A Comparative Spatial Assessment of Flood Hazard in Pauh District, Padang City: The 2019 RTRW Map and a GIS-Based Weighted Overlay Model for 2026

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DOI: https://doi.org/10.47772/IJRISS.2026.101000393

Received: 14 October 2026; Accepted: 21 October 2026; Published: 03 November 2026

ABSTRACT

Flood-hazard mapping provides essential spatial information for land-use planning and flood mitigation. This study assesses flood-hazard susceptibility in Pauh District, Padang City, Indonesia using a Geographic Information System (GIS)-based weighted-overlay method and compares the resulting classification with the flood-hazard map in the 2019 Padang City Spatial Plan (Rencana Tata Ruang Wilayah, RTRW). The 2026 assessment integrates five environmental parameters: slope, rainfall, distance to rivers, land cover, and soil type. Each parameter is classified, scored, and weighted to generate a composite flood-hazard susceptibility index. The results indicate that the very-low-susceptibility class covers 11,696.94 ha (73.84%), followed by the low class at 2,389.88 ha (15.09%), the high class at 1,098.33 ha (6.93%), the moderate class at 628.47 ha (3.96%), and the very-high class at 28.43 ha (0.18%). High-susceptibility areas are concentrated primarily in Limau Manis, Pisang, Cupak Tangah, Binuang Kampung Dalam, and Kapalo Koto. In comparison, the 2019 RTRW map classifies 15,586.24 ha (98.39%) as low hazard and 255.81 ha (1.61%) as moderate hazard. However, differences between the two maps cannot be interpreted as direct evidence of temporal changes in flood hazard because their underlying methodologies, input data, and spatial scales are not fully comparable. The findings provide a preliminary spatial basis for prioritizing field verification, drainage assessment, river-corridor management, and land-use planning. Nevertheless, the weighted-overlay model represents relative flood-hazard susceptibility rather than a direct prediction of flood occurrence or a comprehensive flood-risk assessment. Further research should incorporate independent validation using observed flood events, hydrological data, and exposure information to improve the reliability of flood-hazard assessment and support evidence-based spatial planning in Pauh District.

Keywords: Flood-Hazard Susceptibility; Geographic Information System; Weighted Overlay; Spatial Planning; Pauh District

INTRODUCTION

Flooding is a recurrent hydro-meteorological hazard influenced by the interaction of rainfall, topography, drainage characteristics, soil properties, and land cover. Geographic Information Systems (GIS) provide an effective framework for flood-hazard mapping by integrating spatially distributed environmental parameters to identify areas with different levels of potential flood hazard. Such approaches can support land-use planning,

environmental management, and the prioritization of flood-mitigation measures (Farhana, et al., 2026). Previous studies have highlighted the relationships between land-use change, surface runoff, and flood-related processes, while the interaction between land-use dynamics and climate variability further emphasizes the importance of spatially explicit assessments for informed planning and disaster mitigation (Rahman et al., 2021; Nguyen et al., 2024).

Pauh District, located in Padang City, West Sumatra, Indonesia, encompasses diverse topographic conditions, including hilly and forested areas, river corridors, and settlements distributed across different terrain settings. The district is part of the Kuranji River Basin system, making the spatial relationships between topography, rainfall, river proximity, soil characteristics, and land cover relevant to the assessment of flood hazard. Pauh District comprises nine urban villages (*kelurahan*): Piai Tangah, Pisang, Binuang Kampung Dalam, Cupak Tangah, Koto Luar, Kapalo Koto, Limau Manis Selatan, Limau Manis, and Lambung Bukit. Differences in environmental characteristics across these areas may result in spatial variations in flood-hazard levels. Therefore, a GIS-based assessment incorporating multiple environmental parameters is needed to characterize the spatial distribution of flood hazard at the district scale and provide information that can support local spatial planning.

The flood-hazard map included in the 2019 Padang City Spatial Plan (*Rencana Tata Ruang Wilayah*, RTRW) provides an existing spatial-planning reference for flood hazard at the city scale. However, the original methodology, parameter weights, classification thresholds, and input datasets used to produce this map could not be established from the information available for this study. Consequently, its classification scheme cannot be assumed to be directly comparable with that of a new GIS-based assessment. Differences between the two maps may reflect variations in mapping methodology, spatial scale, input data, and classification procedures rather than actual changes in flood hazard over time. A comparison between the existing RTRW map and a parameter-based assessment at the district scale can nevertheless provide useful information on differences in spatial representation, provided that these methodological limitations are explicitly acknowledged.

