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Landslide Vulnerability and Risk Assessment of Matara District Using the Geospatial Technologies

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Abstract: Landslides can be identified as one of the major natural hazards to Sri Lanka. Nearly 20,000 km^2 encompassing ten districts are prone to landslides in Sri Lanka. According to the data from Disaster Management Centre, the highest number of landslides were occurred in Matara District in 2017. So, identifying landslide susceptibility zones are important to take prevention actions of landslides as the first step. GIS- multicriterial evaluation on slope, elevation, topographic wetness, year 2023 vegetation cover and 2013 – 2023 annual average rainfall of physical and environmental landslide susceptible factors using GIS based Weighted Overlay Process, the study has identified Kotapola and Pasgoda Divisional Secretariat Divisions are having more than 5 km^2 areas of landslide susceptibility than other fourteen Divisional Secretariat Divisions of Matara District. Assessing the vulnerability of the landslide is important to mitigate the impact and minimize the damage of the event. Therefore, this research study has identified socio-economic vulnerable zones using built-up areas, road network and population data. Then 13 Grama Niladhari Divisions were from 36 Divisional Secretariat Divisions of Kotapola Divisional Secretariat Division and 12 Grama Niladhari Divisions were from 43 Grama Niladhari Divisions of Pasgoda Divisional Secretariat Division were identified as high landslide vulnerable zones. More than 20 Grama Niladhari Divisions are having risk of landslide and it is occurring since those areas belong to at least one of the socio-economic vulnerability analysis factors. This geospatial approach enables effective sustainable natural resource management via the establishment of environmentally susceptible areas with the landslide susceptibility and risk mapping. Being the non-structural and structural mitigation methods, the geospatial analysis in this study is a core foundation for the implementation of structural mitigation. Determining landslide susceptibility zones as well as socio-economic vulnerability zones, this method enables the first step of the disaster management cycle such that more targeted and improved interventions could be made to prevent landslide hazards.

Keywords: Geo Spatial Approach, Landslide, Risk Assessment, Susceptibility, Weighted Overlay Process

Introduction

The researcher aims to explore the background to the study, providing a general background to landslide susceptibility, vulnerability, and risk assessment with particular focus on the Matara District in Sri Lanka. Situated in the southern part of the country, Matara is characterized by variable landscape and climate that predisposes some sections of the region to be more susceptible to landslides, particularly during the southwest monsoon. As population density rises and there is uncontrolled land use on slopes, landslide hazards have risen, posing threats to life, infrastructure, and livelihood. This study is seeking to resolve the essential research question of inadequate localized measurements and forecasting instruments for landslide risk in Matara, hindering appropriate disaster preparedness and mitigation measures. In so doing, the research formulates crucial questions: What are vulnerability patterns of landslides in space in Matara? What are the key factors leading to vulnerability? And how can risk be assessed and mapped quantitatively for enhancement? The key objectives are to identify landslide hazard areas using GIS and remote sensing, assess community vulnerability, and develop a risk profile for decision-making purposes. The significance of the research is that it can help enhance the resilience of the locality by guiding data-informed planning, infrastructure investment, and policy-making. However, the research is subject to limitations like the availability and resolution of geospatial data, limited access to historical landslide records, and potential issues with field validation. The chapter is wrapped up with an overview summarizing the rationale for the research, laying the groundwork for detailed analysis of landslide risk dynamics within the Matara District.

This research primarily explores landslide risk and vulnerability in the Matara District landslide hazard areas by employing geospatial techniques. A hazard can be understood in a general context as a likely occurrence or process to inflict injury on human beings, society, or the environment. Hazards may be triggered by natural processes or human activities and are generally divided into natural hazards and man-made hazards. Natural hazards are those natural events or conditions that pose a threat to human settlements and the environment around them, some of them include landslides, cyclones, floods, droughts, avalanches, and heatwaves. Of these, landslides constitute a significant natural hazard in Sri Lanka's hill and semi-hill regions, including the Matara District.

In natural hazard terminology, vulnerability is "the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard." Vulnerability tends to be divided into two dimensions: ecological vulnerability, including biodiversity, habitat fragmentation, and conservation status; and socio-economic vulnerability, including population density, building density, and social marginality indexes. In this research, landslide vulnerability is defined by integrating the spatial variation of landslide-inducing parameters such as slope, soil, land use, and rainfall and socio-economic factors pertinent to the Matara District.

This union provides for a landslide risk evaluation, which measures the predicted frequency of landslide events and exposure and vulnerability of people, assets, and the environment. In essence, landslide hazard in Matara is considered to be the product of both physical susceptibility and socio-economic vulnerability.

