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Judul : GIS-based Analysis of Slope, Landslide and Flood Hazards, and Land Use Integrated with Indigenous Knowledge in Nagari Sijunjung, Indonesia

Jurnal : Geographia Technica 20 (2), 336-353

Penulis : Haryani, Eri Barlian, I Nengah Tela, Ezra Aditia, Aprizon Putra

Link : https://technicalgeography.org/index.php/on-line-first/558-21_haryani

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1. **Pengajuan awak ke email editorial-secretary@technicalgeography.org Geographia Technica serta respon Editor untuk kalayakan paper pada tanggal 16 Agustus 2025 (10.54 AM) [LAMPIRAN 1 Bukti Turnitin]**

Webmail
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Ir Haryani <irharyanimtp@bunghatta.ac.id>

Manuscript Submission to Geographia Technica
2 messages

Ir Haryani <irharyanimtp@bunghatta.ac.id> Sat, Aug 16, 2025 at 10:54 AM
To: editorial-secretary@technicalgeography.org, "ionel.haidu@univ-lorraine.fr" <ionel.haidu@univ-lorraine.fr>

Dear Editor,

I am Dr. Haryani from the Department of Urban and Regional Planning, Bung Hatta University, Indonesia. I would like to inquire about the suitability of my manuscript for consideration in Geographia Technica.

The title of the manuscript is:
GIS-Based Analysis of Slope, Landslide and Flood Hazards, and Land Use Integrated with Indigenous Knowledge in Nagari Sijunjung, Indonesia

This study employs GIS-based spatial analysis to integrate slope classification, landslide and flood hazard mapping, and land-use patterns with indigenous knowledge for disaster risk reduction. The approach highlights how traditional ecological wisdom and modern geospatial methods can be combined to inform sustainable land-use planning and hazard mitigation strategies in cultural landscapes.

I have attached the manuscript (an anonymized version without author details and Turnitin plagiarism check) for your review to assess whether it fits within the aims and scope of Geographia Technica.

I would greatly appreciate your kind feedback on the manuscript's suitability for your journal before formal submission.

Thank you for your attention and consideration.

Sincerely,
Dr. Haryani
Department of Urban and Regional Planning (Planology)
Bung Hatta University, Indonesia

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2 attachments

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editorial-secretary@technicalgeography.org <editorial-secretary@technicalgeography.org> Sat, Aug 16, 2025 at 4:39 PM
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Authors: Haryani Haryani (Co-author), Eri Barlian (Corresponding author), I Nengah Tela (Co-author), Ezra Aditia (Co-author), Aprizon Putra (Co-author)
Date submitted: 2025-08-20

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GT-2025-8-4 Revise manuscript (minor revisions)

1 message

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To: irharyanimtp@bunghatta.ac.id

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Dear Dr. Haryani

Thank you very much for submitting the above manuscript to Geographia Technica.

Your manuscript has now been evaluated by external reviewers and members of the editorial board. A number of points of criticism were raised and these must be addressed before your manuscript can be accepted for publication.

When you submit a revised version, please enclose
1. a point-to-point reply to the reviewers' comments that addresses each comment of each reviewer. Please be as specific as possible in your response to the reviewer(s).
2. a revised version of the manuscript with changes made in bold, underlined or highlighted (adding page and line numbers)
3. a clean revised version (without line numbers).

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We look forward to receiving the revised version within 2 weeks and thank you, again, for submitting your manuscript to Geographia Technica.

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Reviewer 1 report:
Comments to authors

Overall, this is a well-prepared manuscript that combines local cultural perspectives with spatial analysis to assess sustainability and hazard potential. The topic is highly relevant and innovative, and the study provides valuable insights. My comments below are intended as constructive suggestions to improve clarity, transparency, and international readability.

1. The manuscript frequently uses local terms such as "Nagari" (village-level unit in West Sumatra) and "Hutan Larangan" (traditional protected forest). Since these terms may not be familiar to an international readership, please consider clarifying them at the first mention (e.g., "Nagari, a traditional village unit in West Sumatra"; "Hutan Larangan, a customary protected forest") and then consistently using more general English equivalents such as "village" and "protected forest" in subsequent sections. This will improve clarity and accessibility for a broader audience while still recognizing the local cultural context.

2. Regarding the statement "topographically, most of the area comprises gentle slopes (2–8%), which are optimal for settlement and agriculture, while steeper slopes (8–15%)", please clarify the source of this information. If it comes from secondary data (maps, government reports, or literature), kindly cite the reference. If it is derived from your own spatial analysis, please make this explicit in the methodology.