This study aims to analyze the spatial distribution of flood hazard in Pauh District, Padang City, using a GIS-based weighted-overlay approach that integrates five environmental parameters: slope, rainfall, distance to rivers, land cover, and soil type. The resulting flood-hazard classification is then examined in relation to the flood-hazard map presented in the 2019 Padang City RTRW. The comparison is intended to describe differences in the spatial distribution of hazard classes between the existing planning map and the parameter-based assessment, rather than to establish temporal changes in flood hazard between 2019 and 2026. By providing a more detailed spatial assessment at the district scale, this study seeks to contribute preliminary information for land-use planning and the identification of areas requiring further flood-hazard investigation. The findings are interpreted within the limitations of the available data and mapping methods, with the need for methodological transparency and independent validation recognized as important considerations for future research.

LITERATURE REVIEW

Geographic Information Systems (GIS) have been widely used in flood-hazard mapping because they can combine different environmental factors in one analysis. These factors include rainfall, elevation, slope, soil characteristics, land cover, drainage conditions, and distance from rivers. By combining these factors, GIS can help identify areas with different levels of flood hazard and provide useful information for land-use planning and disaster mitigation (Mudashiru et al., 2021; Nachappa et al., 2020). GIS-based Multi-Criteria Decision Analysis (GIS-MCDA) is also useful in areas where detailed hydrological data are limited. This method combines several factors to identify areas that may be more vulnerable to flooding (Chen, 2022; Hagos et al., 2022).

Land-use and land-cover changes can influence the occurrence and distribution of flood hazards. The expansion of built-up areas, such as housing, roads, and other infrastructure, can reduce water infiltration into the soil and increase surface runoff. Changes in vegetation cover can also affect how water moves across the land. In addition, rainfall patterns and climate change can influence the amount of runoff and the likelihood of flooding. Previous studies have shown that flooding is related to land-cover change, population growth, and the physical characteristics of an area. These findings highlight the importance of considering both land-use changes and climate conditions in flood-risk management (Rahman et al., 2021; Nguyen et al., 2024).

The weighted-overlay method is one of the techniques used in GIS-MCDA for flood-hazard mapping. This

method combines several environmental factors by assigning a weight to each factor based on its importance in the analysis. Factors such as rainfall, elevation, soil characteristics, land cover, and distance from rivers can then be combined to produce a flood-hazard index. The index is classified into different hazard levels to show the spatial distribution of flood hazards. Previous studies have applied this method to support flood-hazard mapping, especially in areas with limited hydrological data (Kanani-Sadat et al., 2019; Hagos et al., 2022). However, the results depend on the selected factors, their assigned weights, and the classification method. Different choices may produce different hazard maps.

Flood-hazard mapping can use several methods, including statistical approaches, physical models, and combinations of different techniques. Each method has its own strengths and data requirements (Mudashiru et al., 2021). The weighted-overlay method is relatively simple to apply when detailed hydrological and hydraulic data are not available. However, it produces a relative flood-hazard index rather than directly predicting flood depth, water-flow velocity, or the probability of a flood event. Therefore, the results should be interpreted based on the data, factors, and weights used in the analysis. Additional data and validation are needed to determine how well the mapped hazard levels represent actual flood conditions.

Although GIS-based methods have been widely used in flood-hazard studies, comparing flood-hazard maps from different years remains important, particularly in areas experiencing changes in land use and development. Comparing maps from 2019 and 2026 can help identify changes in the spatial distribution of flood-hazard classes. This information can support land-use planning and help identify areas that may require further investigation or mitigation. Therefore, this study uses the GIS-based weighted-overlay method to compare flood-hazard patterns in Pauh District, Padang City, between 2019 and 2026. The main focus is to understand changes in the mapped hazard classes and their relevance to spatial planning, rather than to develop a new flood-prediction model.

RESEARCH METHODOLOGY

Data Collection

Pauh District is located in the eastern part of Padang City, West Sumatra Province, approximately between 0°52′–0°58′ S and 100°27′–100°34′ E. Pauh District consists of nine urban villages: Piai Tangah, Pisang, Binuang Kampung Dalam, Cupak Tangah, Koto Luar, Kapalo Koto, Limau Manis Selatan, Limau Manis, and Lambung Bukit. The administrative area covers 15,840.65 ha. The area comprises lowlands, hills, forest areas, agricultural land, settlements, and river networks show in Figure 1.

