CHAPTER 2:

LITERATURE REVIEW

2.1 Introduction

Landslides categorized as one of the geological hazards. Landslide are classified as geological processes whereby rocks, surfaced and debris move down slopes along a natural incline under the sole influence of gravity (Thirugnanam et al., 2020). They are triggered by natural factors and / or human activities can happen in mountainous regions, hills and flat area such as heavy rainfall, earthquakes, soil moisture condition, loss vegetation, geological factors, volcanic activities and freeze-thaw cycle (Acharya et al., 2022).

Landslides develop in a variety of materials: soil, debris, rock and organics and at various speed ranging from mm yearly to tens of meters per second and in different ways such as topple, fall, flow, slide spread. A landslide can be in any of several stages including relic, dormant, or active which migrate along flat or curved surfaces, can be shallow or deep or they can be retrogressive, progressive, advancing, or enlarge and catastrophic (Geertsema et al., 2020)

Even though there are few instances of major earthquake in Malaysia, cases of landslide and floods are recurring natural disasters which are due to over flooding caused by long periods of rainfall. In Malaysia for instance, the number of cases of landslides increases during the monsoon periods. Majority of the said happenings happened in areas such as Hulu Kelang, Cameron Highlands as well as Genting Highlands (Rahman & Mapjabil, 2017).

2.1.1 Types of landslides

Landslides can be categorized into five types which are a) rockfall, b) topple, c) slides (rotational landslide and translational landslide), d) lateral spreading and e) flows such in ***Table 1*** below (Kazmi et al. 2016 & Varnes 1978).

i. **Rock falls:** Rockfall is defined as a movement of soil, rock or both downhill on a steep incline with little or no shear movement other than falling, bouncing or sliding. They are normally developed on steep or vertical hazel ridges of river channels or coastal cliffs with falling soil fragments, which may break up on impact and runner until they encounter level base.

ii. **Topple:** Causes of toppling may include gravitational forces on the side of an uphill material, water or ice behind the crack, vibrations, undercutting or differential weathering, controlled excavation of slopes or stream erosion. When it happens swiftly that is with high velocity it can prove very destructive.

iii. **Slides:** Slides can be divided into two types which are:

- **Rotational landslides** prevail in homogeneous materials for example in fill areas and are often alleged by duration rain, rapid snowmelt, or by incoming or fluctuating ground water level. Others causes include general abrasion due to rise and fall in water levels, reservoir encroachment and earth movements.
- **Translational landslides** is the movement is in an outward or downward path across a gently inclined surface with little change in leaning. Usually, they occur in areas with weak foundation, gentle rocks, or both, and are invariably sited at faults, joints, bedding planes, or rock/soil contact planes.
- **Lateral spreads** refer to prostrate movement of stiff ground that has ruptured crosswise on week ground such as liquefied clay, without shifting a sharp divide. Such movements can lead to considerable destruction of buildings and constructions; the rate of these movements depends on the water content in the soil.
- **Debris flows** are most frequently observed in steep terrains as gullies, canyons and sparsely vegetated areas, on slopes that was subjected to wildfires or logging, and on volcanic readily eroded soils. These flows occur when rapid rainfall or snowmelt occur and move at high velocities (up to 35mp/h) transporting soil, rocks and other sediments down slopes in fan-shaped deposists at the base of slopes and have been known to cause a significant amount of damage to structures and infrastructures owing to their high velocity, instability and capacity to transport large loads.

