International Research Journal of Advanced Engineering and Science
ISSN (Online): -

Landslide Susceptibility Zonation Using the Storie Index and Geographic Information Systems to Support Infrastructure Planning in Rawa Makmur, Samarinda

Tistro R.[1], Legowo D.Y.H.[2], Ahmad R.[3], Katok A.N. [4], Ramadhan, T. A.[5]
[1,2,3,4,5]Civil Engineering, Samarinda State Polytechnic, Samarinda, East Kalimantan, Indonesia, 75131
Email address: dhinaryoga@polnes.ac.id

Abstract— *Landslides are natural hazards that can threaten public safety, the environment, and infrastructure. Landslide occurrence is influenced by slope gradient, rainfall, soil type, and land use (Puslittanak, 2004). The preparation of landslide susceptibility maps should also follow the principles set out in SNI 8291:2024 concerning the development of landslide susceptibility maps (BSN, 2024). This study aimed to map the landslide hazard index in Rawa Makmur Subdistrict, Palaran District, Samarinda City, using the Geographic Information System (GIS)-based Storie Index method. The study used slope gradient, 2024 rainfall, soil type, and land-use maps. Each parameter was classified and assigned a score according to its contribution to landslide potential. The analysis involved reclassification, spatial overlay, and index calculation using ArcGIS. The Storie Index method combined the scores of slope gradient, land use, rainfall, and soil type through an arithmetic multiplication model to derive landslide hazard classes (Arifin, 2006). Results for the 11.64-ha study area indicated that the low-hazard class was dominant, covering 46.64% of the area. Moderate-, high-, very-low-, and very-high-hazard classes covered 29.38%, 13.83%, 10.05%, and 0.12%, respectively. High- and very-high-hazard zones should be prioritized for mitigation and land-use control. The resulting map can support development planning and improve community preparedness for potential landslides..*

Keywords— *ArcGIS; GIS; landslide hazard; landslide susceptibility mapping; Storie Index..*

I. INTRODUCTION

Landslides are a form of mass movement involving soil, rock, or a mixture of both moving downslope due to disturbed slope equilibrium. These events may be triggered by natural conditions and human activities, including intense rainfall, steep slopes, soils prone to saturation, land-cover change, slope cutting, and infrastructure development. Landslides can cause environmental degradation, damage to settlements and road networks, economic losses, disruption to mobility, and threats to human safety [1; 2; 3].

Indonesia has physiographic conditions that support landslide occurrence in many areas, particularly in hilly and mountainous regions. Approximately 45% of Indonesia's land area consists of mountainous terrain with slopes susceptible to erosion and landslides [4]. Rainfall is an important triggering factor because rainwater infiltration may increase soil moisture and pore-water pressure. These conditions can reduce soil shear strength, decrease slope stability, and facilitate mass movement [5].

East Kalimantan Province has considerable landslide potential that requires attention in regional management. The National Disaster Risk Assessment for East Kalimantan Province for 2022–2026 recorded 109 landslide events in the province [6]. This condition is also evident in Samarinda City. Heavy rainfall from January 28, 2025, until the morning of January 29, 2025, triggered flooding and landslides in several areas, including Palaran District. In Rawa Makmur Subdistrict, a landslide along Parikesit Road caused a fallen tree to strike a residential house, while another incident on Ampera Road partially blocked the roadway [7]. These events demonstrate that landslides can directly affect public safety and infrastructure accessibility; therefore, spatial information on landslide hazard levels is needed to support community preparedness, disaster mitigation, and decision-making in development and land-use management.

Landslide hazard mapping is an important initial step in disaster mitigation. A hazard map identifies the relative distribution of areas with potential landslide occurrence based on their physical characteristics. It differs from a landslide risk map, because risk assessment additionally requires information on exposure, population vulnerability, and the value of potentially affected assets. Therefore, hazard mapping provides a basis for identifying areas that require attention in spatial planning, land-use control, and infrastructure development.

Geographic Information Systems (GIS)-based landslide hazard mapping enables the integration and spatial analysis of multiple landslide-controlling factors. GIS can manage, analyze, and visualize geographically referenced data to generate spatial information that supports area-based modelling [8]. In landslide hazard mapping, slope gradient, rainfall, soil type, and land use can be classified and assigned scores according to their respective contributions to landslide potential [9; 10].