3. In Table 1 (Landslide hazard assessment parameters) and Table 3 (Flood hazard assessment parameters), parameters such as Soil type (e.g., Alluvial, Latosol, Grumosol, etc.) and Geology (e.g., sedimentary, volcanic, igneous/metamorphic) are clearly listed and classified. However, in the Results section, these parameters are not elaborated. It would strengthen the paper if you explain how these parameters work in the spatial model and contribute to the hazard potential analysis for both landslides and floods. This would enhance methodological transparency and help readers understand how soil and geological conditions influence the final hazard maps.

Reviewer 2 report:
Comments to authors

This manuscript is a valuable contribution that integrates indigenous knowledge with GIS-based hazard assessment in Nagari Sijunjung. The topic is original, relevant, and well-presented, combining cultural and spatial perspectives in disaster risk reduction. My suggestions below are intended as constructive feedback to enhance methodological clarity, reduce redundancy, and strengthen the balance between cultural insights and physical geography analysis.

1. The Methods section (pp. 4–6) clearly explains overlay and buffer analysis, but field validation is not quantified. Adding classification accuracy or validation percentages would strengthen the reliability of the spatial results.

2. Sections 4.1–4.3 (pp. 7–12) repeat the same slope categories (0–8% and 8–15%) several times. These should be summarized to avoid redundancy.

3. In Table 7 (landslides, p. 9) and Table 8 (floods, p. 10), area percentages for each hazard class (low, moderate, high) are missing. Including these would make the results clearer and more robust.

4. The Discussion (pp. 11–15) emphasizes indigenous knowledge but gives little detail on physical processes. More explanation of how rainfall, rocks, and vegetation affect hazards, together with examples of how land use (e.g., rubber roots, rice fields) functions as mitigation, would balance cultural and geomorphological perspectives.

Reviewer 3 report:
Comments to authors

(Bukti pemberitahuan via email untuk revisi paper dari 3 reviewer)

Dear Author,

Thank you for the opportunity to review your manuscript submitted to Geographia Technica. I appreciate the trust given to me by both the Author and the Editor.

After carefully reading your paper, I would like to commend the novelty of your work. The study not only conducts GIS-based hazard mapping (slope, landslide, flood, and land use), but also integrates spatial analysis with Minangkabau local wisdom through philosophical perspectives. This is an excellent contribution that combines cultural geography with spatial technical sciences. However, I would like to suggest several points for improvement to further enhance the clarity and quality of your paper:

1. Clarification of Local and Cultural Terms: Some local or cultural terms (e.g., Nagari, Rumah Gadang) are mentioned without sufficient explanation. Please provide clear definitions or explanatory notes so that international readers can better understand their cultural and spatial significance.

2. Language and Grammar: Overall, the manuscript is written clearly, but it would benefit from further refinement. I recommend running a grammar check (e.g., with Grammarly) to improve readability and fluency.

3. Institution Abbreviations: Please provide the full names and standard abbreviations of local institutions, e.g., Geospatial Information Agency (Badan Informasi Geospasial – BIG) and Meteorology, Climatology, and Geophysics Agency (Badan Meteorologi, Klimatologi, dan Geofisika – BMKG). Ensure consistency throughout the manuscript.

4. References and Citations: Kindly re-check the consistency and accuracy of in-text citations and the reference list. Ensure they follow the journal's required format.

In conclusion, my evaluation is that the structure of the paper, introduction, objectives, methodology, and results is already well organized. The suggested revisions ar mainly intended to improve clarity, readability, and international accessibility of the manuscript.

I wish you success in your revision process and in the continuation of your research.

Best regards,

Editorial secretary report:
Comments to authors

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You used a wide variety of data. It should be remembered that the integration of these vector and raster data in a GEODATABASE is essential, when authors use multiple sources, for coherent data structuring and relational analysis, according to the methodology described by Nicoară & Haidu (2011). We therefore recommend citing the following article:
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Geographia Technica, Vol 20, Issue 2, 2025, pp. 336-353

GIS-BASED ANALYSIS OF SLOPE, LANDSLIDE AND FLOOD HAZARDS, AND LAND USE INTEGRATED WITH INDIGENOUS KNOWLEDGE IN NAGARI SIJUNJUNG, INDONESIA