In the region humid tropical climate like in Malaysia, landslide type which often occurs on natural slopes is the type of slip or slide. Due to the content high water and often associated with rain heavy, then slip failure or sliding often followed by flow (Jamaluddin et al., 2020). The presents of landslides can be identified using the geomorphology features of land such in **Figure 1**. The features consist of crown, main scarp, crown cracks, zone of depletion and zone of accumulation (Varnes 1978)

TABLE 1: Summary of types of landslides by Kazmi et. Al 2016

Movement type	**Material classification**		
	Bed rock	Engineering soils	
Fall	Rock fall	Debris fall	Earth fall
Topples	Rock topple	Debris topple	Earth topple
Slides: Rotational / Translational	Rock slide	Debris slide	Earth slide
Lateral spreading	Rock spread	Debris spread	Earth spread
Flows	Rock flow	Debris flow	Earth flow

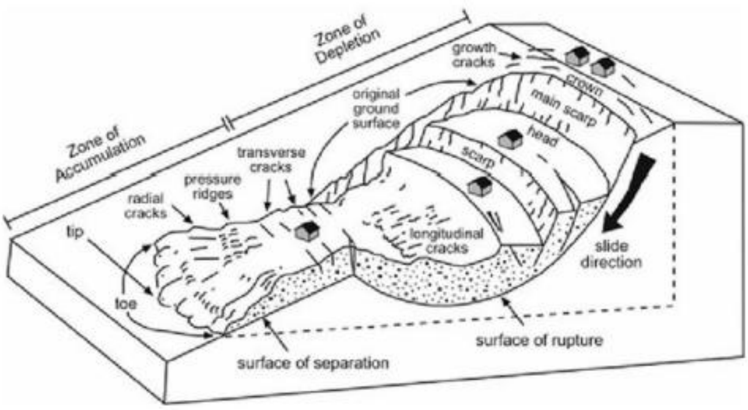

FIGURE 1: Illustration of geomorphological features of landslides

2.1.2 Landslides History

Based on Kazmi et al. 2016, the major of landslides occurrences in Malaysia include Highlands Tower collapsed (1993), Bukit Antarabangsa (2008 and 1999), Taman Zooview (2006), Taman Hillview (2002), Puncak Setiawangsa (2012), Penang Hill (2013), Ukay Perdana (2013), Serendah (2016), Gua Tempurung (1996) and Pos Dipang (1996). Highlands Tower collapsed is the most terrible landslides tragedy occur in Malaysia which killed 48 peoples. Most of the landslides caused by heavy rainfalls and human activities (**TABLE 2**).

The newest major landslides hazards occurred around 3 am on 16 December 2022 at *Father's Organic Farm,* Batang Kali, Selangor. The landslide occurred along the Jalan Batang kali Genting highlands road which caused 31 dead that consider to be the catastrophic tragedy after Highlands Tower Collapse on 1999 (Harvendhar Singh et al. 2022).

Wahab (2024) reported that the Mineral and Geoscience Department listed 38 hotspots area of landslide-prone in Selangor with seven of them classified as critical. Besides the landslide incident happened in Batang Kali on end of December 2022, there is another landslide in Taman Bukit Permai, Ampang, on March 10 that year, killed four people and destroyed 15 homes and 10 vehicles.

Catastrophic landslides are common in Selangor not only because of natural conditions but also due to various anthropogenic factors like intense urbanization and unlawful uses of land that greatly enhance the susceptibility of such landslides, particularly in heavily developed regions, such as Bukit Antarabangsa (Mafigiri et al., 2022). Thus, for efficient landslides prediction and its control, these factors should become the components of the complex models to avoid the disasters in sensitive territories.

TABLE 2: Major landslides in Malaysia by Kazmi et al. 2016

S.No	Landslide	Year	Potential causes
1	Serendah	2016	Swift flow of underground water
2	Ukay Perdana	2013	Negligence in safety precautions/ improper planning
3	Penang Hill	2013	Continuous rainfall/Improper plan by developers in projects
4	Puncak Setiawangsa	2012	Improper design of retaining wall
5	Bukit Antarabangsa	2008	Poor drainage system/long rainfall
6	Tamam Zooview	2006	Design and construction/non-maintenance
7	Tamam Hillview	2002	Heavy rainfall, improper design of slope
8	Bukit Antarabangsa	1999	Rainfall, inadequate design, improper drainage, erosion
9	Gua Tempurung	1996	Geological
10	Pos Dipang	1996	Rainfall, improper design of retaining wall
11	Highland Towers collapse	1993	Rainfall, non-maintenance, design inaccuracies