The Storie Index method is a semi-quantitative approach that combines several parameters through scoring and index multiplication. Originally developed to evaluate soil characteristics for land suitability assessment, the method has subsequently been applied to landslide susceptibility analysis

Tistro R., Legowo D.Y.H., Ahmad R., Katok A.N., and Ramadhan, T. A., "Comprehensive Evaluation of the Precast Production Process: Integrating Quality Improvement and Process Compliance to Enhance Productivity and Time Efficiency through a Kaizen Approach" *International Research Journal of Advanced Engineering and Science*, Volume 11, Issue 4, pp. 105-111, 2026.

International Research Journal of Advanced Engineering and Science
ISSN (Online): -

[11]. In this study, slope gradient, 2024 rainfall, soil type, and land-use data were analyzed in ArcGIS through classification, reclassification, and spatial overlay to produce a landslide hazard index map [12].

This study aims to map the landslide hazard index in Rawa Makmur Subdistrict, Palaran District, Samarinda City, using the GIS-based Storie Index method. The resulting map is expected to provide preliminary information for disaster mitigation, enhance community awareness, and support land-use control and infrastructure development in areas potentially affected by landslides. This study addresses landslide hazard, rather than landslide risk, because it does not incorporate exposure, population vulnerability, or asset values.

II. Material and Methods

This study employed a Geographic Information System (GIS)-based spatial analysis to delineate landslide hazard zones in Rawa Makmur Subdistrict, Palaran District, Samarinda City, East Kalimantan, Indonesia. The analytical framework integrated four landslide-controlling parameters: slope gradient, rainfall, soil type, and land use. Each thematic layer was standardized, reclassified, and combined using the Storie Index method in ArcGIS. The procedure produced a landslide hazard index map that was subsequently grouped into five hazard classes. The assessment addresses landslide hazard rather than landslide risk because exposure, population vulnerability, and asset-value variables were not incorporated:

1. Study Area

The study was conducted in Rawa Makmur Subdistrict, Palaran District, Samarinda City, East Kalimantan, Indonesia. The analyzed area covers 11.64 ha. The site was selected because landslide incidents have been reported in the Palaran area, including along Parikesit Road in Rawa Makmur. The spatial analysis unit was generated from the intersection of the thematic layers used in the assessment. Figure 1 shows the boundary of the study area in Rawa Makmur Subdistrict, Palaran District, Samarinda City.



Figure 1. Boundary of the study area in Rawa Makmur Subdistrict, Palaran District, Samarinda City

2. Data and Software

The analysis used secondary spatial data and ArcGIS software. The datasets included an administrative boundary layer, a slope-gradient layer derived from DEMNAS available through Ina-Geoportal [13], 2025 rainfall data from Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) [14], a soil-type map from the Center for Agricultural Land Resources Research and Development (BBSDLP) issued in 2025 [15]., and a 2025 land-use map from the Directorate of Forest Resource Inventory and Monitoring under the Ministry of Environment and Forestry [16]. All datasets were projected to a common coordinate reference system, clipped to the study boundary, and converted to compatible spatial formats before analysis. The data sources and the analytical roles of the landslide-hazard parameters are summarized in Table 1.

TABLE 1. Data sources and analytical roles of the parameters used for landslide hazard assessment

Parameter	Data source	Analytical role
Slope gradient	DEMNAS / Ina-Geoportal	Represents topographic steepness and the gravitational driving force.
Rainfall	CHIRPS, 2025	Represents the hydro-meteorological trigger associated with soil saturation.
Soil type	BBSDLP, 2025	Represents soil properties associated with infiltration and slope stability.
Land use	Directorate of Forest Resource Inventory and Monitoring, 2025	Represents surface cover and land-management conditions.

3. Parameter Scoring and Classification

The slope-gradient, rainfall, soil-type, and land-use layers were classified and assigned scores from 1 to 5 following the landslide-hazard classification proposed by [9]. A larger score indicates a greater contribution of the corresponding condition to landslide occurrence. Slope classes were represented by five categories, ranging from relatively flat terrain to very steep terrain. The assigned scores were then used as the inputs for the Storie Index calculation.