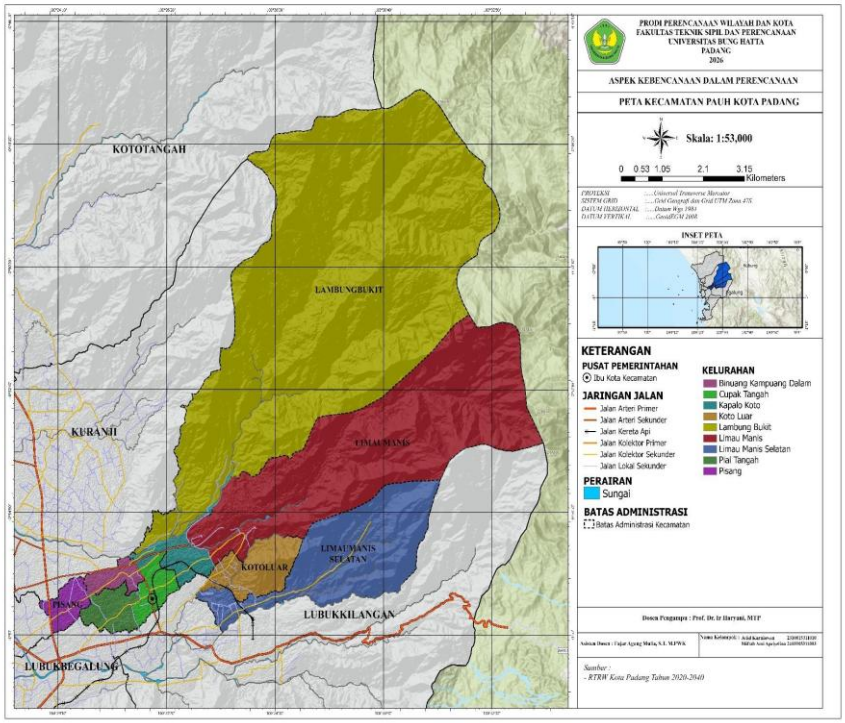

Figure 1. Location and administrative boundaries of Pauh District, Padang City, 2026

Data And Variables

The study used spatial data. Five parameters were considered: slope, rainfall, distance to rivers, land cover, and soil type. Each parameter was classified into five score levels. The spatial datasets were harmonized to a common analytical unit before being integrated using the weighted overlay method show in Table 1.

Table 1. Flood-hazard parameters and weights

Parameter	Classes Used	Score	Weight (%)
Slope	0–2; 2–15; 16–25; 26–40; >40%	5; 4; 3; 2; 1	20
Rainfall	<1,500; 1,500–2,000; 2,000–2,500; 2,500–4,000; >4,000	1; 2; 3; 4; 5	30
Distance to rivers	>100; 75–100; 50–75; 25–50; 0–25 m	1; 2; 3; 4; 5	10
Land cover	Forest; plantation/shrubland; agriculture; built-up land; open land/water	1; 2; 3; 4; 5	20
Soil type	Regosol/Lithosol and related groups; Andosol group; brown forest soil/Mediterranean; Latosol; alluvial group	1; 2; 3; 4; 5	20

The analysis results were classified into five classes: very low (1.20–1.72), low (1.72–2.24), moderate (2.24–2.76), high (2.76–3.28), and very high (3.28–3.80).

The conceptual weighted-overlay formulation is as follows:

$$H = 0.20S + 0.30R + 0.10D + 0.20L + 0.20T$$

where H = composite flood-hazard score; S = slope score; R = rainfall score; D = distance-to-river score; L = land-cover score; and T = soil-type score.

Spatial Analysis and Temporal Comparison

The GIS analysis comprised data classification, scoring, weighting, raster/vector overlay, and reclassification of composite values. The 2026 model integrated the five spatial parameters. For the temporal comparison, the classified results for 2019 and 2026 were used. Changes in the area of each class were calculated through a detailed comparison. Weighting in GIS-MCDA should be understood as a criteria-based decision-making approach; therefore, the results are sensitive to parameter selection, classification scale, and the weights applied (Tang et al., 2018; Nachappa et al., 2020). Accordingly, the weighted-overlay results are interpreted as a spatial flood-hazard/susceptibility index rather than as a deterministic prediction of flood occurrence.

It is important to distinguish spatial flood hazard/susceptibility from overall flood risk. The model estimates potential hazard based on biophysical conditions and does not directly model inundation depth, flow velocity, discharge, drainage capacity, the number of exposed residents, building values, social vulnerability, or community capacity. Therefore, the results are positioned as hazard/susceptibility information to support planning, rather than as a comprehensive disaster-risk index.

Summarize the Results of Data Analysis

The final stage of this study was to draw conclusions based on the analysis results, including changes in the area and spatial distribution of flood-hazard classes. The results represent a relative flood-hazard index that can support land-use planning and mitigation efforts, rather than directly predicting flood events or overall flood risk.

