International Journal on Emerging Technologies **11**(5): 310-314(2020)

ISSN No. (Print): 0975-8364
ISSN No. (Online): 2249-3255

A Comprehensive Deriving the Factors of Landslide Happened in Malaysia

A.A. Ab Rahman[1], N. Abd Majid[2] and S.N. Selamat[3]
[1]Institute for Environment and Development (LESTARI),
Universiti Kebangsaan Malaysia (UKM), 43600 UKM Bangi, Selangor, Malaysia.
[2]Institute for Environment and Development (LESTARI),
Universiti Kebangsaan Malaysia (UKM), 43600 UKM Bangi, Selangor, Malaysia.
[3]Institute for Environment and Development (LESTARI),
Universiti Kebangsaan Malaysia (UKM), 43600 UKM Bangi, Selangor, Malaysia.

(Corresponding author: N. Abd Majid)
(Received 06 July 2020, Revised 10 August 2020, Accepted 01 September 2020)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Malaysia's growing number of landslides are closely related to the growth of new economic and social development infrastructures. This paper presents a review of landslide triggering factors from the previous studies to produce a compilation of the history of landslide phenomena in Malaysia. This review paper aims to highlight the factor triggering landslide occurrences in Malaysia based on historical events. As a finding, it is clear that design errors are the leading cause of landslide occurrences in Malaysia. Development activities on hilly terrain and heavy rainfall were triggered the landslides events in Malaysia was an increase. Ultimately, the government and local authorities must take the necessary measures to ensure proper design and maintenance should be carried out to prevent landslide events. Besides, awareness and knowledge about the danger of landslides should be implemented during the planning and management process. Therefore, historical landslide events should be carried out to provide valuable information during the planning and management process

Keywords: Disaster; Landslide; Factors; Malaysia.

I. INTRODUCTION

Historically, landslide research has defined mass movement, debris or soil below the slope as one of the world's most destructive environmental disasters. Besides, landslides are defined as the mass movement of underlying rocks, debris or soil, according to the U.S. Geological Survey (USGS). Landslide is a kind of material loss which implies the transfer of the soil and rock under the intense gravity pressure. Similarly, [1] describes the phenomenon of the landslide as a moving mass of rock, debris, or soil down a slope under the force of gravity. Hence, the landslide phenomena are considered a natural hazard and dangerous event that able to lead property damage and injury. The term "landslide" includes five modes of slope movement: fall, disconnect, slide, spread, and flow. It is also subdivided by geological materials (rock, shale or earth). Debris flow (typically related to dirt or mud) and rockfall is an indicator of the familiar category of landslides.

Damage caused by landslides can range from loss of topsoil to human death; they can also change landscapes such as causing landslides to occur. When massive landslides obstruct river flow and cause lakes, and this type of dam often occurs in tactical mountains active that cause to the landslide suddenly [2]. Regarding [3] study, noted that the massive scale of landslides mostly occurred along the river area. Thus, the consequences of landslides on the river area have resulted in severe economic losses and property losses. Other than that, the literature has emphasized the landslides are a frequent occurrence in hilly or hilly areas in the rainy season. There are correlation between the density of drainage and distance to the river due to landslides in the hilly area, which had a strong relationship due to erosion phenomena [4].

Due to rapid developments since the 1980s, strategic and appropriate low-lying areas for development have become increasingly unavailable in Malaysia [5]. The development of highland or hilly terrain has increased, particularly in areas adjacent to densely populated cities, thus exposing urban communities to an increased risk of landslides. Activities of land use changes are also causing environmental issues and impacting on local communities [6]. Landslides can cause problems for natural environments and road networks, so evaluation of landslide-prone areas is important to minimize damage [7].

Most of the landslide has a variety of factors. Slope gestures happen as when the forces moving down the slope (mainly attributed to gravity) exceed the strength of the earth-forming surface. Factors include causes that enhance the impact of lower slopes and factors that result in lower or lower strengths. Landslides may begin on the slopes that have been subject to movement by rain, snow, changes in water levels, erosion, and changes in groundwater, earthquakes, volcanic activity, disruption by human activities, or any variation of those factors. Landslides were classified as a group of disasters triggered by the dangers associated with geological processes such as earthquakes, volcanic eruptions and floods in mountainous areas and for the meteorological part are heavy rains, storms, and typhoons [8, 2, 9]. Hence, in the following sections, this paper will show the conditioning to landslide hazards factors in Malaysia. The purpose of this paper is to examine the landslide events in Malaysia during historical events into a single literary article to indicate

the current research. This paper discussed the causal factors of triggering landslide events, and finally concludes the effect of a landslide on community and country.