2.2 Geology and Lithology

Selangor states located at west coast of Malaysia that consists of sedimentary rock, alluvium, metamorphic and granite. These formations include the Kenny Hill Formation, Belata Formation, Kuala Lumpur Limestone, Dinding Schist, Kajang Formation Hawthornden Schist, and Quaternary deposit (Hutchinson & Tan, 2009). Landslides may occur on existing sedimentary rock masses because they are conjointly bedded, are easily water saturated or imbibe water, and contain inherent defects in specified mineral structures. These internal factors coupled with external factors such as rainfall or seismicity makes the sedimentary rocks highly sensitive to slope failures (Liu et al., 2020)

Landslides susceptibility in Selangor is influenced by faults and tectonic and many parts of Selangor are along the active tectonic regions such as the Titiwangsa and Semenyih Faults. These faults that belong to the Sunda Plate affect the setting by eroding the soil and rocks making them susceptible to failure during intense rainfall or earthquakes according to Umor et al. (2018).

Another geology factor that is crucial in control of landslides is the sedimentary slopes that are subject of shallow and low magnitude slides along impervious partings. These slopes are very vulnerable to landslides given that they have low permeability which brings in about lowering of critical rainfall amounts as well as vulnerability to runoff and erosions (Mafigiri et al., 2022).

For example, in a case of Ulu Kelang, Selangor, the lithology mainly consists of highly weathered granite, quartzite, and sandstone, making the area geomorphology very rainfall sensitive (Tajudin et al., 2021). Additionally, Bukit Antarabangsa, Selangor highly susceptible to landslips due to the weathered granite content that tend to turn slippery when wet. Malaysia receives a lot of rainfall that increases pore pressure and weakens clay rich soils by lowering its shear strength leading to slope failures (Ismail et al., 2019).

2.3 Climate Change

Malaysia situated at the geographical coordinates of N 2° 30’ 0” and E 112° 45’ 0”, has tropical climate with near-equatorial temperatures during the year and high percentage of humidity and those includes daily temperatures of between 22°C –33°C and average humidity of about 70%. The average annual precipitation is 2075 mm, this may have wide fluctuations depending in monsoon (Kazmi et al. 2016).

Generally, Malaysia experiences tropical climate, which is characterized by Southwest Monsoon (April – September), and Northeast Monsoon (October – March). These monsoon systems are responsible for the distribution of the country’s annual rainfall distribution, with considerable implications on weathering, hydrosystems and structures, ecological systems and social-economic undertakings (Tang, 2019).

Malaysia Meteorology Department stated that the Northeast monsoon gives the eastern states of Peninsular Malaysia and Sarawak a heavy shower. During the Southwest Monsoon which is often referred to as the dry season, does not trigger heavy rainfall or powerful wind (Ishak et al. 2021).

For example, the Cameron Highlands and the Ulu Klang regions are most vulnerable for landslides during monsoon seasons owing to the geography and high levels of precipitation. Such areas have recorded several landslides, which have led to loss of lives and properties (Fakaruddin et al., 2019, Mukhlisin et al., 2015, Matori et al., 2012).

Landslides have been reported in Ulu Kelang Selangor, majorly during the monsoon season since this leads to fully saturated soil conditions, raise in pore water pressure thus declining slope strength, and is due to steep slopes and increased degree of urbanization.

Combined with the reduced vegetation cover this makes the region very susceptible to soil erosion and therefore slope failure during the wet season as pointed out by Tajudin et al., 2021.

2.4 Geographic Information systems (GIS)

Spatial information system (SIS) or geographical information system (GIS) is a system that enables the collection, storage, analysis, management and presentation of geographic data to solve spatial problems or to gain better understanding of spatial relationships and patterns. This approach of using GIS with machine learning provides a better and more efficient option for risk analysis and assessment as it involves utilizing spatial data like slope, rainfall and soil type for modeling than the traditional deterministic approach to landslide risks assessment and disaster planning (Ganesh et al., 2023).