RESULTS AND DISCUSSION

Characteristics of Flood-Hazard Parameters

Slope is an important factor in flood-hazard mapping. Flat areas tend to collect water, while steeper slopes allow water to flow more quickly toward lower areas. The results show that slopes of 15–25% cover the largest area,

approximately 6,770.32 ha. Flat areas are also found in several urban villages, including Piai Tangah, Pisang, Binuang Kampung Dalam, and Cupak Tangah. However, flood occurrence is not determined by slope alone, as drainage systems and river networks also play important roles.

In 2026, forest is the dominant land-cover type, covering approximately 12,802.89 ha. Built-up areas and open or water-covered areas receive higher scores because they may have lower infiltration capacity or greater runoff potential. Changes in land cover are important for comparing flood-hazard patterns over time, as the expansion of built-up areas can affect surface runoff.

Latosol is the dominant soil type, covering approximately 11,806.62 ha, while alluvial soil receives the highest score in the classification. In the distance-to-river analysis, areas within 0–25 m of a river receive the highest score. These findings highlight the importance of considering soil characteristics, distance from rivers, and land-surface conditions when identifying areas with different levels of flood hazard.

Spatial Distribution of Flood Hazard Susceptibility

The 2026 flood-hazard analysis shows strong spatial heterogeneity. The very-low class covers the largest area, whereas the high- and very-high-hazard classes occur in more concentrated areas. The map indicates that several more developed parts of the district located close to river networks have higher hazard classes. This pattern supports location-based zoning to guide intervention priorities, show in Figure 2.