This research utilizes a Geo-Spatial Method, which involves gathering, analysing, and spatially displaying data with coordinates to accurately identify areas susceptible to landslides before they become disaster zones. Key technologies are Geo Information Systems (GIS) and Remote Sensing (RS), which facilitate visualization and spatial analysis of landslide hazard and vulnerability in the Matara District.

One of the most important methodological frameworks applied in this study is Weighted Overlay process. Following Weighted Overlay is in ArcGIS software, weights are assigned to every landslide-generating factor such that a Landslide Susceptibility Index may be computed. Weighted overlay is applied to combine both physical and socio-economic data, resulting in detailed assessment maps that can inform disaster preparedness, land-use planning, and community resilience action plans in Matara.

Methodology

Evidently, the Matara District is more prone to landslides compared to other regions, highlighting the pressing need for effective mitigation strategies. To address this issue, the researcher aims to identify landslide-susceptible zones, assess their vulnerability, and evaluate the associated risks within the Mathara District using open-source geospatial technology. ArcGIS facilitates the integration of various open data sources, such as OpenStreetMap and satellite imagery, enabling developing countries to utilize free data for landslide disaster management. The following sections outline the methods, data sources, and methodologies employed to delineate the boundaries of Matara District and its Divisional Secretariat Divisions.

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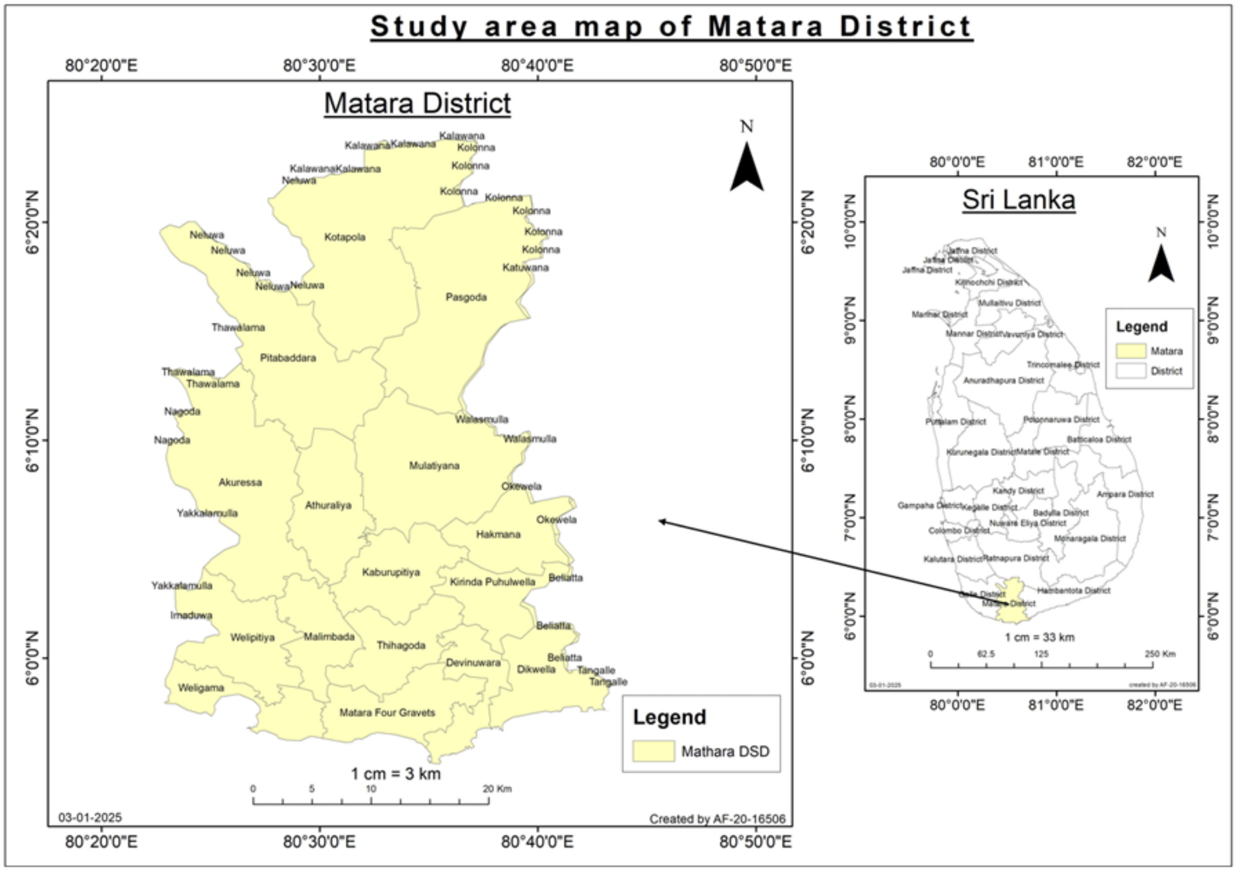
Study Area