II. METHODS

Malaysia located in Southeast Asia, divided into two major parts, namely Peninsula Malaysia and Borneo Island. This country located at latitude 2° N to 7° N and longitude 99.5°E to 120°E. This research utilized secondary information from Malaysia's National Slope Disaster Planning and Management, newspaper and a research paper. Landslides often occur in tropical countries during the monsoon season. This is because the rainfall in this season is more than the average in comparison to other seasons. Weather patterns in tropical countries affect the stability of slope landslides in hilly areas. The number of major landslides reported in Malaysia from 1961 to 2018, as shown in Table 1.

Table 1: Landslide history in Malaysia [10-11].

S.No.	Date	Location
1.	May 1961	Ringlet, Cameron Highlands Pahang
2.	December 1993	Highland Tower at Taman Hillview, Ulu Klang, Selangor
3.	June 1995	Genting Highlands, near Karak Highway
4.	January 1996	North-South Expressway (NSE) near Gua Tempurung, Perak.
5.	August 1996	Pos Dipang Orang Asli settlement in Kampar, Perak
6.	November 1998	Bukit Saujana, Paya Terubung, Penang.
7.	January 1999	Sandakan, Sabah
8.	May 1999	Bukit Antarabangsa, Ulu Klang, Selangor
9.	January 2000	Cameron Highlands, Pahang.
10.	January 2001	Simunjan, Sarawak
11.	December 2001	Gunung Pulai, Johor.
12.	November 2002	Taman Hillview, Ulu Klang, Selangor
13.	November 2003	Klang Valley Expressway (NKVE) near the Bukit Lanjan
14.	November 2004	Taman Harmonis, Gombak, Selangor.
15.	December 2004	hill in Bercham, Ipoh, Perak
16.	May 2006	Kampung Pasir, Ulu Klang, Selangor
17.	March 2007	Precinct 9, Putrajaya
18.	December 2007	Kampung Baru Cina, Kapit Sarawak
19.	February 2009	Bukit Ceylon, Kuala Lumpur.
20.	May 2011	FELCRA Semungkis, Hulu Langat, Selangor
21.	December 2012	Puncak Setiawangsa, Kuala Lumpur
22.	January 2013	Kingsley Hill housing project at Putra Heights
23.	November 2015	km 52.4 of the Kuala Lumpur-Karak Express way
24.	January 2016	Karak Highway, (Kuala Lumpur to Genting Highlands)
25.	February 2016	Puncak Borneo (Bidayuh settlements and Padawan Ring Road)
26.	October 2017	Tanjung Bungah, Penang Island
27.	October 2018	Jalan Bukit Kukus, Georgetown, Penang Island
28.	October 2019	Kampung Teras, Batu Kurau, Perak
29.	November 2019	Genting Highland, Pahang
30.	May 2020	Taman Kelab Ukay, Bukit Antarabangsa
31.	Jun 2020	Taman Silibin Indah, Ipoh
32.	July 2020	Sungai Pencala, Kuala Lumpur

III. RESULTS AND DISCUSSION

A study carries out by [12] reported that the higher percentage causes of landslide occurrence are design errors, and design and construction error with 58% and 19% respectively. Meanwhile, maintenance causes and human causes are represented by 6% and 2% respectively. Fig. 1 shows the causes of landslide occurrences in Malaysia. Design error is highlighted as an essential factor for project performance, leading to additional costs and delays. Design errors such as misuse of the prescriptive process, design errors over-excavation or wrong side excavation, and repair errors such as clogged drainage system triggered landslides phenomena [13]. Based on [10], an analysis carried out in Malaysia on hillside development projects revealed that 60% of 49 landslides in Malaysia were due to design errors and 20% to a combination of design and construction errors in the past.