Coco et al., (2021) utilised GIS for landslide susceptibility maps analysis using statistical methods comprising of the landslides susceptibility index (LSI) and landslide index (LI) for vector data analysis. The GIS-oriented procedure involved the slope unit partitioning and the application of integrated methods like LiDAR, the aerial photo interpretation and the field inventories to develop highly accurate maps as well as for the proper assessment of the landslide susceptibility regions.

Landslide susceptibility maps are generated by GIS-based Multi-Criteria Decision Analysis (MCDA) of multiple datasets with different levels of uncertainty, by techniques like the Analytical Hierarchical process (AHP) and the weighted linear combination (WLC). Superior methods like association rule mining and data mining when incorporated in GIS-MCDA provide better understanding of spatial pattern and relationships that escalate the efficiency of susceptibility mapping (Erener et al., 2016).

Monte Carlo simulations and other probabilistic approaches for modeling are used in combination with GIS to consider uncertainties in, for example, soil cohesion and friction angle to efficiently perform large-scale landslide susceptibility assessments. Discriminant analysis among other multivariate methods of analysis enable GIS to classify the terrains based on susceptibility with improved data handling (Park et al., 2013).

However, GIS remains at the level of limited incorporation of temporal dynamic factors such as variations in rainfall and land use that may greatly affect landslides. Further, it has not paid adequate attention to issues regarding the model uncertainty and transferability of assessment to other areas for susceptibility maps. (Jari et al., 2023).

2.5 Machine Learning

Application of machine learning in GIS improves the relationships identification between the environmental factors and increases the reliability of GIS applications in landslide susceptibility mapping and analyzed the data in greater detail (Abdessamad Jari et al., 2023).

Sparse feature extraction coupled with GIS and remote sensing data as well as advanced machine learning algoriths like Random Forest, Support Vector Machines and Gradient Boosting is used to predict the susceptibility of landslide which enhances the predictive capacity with the highest delivering model yielding high AUC (area under control) values and the study underlines the appropriateness of undertaking susceptibility mapping through GIS (Zhu et al., 2021).

Similarly, Acharya et al. (2022) utilizes a variety of machine learning methods that includes, Random Forest, XRDBST, KNN regression, SVR, and Linear regression to forecast the probability of a landslide occurrence given some factors that include the moistures of the soils and energy of an earthquake. Wang et al. (2020) also indicate that machine learning algorithms such as Random Forest, SVM, MLP, GBM, and Logistic Regression were applied to estimate a relationship between landslide occurrences and environmental factors, using GIS data. SVM was among the most preferable methods of landslide analysis since it has the highest accuracy compared to other algorithms.

In addition, SVM was able to correctly estimate the probabilities of landslides more often than the other methods because of its ability to handle complex data, both high dimensional and have good properties and great generality that can be used in different settings and can easily yield good results which can be used to predict landslides in an area when it has not been used before (Marjanović et al., 2011).

Thirugnanam et al. (2020) using two main types of machine learning: nowcast models, whereby real slope conditions are estimated from a very limited information input such as rainfall forecast, the forecast models, whereby slope stability conditions in the next 24 hours are predicted using current information.

Tehrani et al. (2022) defined the subfield in machine learning, which is the deep learning (DL) that employs artificial neural networks (ANN) with multiple layers to deal with the complex data. This makes it particularly friendly for image processing tasks such as image detection and classification, detecting landslides in images such as satellite images or aerial photos, object detection and much more especially saving more details of the landslide areas.

Landslide susceptibility prediction is a complex process owing to the multiple, non-linear relationships that govern the interactions between the various contributing factors of landslides. It is in this context that deep learning models, coupled with autoencoder based feature selection, provide noticeable improvement in predictive accuracy. Thus, by comparing deep learning outcomes against traditional approaches to machine learning, more robust and higher efficiency is seen, particularly in the case of the application of feature selection techniques to the algorithm (Chen & Fan, 2023).