4. Quality Improvement Framework

The Storie Index was used as a semi-quantitative model to integrate the four scored parameters through arithmetic multiplication. The index was calculated for each spatial unit using Equation (1).

$$L = A \times (B/10) \times (C/10) \times (D/10) \quad (1)$$

where L is the landslide hazard index; A is the slope-gradient score; B is the land-use score; C is the rainfall score; and D is the soil-type score. The resulting index values were classified into five classes: very low, low, moderate, high, and very high hazard, following the Storie Index classification adopted from [9]. The resulting Storie Index values range from 0.001 to 0.625. Based on the classification matrix proposed by Puslittanak (2004), the index values were grouped into five landslide hazard levels: very low, low, moderate, high, and very high, as presented in Table 2. This classification matrix was used as the reference for converting the calculated index values into spatial landslide hazard classes in the study area.

Tistro R., Legowo D.Y.H., Ahmad R., Katok A.N., and Ramadhan, T. A., "Comprehensive Evaluation of the Precast Production Process: Integrating Quality Improvement and Process Compliance to Enhance Productivity and Time Efficiency through a Kaizen Approach" *International Research Journal of Advanced Engineering and Science*, Volume 11, Issue 4, pp. 105-111, 2026.

International Research Journal of Advanced Engineering and Science
ISSN (Online): -

5. *Spatial Analysis Workflow*

The spatial analysis consisted of five stages. First, all thematic datasets were prepared by harmonizing projections, clipping the data to the study boundary, and ensuring compatible formats. Second, each parameter layer was reclassified using the assigned hazard scores. Third, the reclassified layers were overlaid to construct spatially homogeneous units. Fourth, the Storie Index was calculated using Raster Calculator or an equivalent attribute-calculation operation in ArcGIS. Finally, the resulting index raster was reclassified into five hazard classes and compiled into a final map layout containing a title, legend, north arrow, and scale bar.

TABLE 2. Storie Index matrix for landslide potential

Slope gradient	Land use	Soil type	Rainfall	Storie Index	Index range	Hazard level
1	1	1	1	0.001	<0.001	Very low
2	2	2	2	0.016	0.001-0.0016	Low
3	3	3	3	0.081	0.016-0.081	Moderate
4	4	4	4	0.256	0.081-0.256	High
5	5	5	5	0.625	>0.256	Very High

Source: Adapted from Puslittanak (2004)

6. *Output and Interpretation*

The principal output was a landslide hazard index map for Rawa Makmur Subdistrict. The area and percentage of each hazard class were calculated to describe the spatial distribution of landslide hazard. Areas classified as high and very high hazard were identified as priority zones for mitigation and land-use control. The map is intended to support preliminary spatial planning and disaster-mitigation considerations.

III. RESULT AND DISCUSSION

This section presents the landslide hazard assessment in Rawa Makmur Subdistrict, Palaran District, Samarinda City. The assessment applied Geographic Information System (GIS) analysis and the Storie Index method to integrate slope gradient, rainfall, land use, and soil type. Each parameter was scored and overlaid in ArcGIS to generate a landslide hazard index map. The resulting index was classified into five hazard levels: very low, low, moderate, high, and very high.

1. *Landslide Hazard Parameter Maps*

The landslide hazard assessment used four spatial parameters: slope gradient, rainfall, land use, and soil type. All datasets were standardized to a consistent coordinate reference system before analysis to ensure spatial correspondence during overlay. The following maps present the spatial distribution and role of each parameter in the Storie Index analysis.

The slope-gradient map was derived from DEMNAS/Ina-Geoportal data and was used to represent the topographic condition of the study area, as shown in Figure 1. Slope gradient is an important landslide parameter because steeper terrain produces a greater driving force on soil mass and may increase slope instability. In this study, slope gradients were classified into five classes: <8%, 8–15%, 15–25%, 25–45%, and >45%, with higher scores assigned to steeper slopes. As illustrated in Figure 2, relatively gentle slopes are more widespread in Rawa Makmur, whereas steep and very steep slopes occur locally, particularly around the eastern and central parts of the mapped area; these locations require greater attention because slope cutting and changes in water conditions may increase instability.