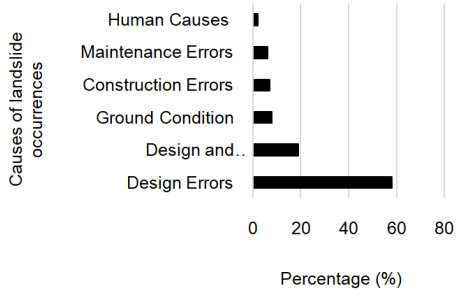

Fig. 1. Six causes of landslide occurrences [14].

However, several causal factors contribute to the triggered landslide occurrences in Malaysia such as slope, elevation, rainfall, and distance from faults, rivers and roads. Regarding [15] explained that one of landslide occurrences conditioning factors is a topographical factor that can play an essential role in

the analysis of landslide susceptibility. The topology of each area affects the different scales of landslide occurrences as various topologies have specific landmass. Method for mapping the susceptibility of landslides to the area along the E-W Highway from Gerik to Jeli was shown slope is one of the factors in occurring the landslide hazards [16], and this is supported by [17] stated that since it is directly causing a landslide, it is often employed generating landslide susceptibility map. Landslides frequently occur in highways area or hillsides in mountainous areas [15]. Slope failure is likely to occur at certain times in the region, potentially with destructive magnitude. That failure slopes are involved in geological disasters other than floods, earthquakes, volcanic activity and the tsunami.

Besides that, the topography aspect is among the factors that trigger the landslide occurrences. It is related to the elevation information, which is called the Digital elevation model (DEM). Earth's topography is three-dimensional modelling of the DEM considered as one of the primary data sources [18]. Based on DEM and topography, contour and survey base point that had elevation values can be extracted to view the pattern of the topography on the landslide area. Also using DEM, the slope, aspect and curvature can be calculated [19].

These results agree with the findings of other studies in a research finding by [20-21] reveals that this topographical factor is closely related to landslides incident. That also indicates that DEM has recently found widespread application in the geographic information system and landslide hazard mapping [22]. Regarding to [23], added that geographical information system is widespread application used for DEM and landslide event mapping. All this information is important in the study of landslide analysis. All this information is important in the study of landslide analysis. Fig. 2 shows the landslide event at Penang Hill.

Fig. 2. Topography pattern during landslide hazards at Tanjung Bungah, Penang [24].

In contrast, rainfall is one of the triggers of landslides in Malaysia. In the years 2006 to 2009, intense rain caused landslides and mud floods along the east coast of the coastal highlands of the Peninsula of Malaysia, Sabah (East Malaysia) and Penang [16]. On the other hand, the author said the same situation happened Cameron Highland, area of Selangor and Penang Island encounter mudflow events and numerous landslide and caused substantial destruction in these areas. The research study by [20] also found that heavy rainfall that occurred in Penang Island has an average between 2670 and 6240 mm per annum during peaks period between March to May and November to December every year. [14] added that the factor of increasing the number of landslides are usually due to the slope failure, and mostly, triggered by regional rainfall. Therefore, rainfall was categorizedas a significant triggering factor landslide occurrences in Malaysia.

Regarding the study [25] was reported, that the distance from roads, elevation, and distance from rivers had the greatest impact on landslide occurrence. Distance from faults has been identified as one contributing factor in the environmental aspect for landslide hazards. In 2010, research conducted at Cameron Highland, [26] found that it is a weakness zones, which prone to instability. Failures form a line or vulnerability zone marked by a broken stone. The buffer distance for this structure increases the likelihood of landslides [27-28]. Specified erosion and movement of water around fault lines/planes simulate these phenomena.

The distance of the slopes to drainage network is another essential factor cause of landslide occurrence. The impact of the river system on landslide occurrence depends on the scale of the channel and the path to the river and in fact, the region closest to the river and nearer to the high flux has a higher landslide ratio [29]. The range from the river represents the proximity of the river and the drainage to the area. The dendritic pattern is the most basic form of drainage is observed in the study area. On the other hand, [27]also state that distance to the road is a road cutting which often sites of anthropological instability. All the given roads can work as a buffer, a clean source, a clean sink or a water stream corridor. They usually act as landslides depending on their location in the region.