ANN have before been applied in the efficient analysis of big data and supplied accurate susceptibility maps in concordance with the documented landslide areas (Bragagnolo et al., 2020). It has been identified that ANN models can offer higher accuracy in landslide susceptibility mapping than any other approaches. As compared with frequency ratio and logistic regression models, ANN yielded higher AUC values, which implies better prediction performance in research (Aditian et al. 2018).

The Landslide Susceptibility model for the Langat River Basin reported here was created using Artificial Neural Network (ANN) wherein conditioning factors were rightly conditioned through the connection weights. From the findings of the present study, it could be concluded that the ANN offered a good forecasting ability thereby making it a credible identification tool for delineating landslide prone regions (Selamat et al., 2022).

REFERENCES

Acharya, V., Ghosh, A., Kang, I., Thilanka Munasinghe, & Binita, K. C. (2022). Landslide Likelihood Prediction using Machine Learning Algorithms. *2021 IEEE International Conference on Big Data (Big Data)*, 5395–5403. https://doi.org/10.1109/bigdata55660.2022.10020433

Aditian, A., Kubota, T., & Shinohara, Y. (2018). Comparison of GIS-based landslide susceptibility models using frequency ratio, logistic regression, and artificial neural network in a tertiary region of Ambon, Indonesia. *Geomorphology*, *318*, 101–111. https://doi.org/10.1016/j.geomorph.2018.06.006

Bragagnolo, L., da Silva, R. V., & Grzybowski, J. M. V. (2020). Landslide susceptibility mapping with r.landslide: A free open-source GIS-integrated tool based on Artificial Neural Networks. *Environmental Modelling & Software*, *123*, 104565. https://doi.org/10.1016/j.envsoft.2019.104565

Chang, K.-T., Merghadi, A., Yunus, A. P., Pham, B. T., & Dou, J. (2019). Evaluating scale effects of topographic variables in landslide susceptibility models using GIS-based machine learning techniques. *Scientific Reports*, *9*(1). https://doi.org/10.1038/s41598-019-48773-2

Chen, C., & Fan, L. (2023). Selection of contributing factors for predicting landslide susceptibility using machine learning and deep learning models. *Stochastic Environmental Research and Risk Assessment*. https://doi.org/10.1007/s00477-023-02556-4

Coco, L., Macrini, D., Piacentini, T., & Marcello Buccolini. (2021). Landslide Susceptibility Mapping by Comparing GIS-Based Bivariate Methods: A Focus on the Geomorphological Implication of the Statistical Results. *Remote Sensing*, *13*(21), 4280–4280. https://doi.org/10.3390/rs13214280

Ekeanyanwu, C. V., Obisakin, I., Aduwenye, P., & Dede-Bamfo, N. (2022). Merging GIS and Machine Learning Techniques: A Paper Review. *Journal of Geoscience and Environment Protection*, *10*(09), 61–83. https://doi.org/10.4236/gep.2022.109004

Erener, A., Mutlu, A., & Sebnem Düzgün, H. (2016). A comparative study for landslide susceptibility mapping using GIS-based multi-criteria decision analysis (MCDA), logistic regression (LR) and association rule mining (ARM). *Engineering Geology*, *203*, 45–55. https://doi.org/10.1016/j.enggeo.2015.09.007

Fakaruddin, F. J., Yip, W. S., Diong, J. Y., Dindang, A., K. Chang, N., & Abdullah, M. H. (2019). Occurrence of meridional and easterly surges and their impact on Malaysian rainfall during the northeast monsoon: a climatology study. *Meteorological Applications*, *27*(1). https://doi.org/10.1002/met.1836

Ganesh, B., Vincent, S., Pathan, S., & Raquel, S. (2023). *Integration of GIS and Machine Learning Techniques for Mapping the Landslide-Prone Areas in the State of Goa, India*. https://doi.org/10.1007/s12524-023-01707-y

Hutchison, C. S., & Tan, D. N. K. (2009). *Geology of Peninsular Malaysia* (1st ed., pp. 73–79). Universiti Malaya and Geological Society of Malaysia.