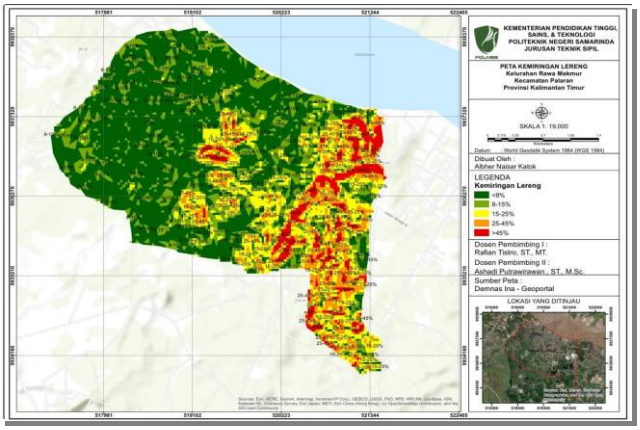


Figure 2. Slope gradient map of the study area
Palaran District, Samarinda City
source : Demnas Ina-Geoportal

The rainfall map was prepared using 2025 Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS), as presented in Figure 3. Rainfall is included as a triggering factor because prolonged or intense precipitation can increase soil moisture and saturation, thereby reducing the effective shear strength of soil materials. Figure 2 shows the spatial rainfall condition used in the scoring process for the study area. In Rawa Makmur, rainfall is evaluated together with slope, land use, and soil type because rainfall alone does not determine landslide occurrence, but it can activate slope failure where other conditions are unfavorable.

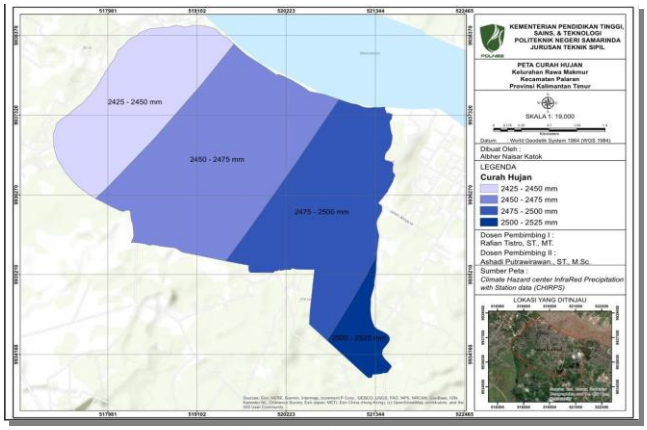


Figure 3. Rainfall map of the study area in 2026
Palaran District, Samarinda City
source : CHIRPS

The land-use map was obtained from the Ministry of Environment and Forestry (KLHK) for 2025 and is presented in Figure 4. This map describes the distribution of surface-

Tistro R., Legowo D.Y.H., Ahmad R., Katok A.N., and Ramadhan, T. A., "Comprehensive Evaluation of the Precast Production Process: Integrating Quality Improvement and Process Compliance to Enhance Productivity and Time Efficiency through a Kaizen Approach" *International Research Journal of Advanced Engineering and Science*, Volume 11, Issue 4, pp. 105-111, 2026.

International Research Journal of Advanced Engineering and Science
ISSN (Online): -

cover conditions and human activities, including settlement, vegetation, agricultural land, and other land-cover classes. Land use influences landslide hazard by affecting infiltration, surface runoff, vegetation protection, and disturbance of natural slopes. As shown in Figure 3, areas undergoing land development or having reduced vegetation cover in Rawa Makmur should be considered carefully, particularly when they overlap with steeper slopes, because land-use change may reduce natural slope protection.

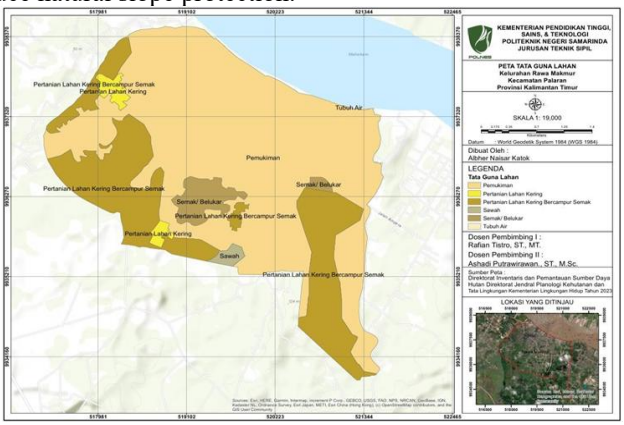


Figure 4. Land-use map of the study area.
source : KLHK,2026

The soil-type map was obtained from the Indonesian Center for Agricultural Land Resources Research and Development (BBSDLP), Ministry of Agriculture, based on 2025 data, as shown in Figure 5. Soil type was used to identify the physical characteristics of soil that may influence infiltration, drainage, and the response of soil materials under saturated conditions. The mapped soil units include alluvial soil, gleysol, cambisol, and oxisol, as presented in Figure 4. In Rawa Makmur, differences in soil characteristics were incorporated into the Storie Index.

