.7	1.3	6.2	108.1	Rotational
1.3	6.6	1.8	2.6	0.4	6.7	8.3	19.7	4.5	1.2	6.5	107.5	Planar
1.2	6.8	2.3	3.7	0.5	7.2	9.3	17.6	4.6	1.3	7.4	134.2	Planar

Source: Data Analysis in 2019.

The table above shows the typology of landslides that occurred in the study area is the type of planar slide and rotational slide. Typology of planar slide landslides generally occurs in shallow or thin soil layers and follows a flat slip plane following the geological structure, whereas rotational slide landslides typologies generally occur in areas that have thick soil solum and the main scarp forming a semicircle [2,3]. The highest depletion index is 4.6, this indicates the resilience of the material displaced by a landslide occurrence that is largely determined by the size of the landslide material and the effect of the slope on the microrelief formed. The largest widening index of 1.3 shows the size of the landslide and the classification of the landslide, especially for the type of flow. Landslides that occurred in the study area have a small flow type so that the material that experienced landslides in the form of soil and ragged material. The highest displacement index of 7.4 shows that the amount of material displacement moved by a landslide event from its original position on the main slope. The highest flow index of 134.2 shows the fluidity that is controlled by water and the effect of the slope and shows the speed of material movement at the time of a landslide event [11-15].

3.3 Prediction of the Population Loss

Prediction of the population in areas with potential landslides is done by analyzing the hazard map of landslides, Ikonos imagery and Koto XI Tarusan Sub-district data published by the Central Statistics Agency in 2018. For more details the prediction of the population contained in areas that have the potential for landslides can be seen in the following Fig.4 below:

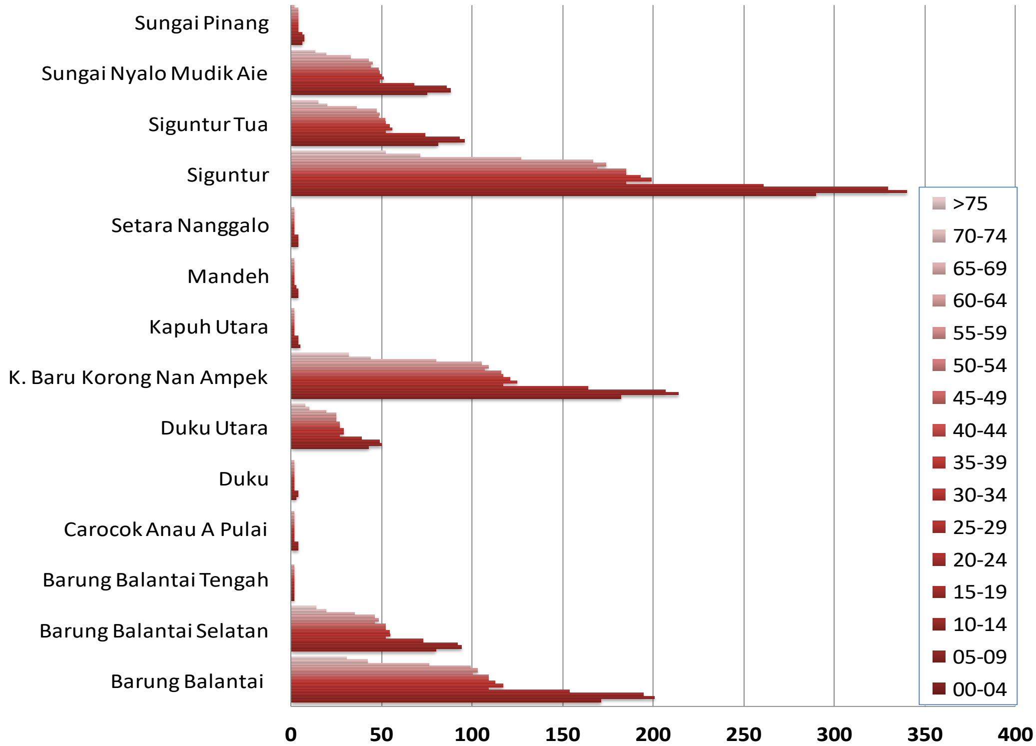

Fig.4 Predictions of Population in Areas with Potential Natural Landslides

4. CONCLUSION

Based on the results and discussion above, several conclusions can be drawn as follows; 1) The hazard of landslides that occur in the study area can be divided into three parts, i.e high, medium and low; 2) Morphometry and typology of landslides that occur in the study area in the form of rotational and planar landslides, and 3) Prediction of the number of population affected by landslides is greatly influenced by the development of community settlements so that the prediction of the population most affected by landslides is Nagari/Siguntur village with a prediction of a population of 1,511 male and 1,495 female.