Ismail, N. E. H., Taib, S. H., & Abas, F. A. M. (2019). Slope monitoring: an application of time-lapse electrical resistivity imaging method in Bukit Antarabangsa, Kuala Lumpur. *Environmental Earth Sciences*, *78*(1). https://doi.org/10.1007/s12665-018-8019-9

Jari, A., Khaddari, A., Hajaj, S., Bachaoui, E. M., Mohammedi, S., Jellouli, A., Mosaid, H., El Harti, A., & Barakat, A. (2023). Landslide Susceptibility Mapping Using Multi-Criteria Decision-Making (MCDM), Statistical, and Machine Learning Models in the Aube Department, France. *Earth*, *4*(3), 698–713. https://doi.org/10.3390/earth4030037

Lim, C.-S., Jamaluddin, T. A., & Komoo, I. (2019). Human-induced landslides at Bukit Antarabangsa, Hulu Kelang, Selangor. *Bulletin of the Geological Society of Malaysia*, *67*, 9–20. https://doi.org/10.7186/bgsm67201902

Liu, J., Xu, Q., Wang, S., Siva Subramanian, S., Wang, L., & Qi, X. (2020). Formation and chemo-mechanical characteristics of weak clay interlayers between alternative mudstone and sandstone sequence of gently inclined landslides in Nanjiang, SW China. *Bulletin of Engineering Geology and the Environment*. https://doi.org/10.1007/s10064-020-01859-y

Liu, L., Chen, X., Zhao, L., & Cao, W. (2023). Evaluation of Landslide Susceptibility Using Machine Learning Based on Information Value Sampling Method. *2021 China Automation Congress (CAC)*. https://doi.org/10.1109/cac59555.2023.10451427

Mafigiri, A., Faisal Abdul Khanan, M., Che Din, A. H., & Abdul Rahman, M. Z. (2022). Assessing the Influence of Anthropogenic Causal Factors on Landslide Susceptibility in Bukit Antarabangsa, Selangor. *International Journal of Built Environment and Sustainability*, *10*(1), 43–60. https://doi.org/10.11113/ijbes.v10.n1.1051

Mafigiri, A., Khanan, A., Hassan, A., & Rahman, A. (2022). Assessing the Influence of Anthropogenic Causal Factors on Landslide Susceptibility in Bukit Antarabangsa, Selangor. *International Journal of Built Environment and Sustainability*, *10*(1), 43–60. https://doi.org/10.11113/ijbes.v10.n1.1051

Majid, N. A., Taha, N. R., & Selamat, S. N. (2020). Historical landslide events in Malaysia 1993-2019. *Indian Journal of Science and Technology*, *13*(33), 3387–3399. https://doi.org/10.17485/ijst/v13i33.884

Matori, A. N., Basith, A., & Harahap, I. S. H. (2012). Study of regional monsoonal effects on landslide hazard zonation in Cameron Highlands, Malaysia. *Arabian Journal of Geosciences*, *5*(5), 1069–1084. https://doi.org/10.1007/s12517-011-0309-4

Mukhlisin, M., Matlan, S. J., Ahlan, M. J., & Taha, M. R. (2015). Analysis of Rainfall Effect to Slope Stability in Ulu Klang, Malaysia. *Jurnal Teknologi*, *72*(3). https://doi.org/10.11113/jt.v72.4005

Nor Diana, M. I., Muhamad, N., Taha, M. R., Osman, A., & Alam, Md. M. (2021). Social Vulnerability Assessment for Landslide Hazards in Malaysia: A Systematic Review Study. *Land*, *10*(3), 315. https://doi.org/10.3390/land10030315