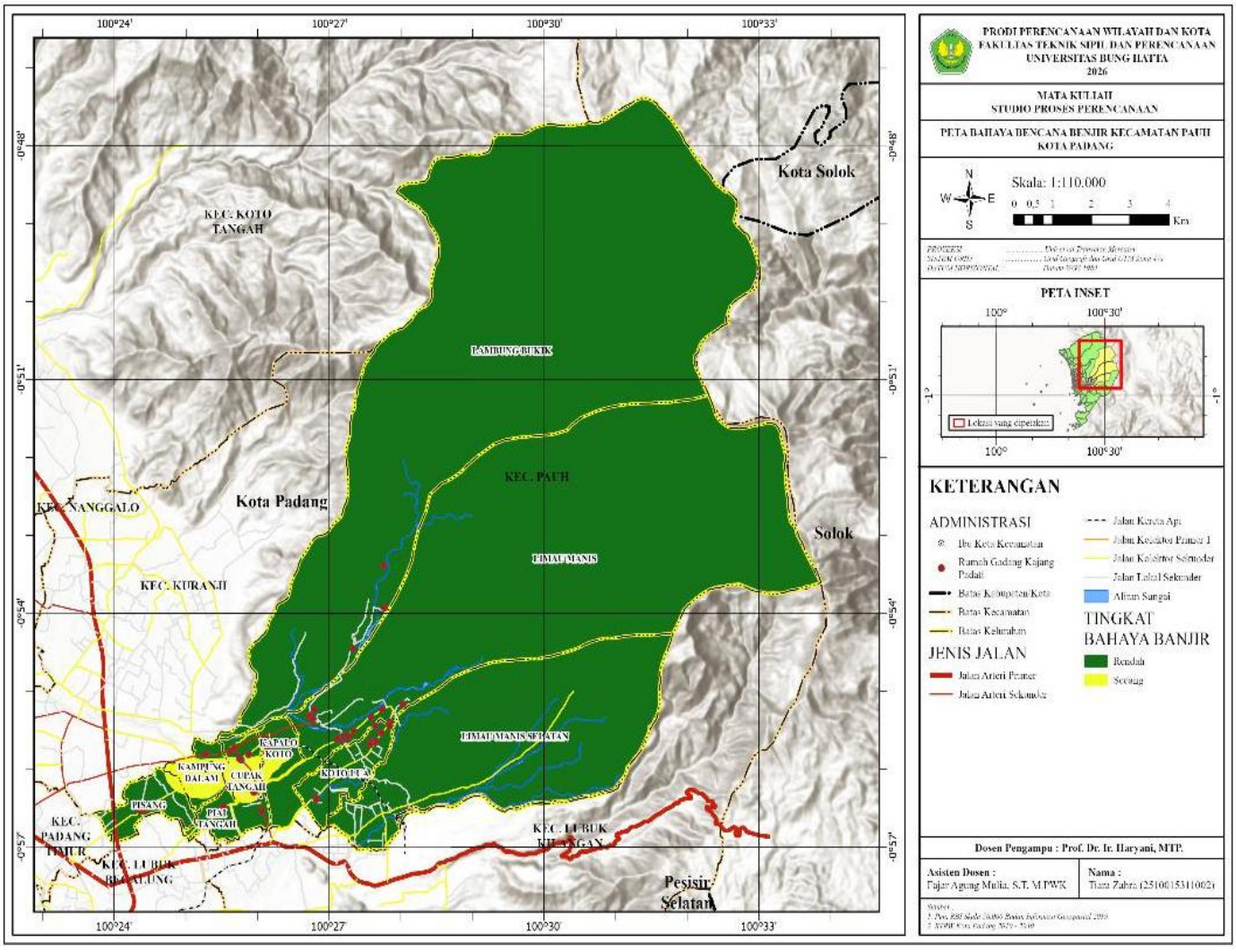

Figure 2. Spatial distribution map of flood-hazard classes in Pauh District, 2026

Analytically, the dominance of the very-low and low classes in 2026 should be interpreted in conjunction with

the biophysical composition of Pauh District. The extensive forest area contributes to relatively low scores in the model, whereas high-hazard zones tend to be concentrated in areas resulting from combinations of parameters with higher scores. Thus, hazard concentration is not simply a function of distance to rivers but results from interactions among slope, rainfall, land cover, soil type, and proximity to rivers. This approach is consistent with the principles of multi-criteria mapping, in which the final class represents the spatial aggregation of multiple controlling factors rather than the effect of a single variable (Kanani-Sadat et al., 2019; Hagos et al., 2022).

The 2026 flood-hazard susceptibility assessment reveals a predominantly low-susceptibility pattern across Pauh District, Padang City (Table 2). The very low and low classes cover 11,696.94 ha (73.84%) and 2,389.88 ha (15.09%), respectively, accounting for 88.93% of the district. By comparison, the moderate, high, and very high classes occupy 628.47 ha (3.96%), 1,098.33 ha (6.93%), and 28.43 ha (0.18%), respectively. Despite their limited extent, the high- and very-high-susceptibility zones warrant particular attention because of their implications for spatial planning and localized flood mitigation.

Table 2. Distribution of flood-hazard classes in 2026

Class (2026)	**Area (ha)**	**(%)**
Very low	11,696.94	73.84
Low	2,389.88	15.09
Moderate	628.47	3.96
High	1,098.33	6.93
Very high	28.43	0.18
Total	15,840.65	100.00

The high-susceptibility class is concentrated primarily in Limau Manis (246.73 ha), Pisang (210.46 ha), Cupak Tangah (187.50 ha), Binuang Kampung Dalam (141.81 ha), and Kapalo Koto (124.25 ha). This spatial variation may reflect the combined influence of topography, rainfall, proximity to rivers, land cover, and soil characteristics represented in the weighted-overlay model. However, the mapped pattern should be interpreted as relative susceptibility rather than evidence of observed flood occurrence, as the model does not explicitly simulate inundation dynamics or drainage performance.

From a planning perspective, high- and very-high-susceptibility zones provide an initial basis for prioritizing field surveys, drainage assessments, river-corridor management, and the identification of suitable water-retention areas. Preserving forest cover and infiltration zones may also help maintain hydrological functions and limit surface runoff. Nevertheless, these interventions should be guided by site-specific hydrological assessments rather than susceptibility classes alone.

The findings also highlight the need to validate the mapped patterns against historical flood records and observed inundation. As a GIS-based multi-criteria decision analysis (GIS-MCDA) approach, the weighted-overlay model is sensitive to parameter selection, scoring schemes, and assigned weights (Mudashiru et al., 2021; Nachappa et al., 2020). Accordingly, the resulting map is best used as a screening tool for spatial planning and mitigation prioritization, rather than as a standalone flood-risk assessment. Incorporating hydrological observations, inundation characteristics, drainage capacity, and exposure data would strengthen the assessment and support more comprehensive flood-risk management in Pauh District.

Temporal Changes in Flood-Hazard Susceptibility, 2019–2026

The main finding is a redistribution of hazard classes between 2019 and 2026. In 2019, the detailed comparison table shows only the low and moderate classes. In 2026, all five classes are present. This change indicates differences in the spatial patterns produced by the model between periods; however, it cannot be interpreted solely as a change in actual flood occurrence because the model is a deterministic index and independent inundation observations were not reported.