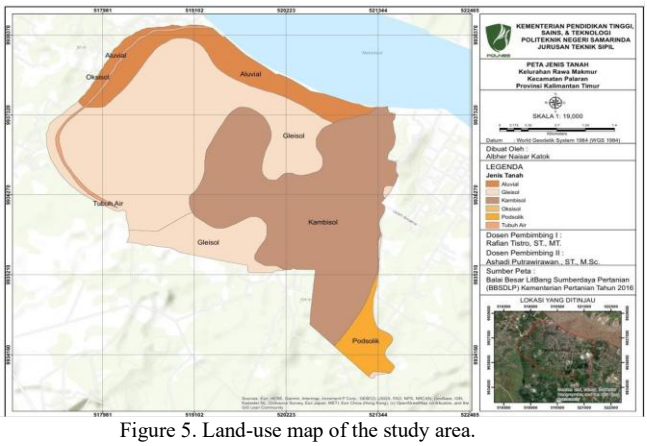


Figure 5. Land-use map of the study area.
source : BBSDLP,2026

The four parameter maps subsequently served as inputs for the Storie Index scoring and overlay analysis. Each parameter class was reclassified into a score from 1 to 5 according to the adopted landslide hazard criteria. The scored layers were then spatially combined in ArcGIS, and the Storie Index was calculated using Raster Calculator to obtain an integrated index value for each location. These values were subsequently classified into five landslide hazard levels to produce the final hazard map.

2. *Storie Index Scoring and Overlay*

Each class in the four parameter maps was reclassified into a score from 1 to 5, where a higher score represents a greater relative contribution to landslide hazard. The reclassified layers were calculated in Raster Calculator using the Storie Index equation: $L = A \times (B/10) \times (C/10) \times (D/10)$. A denotes slope score, B land-use score, C rainfall score, and D soil-type score. The multiplicative model means that the final value reflects the combination of all parameters at each location. Consequently, an area is not categorized as hazardous solely because of one factor, but because unfavorable terrain, rainfall, soil, and land-surface conditions coincide. The reclassification, overlay, and raster-calculation procedures are shown in Figure 6.

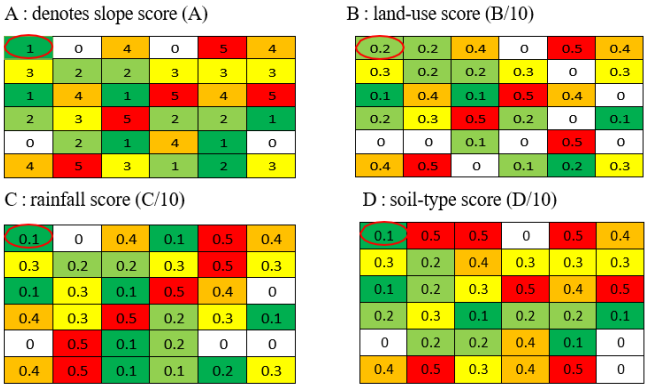


Figure 6. Reclassification, overlay, and Storie Index calculation procedures in ArcGIS.

3. *Landslide Hazard Index Map*

The Storie Index results were classified into five landslide hazard classes: very low, low, moderate, high, and very high. The spatial distribution of these classes in Rawa Makmur Subdistrict is presented in Figure 7. The map was generated by integrating the scored slope-gradient, rainfall, land-use, and soil-type layers through the Storie Index calculation in ArcGIS.

As shown in Figure 7, the low-hazard class is dominant and is mainly distributed across the western and central parts of the study area. This pattern indicates that these locations generally have more favorable combinations of slope conditions, land cover, rainfall, and soil characteristics. However, a low-hazard classification does not mean that landslides cannot occur; changes in drainage, land clearing, slope cutting, or intense rainfall may still increase local instability.