Effect of landslide: In many years, there has been an increasing amount of landslides occurring in Malaysia. This phenomenon causes property loss, loss of life, disruption of public comfort as well as increasing infrastructure maintenance costs [30]. Landslide events affect a variety of resources and the environment such as forests, water supply, dams, sewage systems, and road. It may be affected for a few years after the landslide events and may take time to recover. Landslides leave a negative impact indirectly on the economy as the costs of reconstruction, loss of property and indirect damages. Finding by [16] shows soil erosion is something that will happen in the event of a landslide due to the weak soil structure at a few places such top hilly area and lowland areas that already developed by the developer at Penang Island. On the other hand, research by [31] showed landslide event occurred at Bukit Antarabangsa, Hulu Klang, Selangor happened due to the degradation of gondola idle land for a long period from construction to completion, construction practices, and construction on slope sites that have a history of landslides or have been modified that occurred in the last 50 years. In Fact, effect from that, at most 65 lives have been killed as a result of this landslide phenomenon around 1990 until 2010.

The research conducted by [32] found that at least ten facilities and financial loss reach until hundred thousands of Malaysian ringgit caused by this event

that happened in Lok Bunuq village area, Sabah. Subsequently, research by [33] found that environmental hazards caused by developing hills are the high soil erosion occurrences that have experienced in many areas of the slopes of Penang. In another significant study by [34-35] about landslide oh Highland Towers in 1993 reported that one whole Block 1 of Highland Tower Condominium has fallen to the ground with 48 deaths caused by a major failure of improper soil testing. The finding is consistent with the study by [22], stated that Ulu Kelang is the hotspot area for major landslide, especially from the year 1993 to 2008. Often significant causes leading to landslides in prompt to causal factors are related to human activities, lack of maintenance, lack of design and construction problems.

IV. CONCLUSION

The current study contributes to our knowledge by addressing the significant aspect of landslide factors occurrence in Malaysia. Landslides were not triggered by one factor. However, the landslide event can be triggered by two or more factors. Based on the research finding, shows there are many causes of landslide occurrences including design error, construction error, ground conditioning, maintaining characteristics, and human factors. Other than that, several causal factors that are triggering the landslide occurrences such as rainfall, elevation, topographic factor, and others.

Nevertheless, based on historical landslide events in Malaysia shows that the main triggering factor of landslide events was a development activity on a hilly area and rainfall factors. A heavy rainfall that affects the soil can make the soil softer and weaker, thereby maximizing landslide occurrences. Hence, the government and state authorities should take action to prevent landslide phenomena through proper planning for development activities and avoid any development at the nearest hilly area. It is recommended that future research was undertaken focusing on the strengthen in mitigation for prevention landslide hazards at hotspot places and put more focus on the hilly area that near to the civilians. Therefore, the best mitigation is to stay away from any development in the hilly area, and awareness and knowledge should be implemented during the planning and management process.

V. FUTURE SCOPE

The review of the literature indicatesthe landslide phenomena and causes of landslide occurrences. To minimize the landslide phenomena, susceptibility studies should be carried out and these findings useful for planning and decision making.

ACKNOWLEDGEMENTS

Fundamental Research Grant Scheme (FRGS), grant number FRGS/1/2019/SS07/UKM/02/1.The authors would like to thanks the editor and anonymous for their comments and suggestion, which helped a lot in making this paper.

Conflict of Interest. The authors confirm that there are no established conflicts of interest involved with this article.

REFERENCES

[1]. Cruden, D. M. A simple definition of a landslide. (1991). *Bulletin of the International Association of Engineering Geology-Bulletin de l'Association Internationale de Géologie de l'Ingénieur, 43*(1): 27-29.

[2]. Sanderson, D., & Sharma, A. (2016). World Disasters Report 2016: Resillence: Saving Lives Today, Investing for Tomorrow, in World Disasters Report *IFRC* (pp. 282). Switzerland.

[3]. Sun, X., Chen, J., Han, X., Bao, Y., Zhan, J., & Peng, W. (2020). Application of a GIS-based slope unit method for landslide susceptibility mapping along the rapidly uplifting section of the upper Jinsha River, South-Western China. *Bulletin of Engineering Geology and the Environment, 79*(1): 533-549.