The comparison of flood-hazard susceptibility maps for 2019 and 2026 reveals substantial changes in the spatial composition of the modeled hazard classes in Pauh District, Padang City (Table 3). In 2019, the classified area

consisted of two categories: low hazard, covering 15,586.24 ha (98.39%), and moderate hazard, covering 255.81 ha (1.61%). By 2026, all five hazard classes were represented, indicating a substantial redistribution of the composite index values across the study area.

Table 3. Comparison of flood-hazard classes between 2019 and 2026

Flood-hazard class	2019 Area (ha)	2019 (%)	2026 Area (ha)	2026 (%)
Very low	—	—	11,696.94	73.84
Low	15,586.24	98.39	2,389.88	15.09
Moderate	255.81	1.61	628.47	3.96
High	—	—	1,098.33	6.93
Very high	—	—	28.43	0.18

As shown in Table 3, the low-hazard class decreased by 13,196.36 ha, from 15,586.24 ha in 2019 to 2,389.88 ha in 2026. Conversely, the very-low-hazard class appeared in 2026, covering 11,696.94 ha (73.84%). The moderate-hazard class increased from 255.81 ha to 628.47 ha, while the high- and very-high-hazard classes emerged, covering 1,098.33 ha (6.93%) and 28.43 ha (0.18%), respectively. These results indicate a pronounced shift in the distribution of modeled susceptibility classes between the two periods. However, the changes represent differences in the composite index classification and should not be interpreted directly as changes in observed flood occurrence or inundation extent.

At the urban-village level, substantial changes occurred in Binuang Kampung Dalam and Cupak Tangah. In Binuang Kampung Dalam, the 2019 classification comprised 30.40 ha of low-hazard area and 111.54 ha of moderate-hazard area. In 2026, the reported distribution included 141.81 ha of high-hazard area and 0.10 ha of very-high-hazard area. Similarly, in Cupak Tangah, the low- and moderate-hazard areas in 2019 covered 104.03 ha and 91.53 ha, respectively, whereas the 2026 classification included 187.50 ha of high-hazard area and 8.03 ha of very-high-hazard area (Figure 3). These changes illustrate the substantial spatial variation in the modeled susceptibility index across individual urban villages.