Moderate- and high-hazard zones are concentrated mainly in the eastern portion of the study area. These zones reflect locations where less favorable parameter conditions overlap, particularly where steeper terrain coincides with susceptible soil conditions and land-use characteristics that may provide limited protection to the slope. Therefore, these areas should be considered priority locations for field inspection, drainage

Tistro R., Legowo D.Y.H., Ahmad R., Katok A.N., and Ramadhan, T. A., "Comprehensive Evaluation of the Precast Production Process: Integrating Quality Improvement and Process Compliance to Enhance Productivity and Time Efficiency through a Kaizen Approach" *International Research Journal of Advanced Engineering and Science*, Volume 11, Issue 4, pp. 105-111, 2026.

management, vegetation maintenance, and control of slope-modification activities.

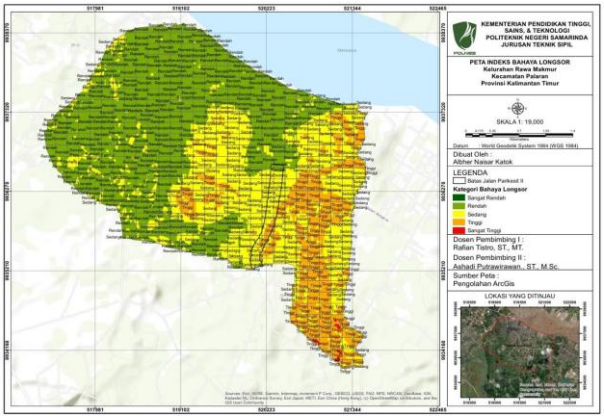


Figure 7. Landslide hazard index map of Rawa Makmur Subdistrict using the Storie Index method.

The area distribution provides a quantitative description of the proportion of Rawa Makmur Subdistrict assigned to each landslide hazard class. As summarized in Table 3, the reported mapped area is 11.64 ha, with low hazard forming the largest class at 5.43 ha (46.64%). Moderate hazard occupies 3.42 ha (29.38%), followed by high hazard at 1.62 ha (13.83%), very low hazard at 1.17 ha (10.05%), and very high hazard at approximately 0.01 ha (0.12%). These values describe the spatial extent of the classified index, rather than the probability of a landslide occurring within a specified period.

TABLE 3. Storie Index matrix for landslide potential

Hazard level	Index range	Area (Ha)	Area (%)
Very low	<0.001	1.17	10.05
Low	0.001-0.0016	5.43	46.64
Moderate	0.016-0.081	3.42	29.38
High	0.081-0.256	1.62	13.83
Very High	>0.256	0.01	0.12

Based on the displayed percentages, very low and low hazard together account for approximately 56.69% of the mapped area. This predominance should not be interpreted as evidence that these locations are entirely safe. Changes in drainage, slope geometry, or land cover may alter local conditions; therefore, maintaining drainage performance and limiting unnecessary slope disturbance remain appropriate precautionary measures.

Moderate, high, and very high hazard together account for approximately 43.33% of the mapped area based on the reported percentages. This substantial share supports prioritizing more detailed site assessment where elevated index classes intersect roads, settlements, or proposed development. The moderate-hazard class is particularly important because of its relatively extensive coverage, while high-hazard locations warrant closer examination before slope modification or construction.

Although the very-high-hazard class occupies the smallest reported area, its limited extent does not necessarily imply limited consequences. Potential impacts depend on the position of unstable slopes, possible movement paths, and nearby people or infrastructure. Accordingly, the mapped classes should be used to guide field verification and mitigation priorities rather than treated as a substitute for geotechnical investigation or a complete assessment of landslide risk.

4. Discussion and Mitigation Implications

The Storie Index results indicate that landslide hazard in Rawa Makmur varies spatially according to the combined scores of slope gradient, rainfall, land use, and soil type. Although the low-hazard class occupies the largest proportion of the mapped area, the presence of moderate-, high-, and very-high-hazard zones demonstrates that the dominant class should not be used to characterize the entire area as safe. These classes represent relative differences under the adopted scoring system rather than measured slope safety factors or probabilities of failure. Furthermore, the overlay identifies combinations of potentially unfavorable conditions but does not independently establish which parameter is the dominant cause of instability at a particular location.