Figure 1: Matara District Map



Source: Created by Author 2025

As the study area Matara district of Southern Province of Sri Lanka. There are 16 divisional secretariats division, each serving as an administrative division. And Matara District is approximately 1,247 square Kilometers. And the location of the study area is latitude 5.94810N and longitude is 80.53530N

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Data and Methods

Table 1: Data Type Used in the Study

Variables	**Operational Definitions**
Slop	A slope refers to an inclined surface, and its stability is a key factor in understanding the risk of landslides and other geological hazards (Lee & Jones,2014).
Vegetation cover	According to Renaud, Sudmeier, Rieux & Estrella (2013). Vegetation cove plays a significant role in reducing the frequency and impact of natural disasters such as landslides, floods, and soil erosion by stabilizing the soil and absorbing rainfall.
Elevation	Elevation is a significant factor influencing landslide susceptibility, as higher slopes and steeper terrains at greater elevations are more prone to landslide occurrences (Bishop,2007).
Rainfall	The duration and intensity of rainfall significantly affect landslide occurrence; short, heavy rainstorms are particularly hazardous in areas prone to landslide (Nicolini et all.,2008). And according to the Dain & Lee (2002), Internes rainfall is a primary trigger of landslides, as it increases the water content in the soil, reducing stability and leading to slop failure.
Population	In the context of disaster the population at risk is a critical factor in assessing and managing disasters, as it determines the scale of vulnerability and potential impact (Alexander, 2002).
Build up areas	Build up areas are particularly susceptible to disasters as they concentrate people, infrast (Alexander, 2002).
Transport network	Damege to transportation infrastructure during disasters can isolate communities and delay relief efforts (Coppola, 2021).

Source: Created by Author 2025

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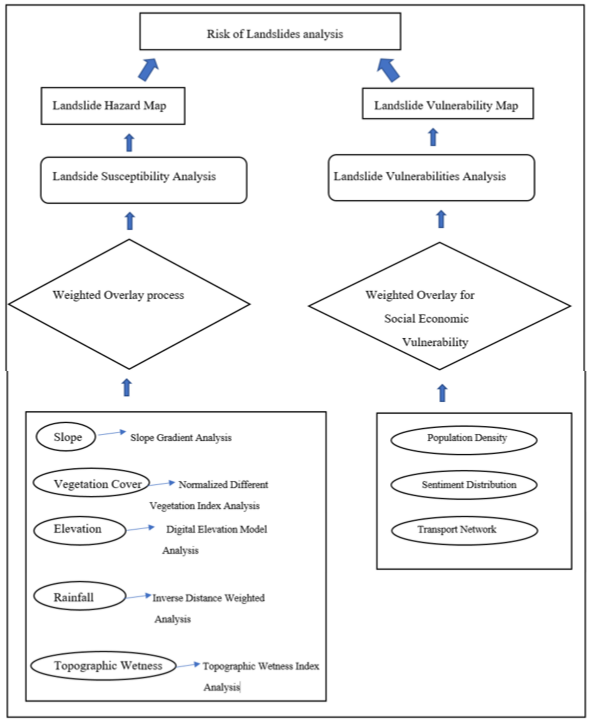
Table 2: Indicators and Measures of Variables

Assessment	Variables	Indicator	Measures
Landslide Susceptibility	Slope	Angle of the slope,	Weighted Overlay and extracted landslide susceptible DSDs in Matara District.
	Elevation	Distance above Mean Sea Level (DEM)	
	Rainfall	Average of 10 years annual rainfall	
	Vegetation Cover	Area of different vegetation canopy coverage (NDVI)	
	Topographic Wetness	Topographic Wetness Index Map	
Landslide Socio-Economic Vulnerability of High Susceptible Areas	Population	Total Population, Population Density	Identify vulnerable GNDs in Matara District by evaluating population, buildup and transport data in areas where susceptibility is high
	Built-up Ares	Settlement distribution	
	Transport Network	Length of transportation networks and road density calculation	
	High Susceptible & Vulnerable Areas	Combined high susceptibility and high vulnerability locations	Select DSDs where the area is highly susceptible and socio-economically vulnerable
Risk of Landslide			Identify DSDs in Matara District that have both high susceptibility and high vulnerability and classify them as high-risk landslide zones

Source: Created by Author 2025

Figure 2: Method of Data Analysis



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The diagram outlines the overall process adopted in evaluating landslide hazard through the amalgamation of physical and socio-economic parameters. The methodology involves two major components: developing a Landslide Hazard Map and a Landslide Vulnerability Map.