Park, H. J., Lee, J. H., & Woo, I. (2013). Assessment of rainfall-induced shallow landslide susceptibility using a GIS-based probabilistic approach. *Engineering Geology*, *161*, 1–15. https://doi.org/10.1016/j.enggeo.2013.04.011

Rosly, M. H., Mohamad, H. M., Nurmin Bolong, & Herayani, S. (2022). An Overview: Relationship of Geological Condition and Rainfall with Landslide Events at East Malaysia. *Trends in Sciences*, *19*(8), 3464–3464. https://doi.org/10.48048/tis.2022.3464

Selamat, S. N., Majid, N. A., Taha, M. R., & Osman, A. (2022). Landslide Susceptibility Model Using Artificial Neural Network (ANN) Approach in Langat River Basin, Selangor, Malaysia. *Land*, *11*(6), 833. https://doi.org/10.3390/land11060833

Soon, L. W. (2023, February 2). Beef Up Protection Of Environmentally Sensitive Areas To Prevent Deadly Landslides – Experts. *Bernama*. https://www.bernama.com/en/bfokus/news.php?environment&id=2161129

Sulaiman, N., Robin, M. F. A., Muhammad Jamil, R., Sulaiman, N., Udin, W. S., Shafiee, N. S., & Sulaiman, F. R. (2024). Geology and Landslide Susceptibility Using GIS at Kampung Belahat, Jeli, Kelantan. *BIO Web of Conferences*, *131*, 04009. https://doi.org/10.1051/bioconf/202413104009

Tajudin, N., Ya'acob, N., Ali, D. M., & Adnan, N. A. (2021). Soil moisture index estimation from landsat 8 images for prediction and monitoring landslide occurrences in Ulu Kelang, Selangor, Malaysia. *International Journal of Power Electronics and Drive Systems/International Journal of Electrical and Computer Engineering*, *11*(3), 2101–2101. https://doi.org/10.11591/ijece.v11i3.pp2101-2108

Tang, K. H. D. (2019). Climate change in Malaysia: Trends, contributors, impacts, mitigation and adaptations. *Science of the Total Environment*, *650*(2), 1858–1871. https://doi.org/10.1016/j.scitotenv.2018.09.316

Thirugnanam, H., Ramesh, M. V., & Rangan, V. P. (2020). Enhancing the reliability of landslide early warning systems by machine learning. *Landslides*. https://doi.org/10.1007/s10346-020-01453-z

Umor, M. R., Ghani, A. A., Leman, S., Ali, C. A., & Sian, C. (2018, December 15). *Geochemistry and Petrology of Klang Gate Quartz Dyke in Gombak, Selangor and Its Bearings on Tectonic Evolution of Peninsular Malaysia*. Konferens Tapak Warisan Selangor Ke Arah Pengiktirafan Dunia. https://doi.org/10.13140/RG.2.2.27312.61446

Wahab, F. (2024, October 11). *Selangor gears up for rescue ops*. The Star. https://www.thestar.com.my/metro/metro-news/2024/10/12/selangor-gears-up-for-rescue-ops

Wang, Z., Liu, Q., & Liu, Y. (2020a). Mapping Landslide Susceptibility Using Machine Learning Algorithms and GIS: A Case Study in Shexian County, Anhui Province, China. *Symmetry*, *12*(12), 1954. https://doi.org/10.3390/sym12121954

Wang, Z., Liu, Q., & Liu, Y. (2020b). Mapping Landslide Susceptibility Using Machine Learning Algorithms and GIS: A Case Study in Shexian County, Anhui Province, China. *Symmetry*, *12*(12), 1954. https://doi.org/10.3390/sym12121954

Zhu, L., Wang, G., Huang, F., Li, Y., Chen, W., & Hong, H. (2021). Landslide Susceptibility Prediction Using Sparse Feature Extraction and Machine Learning Models Based on GIS and Remote Sensing. *IEEE Geoscience and Remote Sensing Letters*, *19*, 1–5. https://doi.org/10.1109/lgrs.2021.3054029