High- and very-high-hazard zones should therefore receive priority for field verification, particularly where they intersect road corridors, settlements, or proposed development sites. Their limited spatial extent does not necessarily imply limited consequences, since impacts also depend on the position of exposed infrastructure and the possible movement paths of displaced material. Field inspections should examine ground cracks, seepage, blocked or damaged drains, surface erosion, and visible deformation of slopes or retaining structures. These observations would help determine whether mapped priority zones coincide with actual evidence of instability and whether more detailed investigation is required. Slope excavation, uncontrolled filling, vegetation removal, and concentrated runoff should be carefully assessed because they may modify local conditions beyond those represented in the input maps.

Mitigation measures should be differentiated according to the mapped hazard level and verified site conditions. In very-low- and low-hazard zones, management should emphasize maintaining vegetation cover, preserving functional drainage, and avoiding unnecessary slope disturbance. Moderate-hazard zones warrant closer attention to runoff pathways, erosion protection, and proposed loading near slope crests. In high- and very-high-hazard zones, proposals involving slope cutting, filling, or additional structural loads should undergo site-specific geotechnical assessment before implementation. Potential measures include controlled drainage, erosion protection, revegetation, and engineered slope stabilization; however, the selection and design of retaining structures, reinforcement, or subsurface drainage must be supported by investigation of soil properties, groundwater conditions, and slope geometry. The map alone is insufficient to determine an appropriate engineering solution.

Several limitations should be considered when interpreting the results. The index is sensitive to the selected scoring criteria, class boundaries, and the resolution and acquisition dates of the input datasets. Because the model combines parameter scores multiplicatively, a low score in one layer can reduce the final index even when another parameter has a high

score. The assessment also does not explicitly incorporate detailed lithology, soil depth, groundwater fluctuations, engineering soil properties, or the geometry of individual cut slopes. In addition, the map does not quantify exposure, vulnerability, or potential losses and should therefore be interpreted as a preliminary relative hazard map rather than a complete risk assessment. Its principal value is to support screening, prioritize field investigations, and inform land-use and infrastructure planning. Future refinement should include comparison with a verified landslide inventory and site-specific observations before the results are used for detailed construction or mitigation decisions.

IV. Conclusion

This study integrated slope gradient, rainfall, land use, and soil type within a GIS-based Storie Index framework to characterize the spatial distribution of landslide hazard in Rawa Makmur Subdistrict, Palaran District, Samarinda City. The assessment provides an initial basis for identifying areas requiring further investigation and directing mitigation priorities. Based on the mapping results and their implications for slope management, the main conclusions are presented as follows:

1. Landslide Hazard Mapping. The integration of slope gradient, rainfall, land use, and soil type through reclassification, scoring, and spatial overlay produced five landslide hazard classes: very low, low, moderate, high, and very high. The resulting map provides a spatial basis for distinguishing areas with different combinations of potentially unfavorable slope conditions.
2. Hazard-Class Distribution. Low hazard was the dominant class, representing a reported 46.64% of the mapped area, followed by moderate hazard at 29.38%, high hazard at 13.83%, very low hazard at 10.05%, and very high hazard at 0.12%. Although higher-hazard zones occupy smaller areas, their presence indicates that mitigation priorities should consider local hazard conditions rather than the dominant class alone.
3. Mitigation Priorities. High- and very-high-hazard zones should receive priority for field verification, particularly where they intersect roads, settlements, or proposed development. Recommended initial measures include drainage maintenance, vegetation protection, and control of slope excavation, filling, and additional loading. Engineering stabilization measures should be selected only after site-specific geotechnical investigation.
4. Application and Limitations. The resulting map supports preliminary screening, investigation prioritization, and land-use and infrastructure planning. However, the index represents relative hazard under the adopted scoring system, not a measured slope safety factor or a complete assessment of landslide risk. Field verification and detailed slope-stability analysis remain necessary before construction or mitigation decisions are finalized.