In hazard mapping, the procedure begins from landslide susceptibility mapping, wherein a weighted overlay technique is employed. The procedure takes into consideration a number of fundamental physical parameters including slope, vegetation cover, elevation, rainfall, and the topographic wetness index. All these variables are analysed with some geospatial techniques: slope is analysed with slope gradient analysis, vegetation is analysed with Normalized Difference Vegetation Index, elevation is derived from Digital Elevation Models, rainfall distribution is simulated with Inverse Distance Weighted interpolation, and surface moisture is analysed with Topographic Wetness Index. All the layers are then combined using weighted overlay to generate the final Landslide Hazard Map.

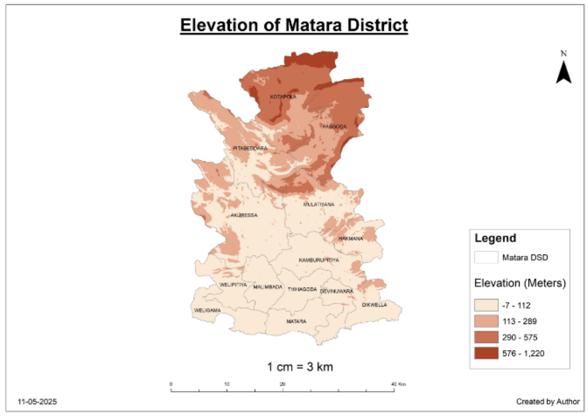
Concurrently, vulnerability mapping deals with socio-economic factors. This entails another weighted overlay consisting of population density, settlement pattern, and transportation infrastructure. These elements help identify areas where human and infrastructural risk due to landslides is most prevalent, and thus develop the Landslide Vulnerability Map.

The final step involves the merging of both the hazard and vulnerability maps to conduct an overall landslide risk assessment. The joined strategy offers an understandable view of not only where landslides are going to happen, but also which assets or populations are at greatest risk. Integration allows for more accurate risk zoning, planning, and the creation of effective disaster risk reduction programs. Furthermore data analysis can be represented as below.

Results and Discussion

Matara District elevation data was obtained from a Digital Elevation Model (DEM) and classified into four susceptibility levels: low, moderate, high, and very high. Classification thresholds were obtained from previous studies and national guidelines that relate elevation to landslide susceptibility (National Building Research Organisation [NBRO], 2020; Yalcin, 2008; Ghosh, Kar, & Maiti, 2011). Altitude influences slope steepness and geomorphological processes that predispose slopes to instability (Pourghasemi, Mohammady, & Pradhan, 2012). Thus, elevation at higher altitudes was assigned greater weight values due to its greater susceptibility to mass movement. This reclassified elevation layer was included in the Weighted Overlay analysis in GIS, which cumulatively resulted in the final landslide susceptibility map of the Matara District.

Figure 3: Elevation of Matara District



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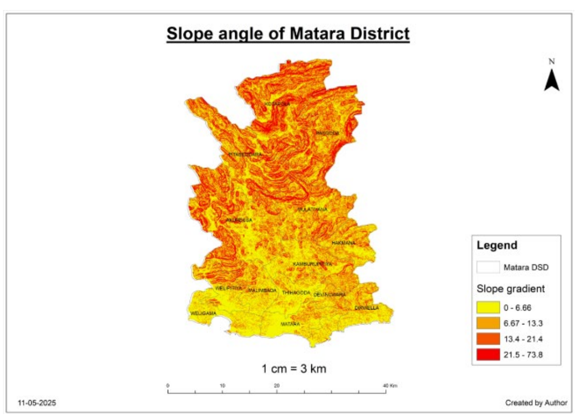
According to the elevation map, the highest elevation between 576- 1220 m records in upper areas of Kotapola and PasgodaDSDs. Total area of the highest elevation is 37.977Sq Km. The elevation value of 290- 575m area boundaries and middle of Kotapola and Pasgodo, and upper part of Mulathiyana Divisional Secretariat Division. The extent of the areas belongs to this category is 205.885SqKm and it is higher than highest elevation rate but at a glance most of the areas represent elevation -7-112m.

Slope in the Matara District was classified into four classes for landslide susceptibility evaluation based on national and international standards (National Building Research Organisation [NBRO], 2020; Guzzetti, Galli, Reichenbach, Ardizzone, & Cardinali, 2006; Food and Agriculture Organization of the United Nations [FAO], 2003). Slope ranges were defined as follows: 0°–6.66° as Low, 6.67°–13.3° as Moderate, 13.4°–21.4° as High, and 21.5°–73.8° as Very High susceptibility. These classes are founded on the role of steepness of slope in accelerating gravitational force and shear stress, both of which have direct effects on slope stability. These classes were used in the weighted overlay analysis to map and identify landslide-prone lands in the district.