[4]. Soma, A. S., & Kubota, T. (2017). The Performance of Land Use Change Causative Factor on Landslide Susceptibility Map in Upper Ujung-Loe Watersheds South Sulawesi, Indonesia. *Geoplanning: Journal of Geomatics and Planning, 4*(2): 157-170.

[5]. Rahman, H., & Mapjabil, J. (2017). Landslides disaster in Malaysia: an overview. *Health, 8*(1): 58-71.

[6]. Abd Majid, N., Rainis, R., & Mohamed, A. F. (2018). Spatial analysis of development pressure in the Langat Basin, Selangor, Malaysia.

[7]. Dou, J., Bui, D. T., Yunus, A. P., (2015). Optimization of causative factors for landslide susceptibility evaluation using remote sensing and GIS data in parts of Niigata, Japan. *PloS one, 10*(7): e0133262.

[8]. Casagli, N., Elisabeth, K., Raimond, E., & Maureen, W. (2017). Chapter 3 Understanding Disaster Risk: Hazard Related RiskIssues—Section II, in Science for Disaster Risk Management 2017 *Chapter 3*(pp. 209–238). Belgium: European Commission.

[9]. Wen, B., Wang, S., Wang, E., & Zhang, J. (2004). Characteristics of rapid giant landslides in China. *Landslides, 1*(4): 247-261.

[10]. Gue, S., & Tan, Y. (2006). *Landslides: Case histories, lesson learned and mitigation measure.* Paper presented at the Conference on Landslide, Sinkhole, Structure Failure: MYTH or SCIENCE.

[11]. Abdullah, C. (2016). Landslide risk management in Malaysia. *Management of Natural Disasters, 92*: 259.

[12]. JKR. (2009). National Slope Master Plan. Sectoral Report Research and Development. In J. K. R. Malaysia (Ed.).

[13]. Kazmi, D., Qasim, S., Harahap, I., Baharom, S., Imran, M., & Moin, S. (2016). A study on the contributing factors of major landslides in Malaysia. *Civil Engineering Journal, 2*(12): 669-678.

[14]. Akter, A., Johari, M., Mohd, M., Goto, M., Khanam, S., & Parvez, A. (2019). Landslide Disaster in Malaysia : An Overview. *International Journal of Innovative Research & Development, 8*(6): 292-302.

[15]. Waleed, M. A., & Biswaeet, P. (2016). Landslide vulnerability and risk assessment for multi-hazard scenarios using airborne laser scanning data (LiDAR). *Lanslide*.

[16]. Pradhan, B., Chaudhari, A., Adinarayana, J., & Buchroithner, M. F. (2012). Soil erosion assessment and its correlation with landslide events using remote sensing data and GIS: a case study at Penang Island,