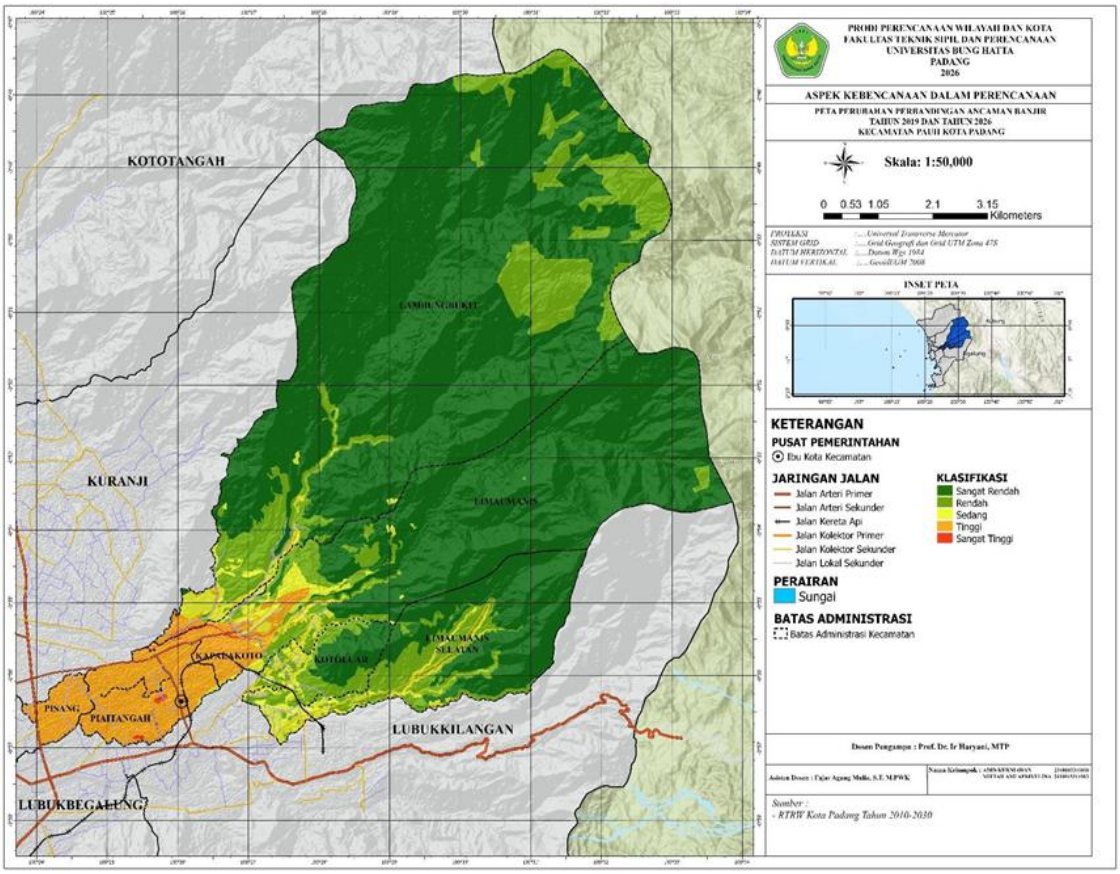

Figure 3. Flood Hazard in 2026

In contrast, Lambung Bukit, Limau Manis, and Limau Manis Selatan exhibited more varied patterns of change. Although substantial areas previously classified as low hazard were classified as very low hazard in 2026, other areas shifted into moderate- and high-hazard categories. The distribution of these changes suggests that the resulting classification reflects the combined influence of multiple spatial parameters rather than a single controlling factor. Limau Manis, Pisang, Cupak Tangah, Binuang Kampung Dalam, and Kapalo Koto also contained the largest reported areas of high susceptibility in 2026, making them relevant locations for more detailed spatial investigation.

The observed redistribution of hazard classes should be interpreted in the context of the weighted-overlay methodology. Because the composite index is calculated by combining the scores of slope, rainfall, distance to rivers, land cover, and soil type using predefined weights, changes in one or more input parameters may cause index values to cross class boundaries. Land-cover change may be particularly relevant because the expansion of impervious surfaces can reduce infiltration and increase surface runoff. Rainfall characteristics and other biophysical conditions may also influence the resulting index. Nevertheless, the emergence of high- and very-high-hazard classes cannot be attributed solely to land-cover change without a systematic analysis of parameter-specific contributions.

The comparability of the 2019 and 2026 results also depends on the consistency of the input datasets, spatial resolution, scoring schemes, weighting factors, and classification thresholds. In particular, because only the low- and moderate-hazard classes were reported for 2019, the apparent emergence of the very-low, high, and very-high classes in 2026 requires verification that both maps were generated using comparable analytical procedures. Without such verification, differences in class distribution may partly reflect methodological inconsistencies rather than changes in the underlying spatial conditions. Independent validation using historical flood records or observed inundation data is therefore necessary to evaluate the reliability of the mapped patterns (Mudashiru et al., 2021; Nachappa et al., 2020).

From a spatial-planning perspective, the 2026 susceptibility map provides an initial screening tool for identifying locations that warrant further investigation. The relatively extensive high-hazard areas in Limau Manis, Pisang, Cupak Tangah, Binuang Kampung Dalam, and Kapalo Koto may be prioritized for field surveys, drainage-capacity assessments, river-corridor inspections, and hydraulic modeling. Where appropriate, the results can also inform the evaluation of land-use practices and the preservation of infiltration and water-retention areas. However, prioritization should be based on the spatial distribution of susceptibility within each urban village rather than on administrative boundaries alone, because hazard conditions may vary considerably between locations.

Overall, the comparison demonstrates substantial changes in the spatial distribution of the modeled flood-hazard susceptibility classes between 2019 and 2026. These findings support the use of GIS-based susceptibility mapping as a preliminary planning instrument, while highlighting the need for consistent temporal datasets, parameter-contribution analysis, and independent validation. The results should therefore be interpreted as changes in a relative susceptibility index, rather than as direct evidence of changes in flood frequency, inundation extent, or overall flood risk.

Implications for Spatial Planning and Flood Mitigation

The spatial distribution and temporal changes in flood-hazard susceptibility identified in Pauh District provide a basis for developing spatially targeted planning and mitigation strategies. Given the predominance of the very-low and low-susceptibility classes in 2026, alongside the presence of high- and very-high-susceptibility areas in several urban villages, mitigation measures should be differentiated according to local conditions rather than applied uniformly across the district.

First, areas classified as high or very high susceptibility should be prioritized for detailed assessment and closer review of proposed land-use changes, particularly where they coincide with river corridors, settlements, or critical infrastructure. In urban villages with relatively extensive high-susceptibility areas, including Limau Manis, Pisang, Cupak Tangah, Binuang Kampung Dalam, and Kapalo Koto, field verification and assessments of drainage performance and river-corridor conditions would help identify locations requiring further

intervention. Second, forest cover and areas that support infiltration should be maintained to preserve hydrological functions and limit potential increases in surface runoff. Third, drainage systems and runoff-control infrastructure should be assessed in locations where high susceptibility coincides with existing development or inadequate drainage. Where justified by local risk assessments, additional measures may include water-retention facilities, improved drainage networks, and the preservation of open spaces. Fourth, preparedness measures, including evacuation-route planning, designated emergency assembly areas, and early-warning systems, should be considered in locations where further assessment confirms potential flood exposure.