Figure 4: Slope of Matara District



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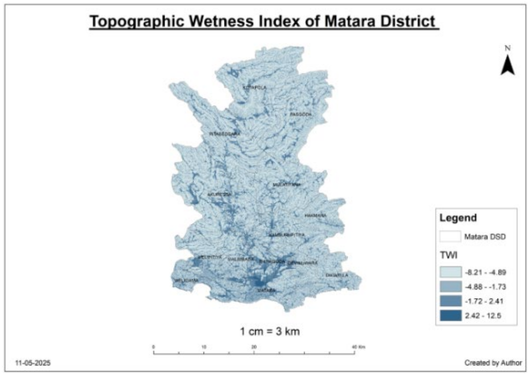
According to the slope map, the highest elevation between 21.5-73.8 m highland records in upper areas of Kotapola, Pasgoda and Pitabaddara Divisional Secretariat Divisions and boundaries of Akurassa, Mulathiyana. Total area of the highest elevation is 117.048SqKm. The slope value of 13.4-21.4m upper land areas are higher in the above Divisional Secretariat Divisions s than the highland slop areas. The extent of the area belongs to this category is 287.464SqKm and it is higher than the highest slope rate but at a glance most of the areas represent slope as zero to 6.66m which means that the Matara area is a lowland area.

Figure 5: Topographic Wetness of Matara District

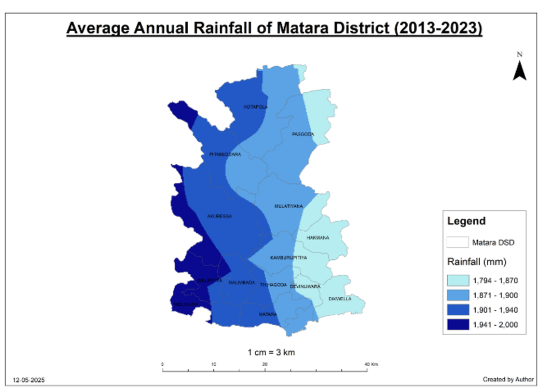


Source: Created by Author 2025

Topographic Wetness Index (TWI) values for the study area were classified into four classes of landslide susceptibility: Very Low (-8.21 to –4.89), Low (-4.88 to –1.73), Moderate (-1.72 to 2.40), and High to Very High (2.41 to 12.5). These thresholds were adopted from the original model of Beven and Kirkby (1979) topographic index and have been widely used in hydrological and geomorphological studies. These intervals have also been tested empirically and validated for applicability in landslide hazard zoning by recent global research (Conforti, Pascale, Robustelli, & Sdao, 2014; PLOS ONE, 2023).

According to the above map, Topography Wetness Index value range of -1.72- 12.5 are higher in Matara District. Those areas belong 13.4-73.8 slope range in degrees. According to the standard measuementin the slop angle, this mentioned rate considers very strong slope to very steep slope. This means, there is no enough wetness capacity in the hydrological process on the topography since there is less rapid water infiltration rate while runoff water on the slope. Then the soil erosion becomes high in these areas. Topography Wetness Index value of -8.21- -1.74 areas are playing second fields to the areas belong to Topographic Wetness Index value range of -1.72-12.5 areas in Matara District. Those areas belong to 0-13.3 slope degree category that the rate considers as level slope to strong slope. The majority values of Topographic Wetness Index is represented in this category which means that indicates we areas of the topography because low slope areas have rapidly water infiltration rate. Then the ground water capacity becomes high. There is soil moisture, which means higher cell values in Topographic Wetness Index represents areas with increased accumulated run off in area.

Figure 6: Rainfall of Matara District

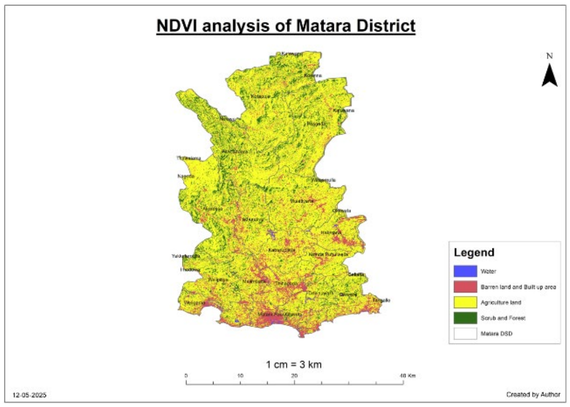


Source: Created by Author 2025

Rainfall zones in Matara District have been classified into four susceptibility levels: 1,794–1,868 mm as Low, 1,869–1,905 mm as Moderate, 1,906–1,939 mm as High, and 1,940–2,003 mm as Very High. The classification is in line with the National Building Research Organisation's landslide risk advisory framework (NBRO, 2020) and supported by international research on the role played by high annual precipitation in slope failure (Guzzetti, Galli, Reichenbach, Ardizzone, & Cardinali, 2006; Nawagamuwa & Perera, 2016).