Overall, the findings emphasize that mitigation planning should consider both the spatial extent of each hazard class and its location relative to roads, settlements, and proposed development. Priority should be given to verifying higher-hazard zones, maintaining drainage and vegetation, and controlling activities that modify slope geometry or loading. The resulting map should therefore be used as a preliminary planning tool, supported by field verification and site-specific geotechnical investigation before detailed engineering decisions are made. Further refinement should focus on checking the classification against documented landslide occurrences and improving the consistency and resolution of the input datasets.

Acknowledgments

The authors express their sincere gratitude to Politeknik Negeri Samarinda (POLNES), particularly the Department of Civil Engineering, for providing the opportunity to undertake this research. Appreciation is also extended to the institutions that made the geospatial datasets available, including Badan Informasi Geospasial (BIG), the Climate Hazards Group, BBSDLP of the Ministry of Agriculture, and the Ministry of Environment and Forestry (KLHK).

References

[1] Astriyan, “Analisis daerah rawan bencana longsor menggunakan metode SMCE di Kabupaten Sinjai, Provinsi Sulawesi Selatan,” 2021.
[2] S. M. Darmatazia, “Analisis penyebab tanah longsor di Gunung Manggah Jalan Otto Iskandardinata, Kelurahan Sungai Dama, Kecamatan Samarinda Ilir, Kota Samarinda,” 2022.
[3] T. Wasisso, “Analisis pengaruh perubahan penggunaan lahan terhadap perubahan tingkat potensi gerakan tanah menggunakan Sistem Informasi Geografis (SIG) di Kecamatan Mojosongo Kabupaten Boyolali,” 2017.
[4] J. Susilo, “Pengembangan model SIG penentuan kawasan rawan longsor sebagai masukan rencana tata ruang (studi kasus Kabupaten Tegal),” tesis, Universitas Diponegoro, Semarang, Indonesia, 2008.
[5] A. Rahmi Wahyuli, “Kerawanan tanah longsor di DAS Pangkajene menggunakan metode Storie,” skripsi, Universitas Hasanuddin, 2019.
[6] Dokumen Kajian Risiko Bencana Nasional Provinsi Kalimantan Timur 2022–2026. [Lembaga penyusun dan tahun terbit perlu diverifikasi.]
[7] Rifandi, [judul berita, media, tanggal publikasi, dan URL perlu dilengkapi], 2025.
[8] G. S. Nusantara, Modul Pelatihan Sistem Informasi Geografis (SIG) Tingkat Dasar. Jakarta, Indonesia: PT Geo Sriwijaya Nusantara, 2019.
[9] Pusat Penelitian dan Pengembangan Tanah dan Agroklimat (Puslittanak), Laporan Akhir Pengkajian Potensi Bencana Kekeringan, Banjir dan Longsor di Kawasan Satuan Wilayah Sungai Citarum–Ciliwung, Jawa Barat Bagian Barat Berbasis Sistem Informasi Geografis, 2004.
[10] S. M. Sarah, “Pengklasan tingkat kerentanan gerakan tanah daerah Sumedang Selatan menggunakan metode Storie,” Pusat Penelitian Geoteknik LIPI, Bandung, Indonesia, 2014.
[11] B. Irawan, “Pemetaan kerawanan longsor di Kecamatan Pesanggaran, Kabupaten Banyuwangi menggunakan metode Indeks Storie,” 2023.
[12] S. Arifin, I. Carolila, and G. Winarso, “Implementasi penginderaan jauh dan SIG untuk inventarisasi daerah rawan bencana longsor (Propinsi Lampung),” INDERAJA, vol. 3, no. 1, pp. 77–86, 2006.
[13] Badan Informasi Geospasial, “Digital Elevation Model Nasional (DEMNAS),” dataset elevasi, Ina-Geoportal. [Online]. Available: https://tanahair.indonesia.go.id.
[14] Climate Hazards Center, University of California, Santa Barbara, “CHIRPS: Rainfall Estimates from Rain Gauge and Satellite Observations,” dataset curah hujan, periode data yang digunakan: 2025. [Online]. Available: https://www.chc.ucsb.edu/data/chirps.
[15] Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan Pertanian (BBSDLP), Kementerian Pertanian, “Peta jenis tanah wilayah penelitian,” dataset spasial, 2025.
[16] Direktorat Inventarisasi dan Pemantauan Sumber Daya Hutan,

Kementerian Lingkungan Hidup dan Kehutanan, “Peta penutupan lahan wilayah penelitian,” dataset spasial, 2025.