These planning directions reflect the need to integrate structural and non-structural approaches to flood mitigation. Land-use management, ecosystem protection, drainage improvement, and emergency preparedness address different aspects of flood susceptibility and its potential consequences. In this context, the susceptibility maps developed in this study can serve as a supporting spatial-information layer for reviewing land-use plans and identifying priorities for further investigation and mitigation programs in Pauh District.

However, the susceptibility maps should not be used as the sole basis for prohibiting development or determining the safety of individual locations. Areas classified as having low susceptibility may still experience flooding because of localized drainage constraints, extreme rainfall, or hydrological processes not represented in the model. Similarly, areas classified as highly susceptible require further assessment before specific regulatory or engineering measures are prescribed. Planning decisions should therefore integrate the susceptibility index with detailed topographic data, drainage capacity, historical flood records, hydraulic modeling, population and building exposure, and applicable spatial-planning regulations.

The interpretation of these findings must also account for the limitations of the GIS-based weighted-overlay method. Although the approach enables the integration of multiple biophysical parameters into a composite index, the results depend on parameter selection, scoring criteria, weighting factors, and classification thresholds. The model does not directly simulate inundation depth, flow velocity, discharge, or drainage performance, nor does it quantify population exposure, economic losses, or social vulnerability. Consequently, the resulting maps represent relative flood-hazard susceptibility rather than deterministic predictions of flood occurrence or comprehensive assessments of flood risk.

Overall, this study provides a spatial basis for identifying areas requiring differentiated planning attention and for examining changes in modeled flood-hazard susceptibility between 2019 and 2026. Its practical value lies in supporting preliminary spatial screening and mitigation prioritization, rather than replacing detailed flood-risk assessments. Further validation against observed flood events and inundation data, together with hydrological analysis and exposure assessment, is necessary to strengthen the reliability of the maps and their application to evidence-based spatial planning and flood mitigation in Pauh District.

CONCLUSION

This study assessed the spatial distribution and temporal changes in flood-hazard susceptibility in Pauh District, Padang City, between 2019 and 2026 using a GIS-based weighted-overlay method incorporating slope, rainfall, distance to rivers, land cover, and soil type. The 2026 results indicate that the very-low-susceptibility class dominates the study area, covering 11,696.94 ha (73.84%), followed by the low-susceptibility class at 2,389.88 ha (15.09%). Nevertheless, high- and very-high-susceptibility areas cover 1,098.33 ha (6.93%) and 28.43 ha (0.18%), respectively, with substantial high-susceptibility areas identified in Limau Manis, Pisang, Cupak Tangah, Binuang Kampung Dalam, and Kapalo Koto.

The temporal comparison reveals a substantial redistribution of the modeled susceptibility classes between 2019 and 2026. While the 2019 classification comprised only low and moderate classes, all five classes were reported in 2026. This change indicates a marked difference in the spatial composition of the composite susceptibility index. However, the observed differences should be interpreted cautiously because they may reflect changes in input parameters, classification procedures, or other methodological factors, in addition to changes in underlying environmental conditions.

The findings provide a spatial basis for prioritizing flood-mitigation assessments and supporting land-use

planning in Pauh District. Areas classified as highly susceptible warrant further investigation through field verification, drainage-capacity assessment, river-corridor evaluation, and, where appropriate, hydraulic modeling. The results also highlight the importance of maintaining forest cover and infiltration areas and integrating susceptibility information with population and infrastructure exposure when developing mitigation strategies.

Nevertheless, the weighted-overlay model represents relative flood-hazard susceptibility rather than a direct prediction of flood occurrence or a comprehensive assessment of flood risk. Future research should validate the mapped classifications against historical flood events and observed inundation, examine the contribution and sensitivity of individual parameters, and incorporate hydrological, infrastructure, and exposure data. These improvements would strengthen the reliability of the assessment and support more robust, evidence-based spatial planning and flood-risk management in Pauh District.

Author Contribution

The contributions of each author are as follows: the first author wrote scientific article and collected data, the second and third author conducted data collection through interviews and data processing, while the fourth, fifth, six and seven authors conducted the literature review and drafted the article.

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