According to the gathered twelve years (2023-2023) data, all the average annual rainfall values are appeared as 1790mm – 2000mm which means there is higher rainfall due to the wet zone area of Matara district with the main contribution over 40 percent of the total being derived from the southwest monsoon. The rest of the fall is received equally from both the northwest monsoon and convectional activity. According to this value, majority areas have received 1880mm – 1900mm rainfall. Kotapola, Pitabaddara,Akurassa areas have 1901mm – 1940mm rainfall and some of the areas of Hakmana, Dikwalla, Devinuwara areas have received 1794mm – 1870mm in Matara District.

Figure 7: Vegetation Cover of Matara District



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Normalized Difference Vegetation values for the Matara District were classified into four classes of vegetation density, with the lower Normalized Difference Vegetation values (–0.1 to 0.3) indicating no or very sparse vegetation thus classified as high to very high landslide susceptibility. The higher Normalized Difference Vegetation values (0.5 to 0.8) indicated high forest cover density, with greater slope stability, and thus were classified as low susceptibility. This kind of classification follows practice in worldwide landslide research (Devkota, Regmi, Pourghasemi, Yoshida, Pradhan, Ryu, Dhital, & Althuwaynee, 2013; Conforti, Pascale, Robustelli, & Sdao, 2014).

According to the above map, Normalized Vegetation Index lands sues of agriculture areas are higher in Maraata district. Those areas belong to moderate and high slope and elevation range in Matara district. The Normalized Vegetation Index analysis map of Matara District indicates that the vegetation cover is scattered across the district. Extremely dense vegetation (green patches), indicative of scrub and forest, is mostly found in northern and central areas particularly around Kotapola, Pasgoda, and Pitabeddara. Moderate vegetation (yellow patches), which are basically agricultural fields, dominates the majority of Akurassa, Thihagoda, and Mulatiyana areas. On the other hand, bare and built-up lands or low vegetation (red) are concentrated in the southern and coastal regions, notably around the areas of Matara Four Gravets, Devinuwara, Weligama, and Hakmana, where urbanization is higher. Water bodies (blue) are small but scattered, and the map overall indicates a clear spatial dichotomy between developed lowlands and vegetated uplands.

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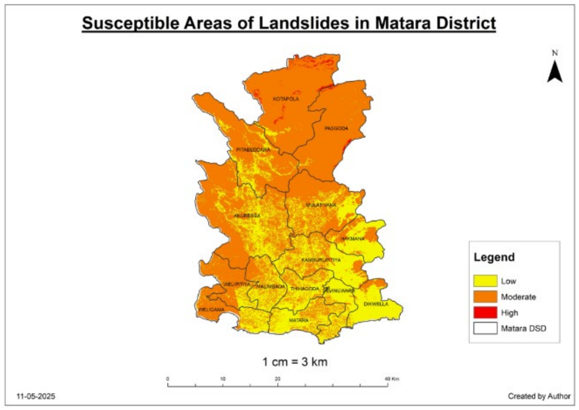
Figure 8: Susceptible Areas of Landslide in Matara District



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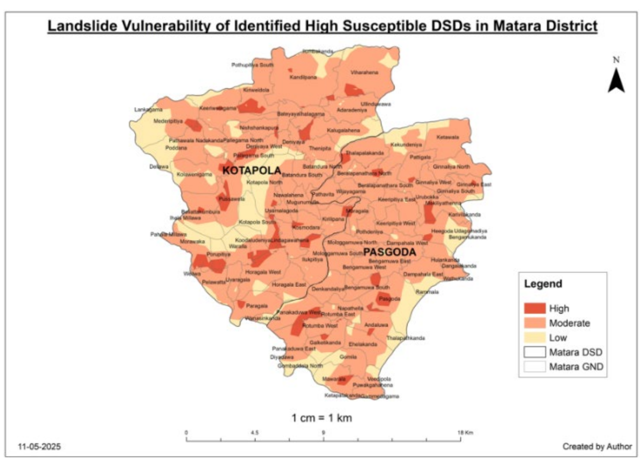
A weighted overlay analysis was conducted using five controlling factors in landslide susceptibility over the Matara District: slope, elevation, rainfall, Topographic Wetness Index (TWI), and Normalized Difference Vegetation Index (NDVI). The factors were all assigned weights based on their relative contribution towards landslide occurrence, as identified from previous research.

Exactly, rainfall was assigned the highest weightage (30%), then slope (25%), elevation (20%), Topographic Wetness Index (15%), and Normalized Difference Vegetation Index (10%). These weightages were adopted from related GIS-based landslide susceptibility mapping in similar geographic and climatic environments in similar regions of Sri Lanka (Perera, Jayawardana, Jayasinghe, & Bandara, 2018; Bandara, Premasiri, & Sudantha, 2021; Gunaratna, de Silva, & Karunanayake, 2017; Wijesekera & Fernando, 2020). The multi-criteria decision-making approach was utilised in a GIS platform to generate a composite landslide susceptibility map.