5. ACKNOWLEDGEMENTS

Acknowledgements are given to Director of Postgraduate – Universitas Negeri Padang, who has provided support for us in carrying out this research. We also express our gratitude to all those who have helped with the administration process as well as those who helped us in the field.

6. REFERENCES

[1] Triyatno., Ikhwan., and Febriandi., Strategy for Community Adaptation in Facing Flood Natural Disasters in Pesisir Selatan Sub-district, West Sumatra. Sumatra Journal of Disaster, Geography and Geography Education, Vol. 2, Issue. *2*, 2018, pp.16-23.

[2] Lihawa F., Patuti I.M., and Nurfaika., Distribution of Spatial Aspects of Landslide Types in the Alo River Basin, Gorontalo Province. Journal Human and Environmental, Vol. 21, Issue. 3, 2014, pp.277-285.

[3] Schmaltz E., Steger S., Bell R., van Beek R., Bogaard T., Wang D., Hollaus H., and Pfeifer N., Evaluation of Shallow Landslides the Northern Walgau Using Morphometric Analysis Techniques. Procedia Earth and Planetary Science 16, 2016, pp.177-184.

[4] Hamza T., and Raghuvanshi T.K., GIS Based Landslide Hazard Evaluation and Zonation – A Case from Jeldu Sub-district, Central Ethiopia. J. King Saud University – Science Vol. 29, 2017, pp.151-165.

[5] Brunetti M.T., Melillo M., Peruccacci S., Ciabatta L., and Brocca L., How Far are we From The Use of Satellite Rainfall Products in Landslide Forecasting. Remote Sensing of Environment Vol. 210, 2018, pp.65-75.

[6] Bera S., Guru B., and Ramesh., Evaluation of Landslide Susceptibility Models: Comparative Study on the Part of Western Ghat Region. Remote Sensing Applications: Society and Environment. 2018, pp.1-32.

[7] Hemasinghe H., Deshapriya R., and Samarakoon L., Landslide Susceptibility Mapping Using Logistic Regression Model (a Case Study in Badulla Sub-district, Sri Lanka). Procedia Engineering. Vol. 212, 2018, pp.1046-1053.

[8] Hermon D., Erianjoni E., Dewata I., Putra A., and Oktorie O., Liquefaction Vulnerability Analysis as a Coastal Spatial Planning Concept in Pariaman City-Indonesia. International Journal of Recent Technology and Engineering, Vol. 8, Issue. 2, 2019, pp.4181-4186.

[9] Triyatno, Berd I., Idris., and Putra V., Hazard analysis and social vulnerability to predict the loss population are affected by the natural disaster of landslides in the Pesisir Selatan Sub-district of West Sumatra. In IOP Conference Series: Earth and Environmental Science, Vol. 314, No. 1, 2019, p.012031.

[10] Guzzetti F., Mondini A.C, Santangelo M., and Chang K.T., Landslide Inventory Maps: New Tools for an Old Problem. J Earth-Science Reviews. Vol. 112, 2012, pp.42-66.

[11] Hong H., Xu C., and Bui B.D., Landslide Susceptibility Assessment at the Xiushui Area (China) Using Frequency Ratio Model. Journal Procedia Earth and Planetary Science, 2015, pp.513-517.

[12] Hermon D., Putra A., and Oktorie O., Characteristics of Melanic Epipedon Based on Biosequence in The Physiography of Marapi-Singgalang, West Sumatra. IOP Conference Series: Earth and Environmental Science. Vol. 314. Issue 1. 2019.

[13] Nakano M., Chigira M., ChounSian L., and Sumaryono G., Geomorphological and geological features of the collapsing landslides induced by the 2009 Padang earthquake. In 10th Asian Regional Conference of IAEG, Kyoto. 2015.

[14] Khan H., Shafique M., Khan M.A., Bacha. M.A., Shah S.U., and Calligaris, C., Landslide Susceptibility Assessment Using Frequency Ratio, a Case Study of Northern Pakistan. The Egyptian Journal of Remote Sensing and Space Sciences. 2018, pp.1-9.

[15] Hadji R., Boumazbeur A.E., Limani Y., Baghem M., Chouabi M., and Demdouma A., Geologic, Topographic and Climatic Controls in Landslide Hazard Assessment Using GIS Modeling: A Case Study of Souk Ahras Region, NE Algeria. Journal Quaternary International Vol. 302, 2013, pp.224-237.