Malaysia. *Environmental monitoring and assessment, 184*(2): 715-727.
[17]. Mutluuoglu, O. (2016). Investigation of the effect of land slope on the accuracy of digital elevation model (DEM) generated from various sources. *Scientific Research and Essays, 5*: 1384-1391.
[18]. Saleem, N., Huq, M., Twumasi, N. Y. D., Javed, A., & Sajjad, A. (2019). Parameters Derived from and/or Used with Digital Elevation Models (DEMs) for Landslide Susceptibility Mapping and Landslide Risk Assessment: A Review. *ISPRS International Journal of Geo-Information, 8*(12): 545.
[19]. Pradhan, B., & Buchroithner, M. F. (2010). Comparison and validation of landslide susceptibility maps using an artificial neural network model for three test areas in Malaysia. *Environmental & Engineering Geoscience, 16*(2): 107-126.
[20]. Pradhan, B., & Lee, S. (2010). Delineation of landslide hazard areas on Penang Island, Malaysia, by using frequency ratio, logistic regression, and artificial neural network models. *Environmental Earth Sciences, 60*(5): 1037-1054.
[21]. Khai-Wern, K. L., Tien, T. L., & Lateh, H. (2011). *Landslide hazard mapping of Penang island using probabilistic methods and logistic regression.* Paper presented at the *2011 IEEE International Conference on Imaging Systems and Techniques*.
[22]. Mukhlisin, M., Idris, I., Nizam, K., & Taha, M. R. (2010). GIS based landslide hazard mapping prediction in Ulu Klang, Malaysia. *Journal of Mathematical and Fundamental Sciences, 42*(2): 163-178.
[23]. Alkhasawneh, M. S., Ngah, U. K., Tay, L. T., Mat Isa, N. A., & Al-batah, M. S. (2013). Determination of important topographic factors for landslide mapping analysis using MLP network. *The Scientific World Journal*.
[24]. Star, T. (Producer). (2018). Huge landslide in Tg Bungah hill. *The Star*. Retrieved from https://www.thestar.com.my/news/nation/2018/05/22/huge-landslide-in-tg-bungah-hill-experts-unable-to-reach-site-to-learn-what-happened-since-there-are
[25]. Chen, W., Pourghasemi, H. R., Kornejady, A., & Zhang, N. (2017). Landslide spatial modeling: Introducing new ensembles of ANN, MaxEnt, and SVM machine learning techniques. *Geoderma, 305*: 314-327.
[26]. Pradhan, B., Sezer, E. A., Gokceoglu, C., & Buchroithner, M. F. (2010). Landslide susceptibility mapping by neuro-fuzzy approach in a landslide-prone area (Cameron Highlands, Malaysia). *IEEE Transactions on Geoscience and Remote Sensing, 48*(12): 4164-4177.
[27]. Hong, H., Chen, W., Xu, C., Youssef, A. M., Pradhan, B., & Tien Bui, D. (2017). Rainfall-induced landslide susceptibility assessment at the Chongren area (China) using frequency ratio, certainty factor, and index of entropy. *Geocarto International, 32*(2): 139-154.
[28]. Sezer, E. A., Pradhan, B., & Gokceoglu, C. (2011). Manifestation of an adaptive neuro-fuzzy model on landslide susceptibility mapping: Klang valley, Malaysia. *Expert Systems with Applications, 38*(7): 8208-8219.
[29]. Bi, R., Schleier, M., Rohn, J., Ehret, D., & Xiang, W. (2014). Landslide susceptibility analysis based on ArcGIS and Artificial Neural Network for a large catchment in Three Gorges region, China. *Environmental earth sciences*, *72*(6): 1925-1938.
[30]. Abd Majid, N., & Wan, W. M. M. W. I. (2017). Pemetaan kegagalan cerun di Pulau Pinang dengan menggunakan Rangkaian Saraf Buatan (ANN) (Mapping slope failure vulnerability in Penang using Artificial Neural Network (ANN). *Geografia-Malaysian Journal of Society and Space, 9*(1).
[31]. Lim, C.-S., Jamaluddin, T. A., & Komoo, I. (2019). Tanah runtuh cetusan manusia di Bukit Antarabangsa, Hulu Kelang, Selangor. Bulletin of the Geological Society of Malaysia, *67*.
[32]. Roslee, R., Jamaluddin, T. A., & Talip, M. A. (2012). Landslide susceptibility mapping (LSM) at Kota Kinabalu, Sabah, Malaysia using factor analysis model (FAM). *Journal of Advanced Science and Engineering Research, 2*(1): 80-103.
[33]. Pourghasemi, H. R., Pradhan, B., Gokceoglu, C., Mohammadi, M., & Moradi, H. R. (2013). Application of weights-of-evidence and certainty factor models and their comparison in landslide susceptibility mapping at Haraz watershed, Iran. *Arabian Journal of Geosciences, 6*(7): 2351-2365.
[34]. Mezughi, T. H., Akhir, J. M., Rafek, A. G., & Abdullah, I. (2012). Analytical hierarchy process method for mapping landslide susceptibility to an area along the EW highway (Gerik-Jeli), Malaysia. *Asian Journal of Earth Sciences, 5*(1): 13.
[35]. Mancini, F., Ceppi, C., & Ritrovato, G. (2010). GIS and statistical analysis for landslide susceptibility mapping in the Daunia area (Italy).

How to cite this article: Ab Rahman, A. A., Abd Majid, N. and Selamat, S. N. (2020). A Comprehensive Deriving the Factors of Landslide Happened in Malaysia. *International Journal on Emerging Technologies, 11*(5): 310–314.