Even though, there are higher low susceptible areas of landslides in Matara district, there are high and very high susceptible areas of landslides Kotapola, Pasgoda and Pitabaddara areas according contribution of elevation, slope, topography wetness index, rainfall and normalized difference vegetation index analysis. Below table shows the area percentage of landslide susceptibility.

Figure 9: Vulnerable Areas of Landslides in Kotapola and Pasgoda DSD



Source: Created by Author 2025

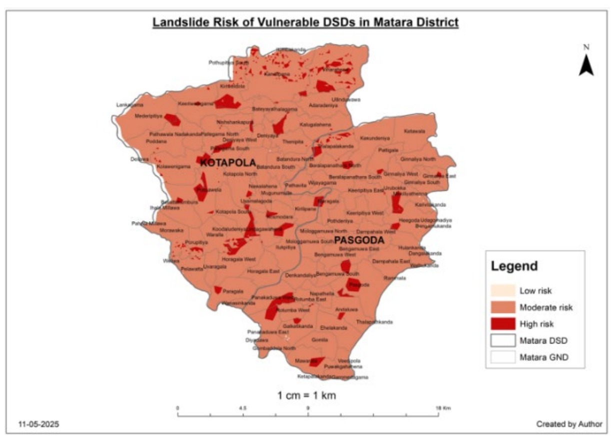
From the available data and interpretation of the landslide risk maps of Kotapola and Pasgoda Divisional Secretariat Divisions (DSDs) of the Matara District, the spatial variation of Grama Niladhari Divisions (GNDs) based on landslide vulnerability differs markedly over the area.

A high concentration of risky areas is visible in Kotapola DSD. There are 13 Grama Niladhari Divisions identified as highly vulnerable to landslides. These include Pussawela, Kotapola South, Kosmodara, Koodaludeniya and Ebidagawagala, Kiriweldola, Deniyaya West, Morawaka, Porupitiya, Waralla, Lindagawahena, Pallegama North, Pallegama South, and Mederepitiya. These areas are defined by high slope, dense cover, and high rainfall significant contributory factors to landslide susceptibility. In addition, approximately 10 Grama Niladhari Divisions such as Kotapola North, Usamalgoda, Pathawila, and Batandura North are found in the moderate vulnerability class, and potential landslide exposure under certain conditions. In particular, no Kotapola Divisional Secretariat Divisions were clearly identified as being in areas low in risk and thus exposed the general unstable nature of this area.

In Pasgoda DSD, the vulnerability is also slightly skewed towards high vulnerability. About 12 GNDs come under the category of high vulnerability, which are Rotumba East, Ilukpitiya, Bengamuwa South, Mawarala, Pasgoda, Galketikanda, and six more GNDs appearing as dark red patches on the susceptibility map, pointing towards extreme risk. Also, around 10 GNDs such as Potdeniya, Deniyaya North, and Ilukpitiya North come under the category of moderate vulnerability, where landslide risks are present but lesser compared to areas of high risk.

According to the interpretation of building density, road density, and population density data, all Grama Niladhari Divisions (GNDs) in the Kotapola and Pasgoda Divisional Secretariat Division (DSD) that possess landslide susceptibility of the total land area are found to be highly prone to landslides. The presence of high infrastructure density and high population density together also emphasizes the greater susceptibility of these Grama Niladhari Divisions towards possible slope failures and associated hazards.

Figure 10: Risk Areas of Landslides in Kotapola and Passgoda



Source: Created by Author 2025

In the current study, the weighted overlay method was used to identify landslide risk in the Matara District. The assigned weights for the variables that were selected, i.e., slope, elevation, rainfall, topographic wetness index (TWI), and Normalized Difference Vegetation Index (NDVI), were derived from a combination of previous research results and the specific environmental setting of the area being studied.

Rainfall was given the highest weight of 30% due to its direct causative impact on landslides, particularly in regions of high rainfall like the Matara District (Alharbi, El Sorogy, Al Kahtany, Salem, & Rikan, 2024; Ranasinghe, Bandara, Puswewala, & Dammalage, 2019). Slope was given a weight of 25%, as it is an important factor influencing gravitational instability and soil movement (Perera, Jayawardana, Jayasinghe, & Bandara, 2018). Elevation was given 20% weight in reflecting its role in climate variation and geomorphological processes (Bandara, Premasiri, & Sudantha, 2021). Topographic wetness index was given a 15% weight because it was highly effective in reflecting zones of possible water accumulation, a primary causative factor in shallow landslides (Gunaratna, de Silva, & Karunanayake, 2017). Normalized Difference Vegetation Index was assigned a weight of 10% since vegetation cover diminishes surface runoff and erosion, but the effect is relatively lower than that of other factors (Wijesekera &

Fernando, 2020). These weights total to 100% and were applied in a raster-weighted overlay in GIS for a final landslide risk map to be classified as high, moderate, and low risk zones.

Table 3: Landslide risk area in Kotapola and Pasgoda DSD

Risk of landslides	Area (Sq Km)	Percentage
Low	0.157	1
Moderate	302.684	94
High	18.613	5

Source - Created by Author2025

Below table shows the area percentage of landslide risk based on the ArcGIS analysis, the landslide risk evaluation above report prepared for the Kotapola and Pasgoda Divisional Secretariat Divisions (DSDs) in the Matara District, most of the land area comes under the moderate risk zone, where about 302.684 square kilometres of the land area, which is 94% of the total area, lies. High landslide risk areas make up about 18.613 square kilometres, which is 5% of the total. Meanwhile, only a tiny fraction, 0.157 square kilometres or 1%, is in the low-risk category. The division indicates that while most of the area has moderate landslide susceptibility, a good part of it still contains high-risk situations, calling for specific disaster risk reduction and preparedness interventions, especially in high-risk locations.

Conclusion and Recommendation

According to the analysis conducted for landslide susceptibility in the Mata District, the selected contributing factors have been appropriate and effective. This is confirmed through comparison with the landslide hazard zonation map developed by the National Building Research Organisation (NBRO). The comparability of the study findings with the NBRO map confirms the reliability of the methodology.

When comparing the researcher-developed landslide susceptibility map with the National Building Research Organisation (NBRO) hazard map, there is a general concurrence in most regions. Most of the high-susceptibility regions identified in this study match what is shown on the NBRO map. There are discrepancies, though some of the very susceptible areas identified by the researcher are stable by the NBRO. These variations can be reduced by field validation, which is done in the field. This would improve the accuracy of the result. Despite the minor inaccuracies, landslide-risk area detection may be improved by using the Weighted Overlay Process to incorporate additional variables, such as, land use, and lithology, to improve precision.

To examine vulnerability more effectively, the study took into account the top two Divisional Secretariat Divisions (DSDs) having the most extensive landslide susceptibility. 1000meter buffer areas were created around the identified landslide susceptible areas, and components such as roads, buildings, and people were analysed within the buffers, demarcated by Grama Niladhari Divisions (GNDs) in high and very high susceptibility regions. This exercise, conducted under the Weighted Overlay Process, confirms the vulnerability of these areas to landslides. The zones of vulnerability so established can thus be interpreted as zones of landslide risk. For further assessment of the degree of risk, a capacity analysis may be used for risk rating and management.

Effective mitigation of landslides begins with an insight into the most significant trigger factors responsible for causing landslides. Determination of the underlying causes is crucial in designing appropriate actions to lessen landslide susceptibility and general risk in susceptible areas. Mitigation, in this context, implies the lessening or reduction of the adverse effects of natural hazards. According to the analysis done in this research, most of the high-risk zones in the Matara District have low to moderate Topographic Wetness Index (TWI) values, high slopes, high terrain, high annual rainfall, and land cover including barren land, illegal buildings, grasslands, and shrubs. Hence, mitigation needs to be effective in directly tackling these underlying causes. Mitigation measures can be generally divided into structural and non-structural measures:

Non-Structural Measures:

Non-structural measures, often intangible, involve planning ahead and preparedness rather than physical intervention. This includes the use of geospatial technology in hazard zone mapping, facilitating decision-making and response in a timely manner. The current research is one such non-structural measure, providing susceptible, vulnerable, and high-risk areas for landslides. Early warning systems should be enhanced, enabling relevant authorities to send out warnings before disasters strike. Spatial planning and land-use policies, including building codes, zoning laws, and demarcation of safe evacuation routes, should also be implemented. Public awareness creation, disaster preparedness exercises, and education are also vital in building resilience among communities.

Structural Measures:

Structural measures are physical engineering solutions that are designed to eliminate or minimize the effects of hazards physically. They include the construction of retaining walls, soil nailing, re-grading unstable slopes, and management of surface and subsurface drainage systems to control water flow. Verification of areas of high risk in the field allows for tailor-made engineering interventions such as hydro-shedding, slope stabilization using nets and concrete, and soil reinforcement interventions. It is also necessary to alert local communities to pre-landslide warning signs. These include the formation of cracks in the ground, sudden ground settlement, tilting of trees or power poles, and the sudden emergence of springs or muddy water especially during heavy rainfall events. Pre-disaster engineering solutions commonly used in Sri Lanka include slope modification, physical barriers, drainage improvement, and retaining walls. Geotechnical methods like soil removal, reinforcement, and slope protection are important for long-term mitigation of landslide hazard and slope stability.

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