HARYANI, Eri BARLIAN, I Nengah TELA, Ezra ADITIA, Aprizon PUTRA

DOI: 10.21163/GT_2025.202.21

ABSTRACT: This study aims to examine how the traditional settlement of Nagari Sijunjung, guided by the Minangkabau philosophy of Alam Takambang Jadi Guru, aligns with the area's physical characteristics and functions as an inherent disaster risk reduction system. Specifically, it analyzes the relationship between slope conditions, land use, and hazard potential by integrating indigenous spatial planning with Geographic Information System (GIS)-based risk analysis. The study was conducted in Nagari Sijunjung, a 157.1 ha cultural heritage site in West Sumatra, Indonesia, containing 77 traditional Rumah Gadang, sacred sites, and diverse clan settlements. Spatial datasets from satellite imagery, Digital Elevation Model (DEM), and official maps were overlaid with indigenous zoning to assess congruence between cultural principles and hazard avoidance strategies. Results show that flat and gentle slopes (0–8%) serve as the core zones for settlements and agriculture, while steeper slopes (8–15%) are preserved as protected forest or rubber plantations, functioning as ecological buffers against landslides. Flood-prone River plains are allocated for seasonal agriculture, while settlements are located on slightly elevated terrain. In conclusion, indigenous zoning closely aligns with physical hazard assessments based on slope, soil, geology, rainfall, and land use analysis, demonstrating that traditional planning offers a culturally grounded and hazard-aware model for community-based disaster risk reduction.

Keywords: Disaster risk reduction; GIS; Indigenous knowledge; Land use planning; Nagari Sijunjung.

Full article here

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Geographia Technica

Technical Geography
an International Journal for the Progress of Scientific Geography

Volume 20, Geographia Technica No. 2/2025

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GIS-BASED ANALYSIS OF SLOPE, LANDSLIDE AND FLOOD HAZARDS, AND LAND USE INTEGRATED WITH INDIGENOUS KNOWLEDGE IN NAGARI SIJUNJUNG, INDONESIA

Geographia Technica • Article • 2025 • DOI: 10.21163/GT_2025.202.21

Haryani[a] ; Barlian, Eri[b] ; Tela, I. Nengah[a] ; Aditia, Ezra[a] ; Putra, Aprizon[c]
[a] Department of Urban and Regional Planning, Universitas Bung Hatta, Padang, Indonesia

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Abstract

This study aims to examine how the traditional settlement of Nagari Sijunjung, guided by the Minangkabau philosophy of Alam Takambang Jadi Guru, aligns with the area's physical characteristics and functions as an inherent disaster risk reduction system. Specifically, it analyzes the relationship between slope conditions, land use, and hazard potential by integrating indigenous spatial planning with Geographic Information System (GIS)–based risk analysis. The study was conducted in Nagari Sijunjung, a 157.1 ha cultural heritage site in West Sumatra, Indonesia, containing 77 traditional Rumah Gadang, sacred sites, and diverse clan settlements. Spatial datasets from satellite imagery, Digital Elevation Model (DEM), and official maps were overlaid with indigenous zoning to assess congruence between cultural principles and hazard avoidance strategies. Results show that flat and gentle slopes (0–8%) serve as the core zones for settlements and agriculture, while steeper slopes (8–15%) are preserved as protected forest or rubber plantations, functioning as ecological buffers against landslides. Flood-prone River plains are allocated for seasonal agriculture, while settlements are located on slightly elevated terrain. In conclusion, indigenous zoning closely aligns with physical hazard assessments based on slope, soil, geology, rainfall, and land use analysis, demonstrating that traditional planning offers a culturally grounded and hazard-aware model for community-based disaster risk reduction.

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GIS-BASED ANALYSIS OF SLOPE, LANDSLIDE AND FLOOD HAZARDS, AND LAND USE INTEGRATED WITH INDIGENOUS KNOWLEDGE IN *NAGARI* SIJUNJUNG, INDONESIA[1]

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ABSTRACT:
This study aims to examine how the traditional settlement of *Nagari* Sijunjung, guided by the Minangkabau philosophy of *Alam Takambang Jadi Guru*, aligns with the area's physical characteristics and functions as an inherent disaster risk reduction system. Specifically, it analyzes the relationship between slope conditions, land use, and hazard potential by integrating indigenous spatial planning with Geographic Information System (GIS)–based risk analysis. The study was conducted in *Nagari* Sijunjung, a 157.1 ha cultural heritage site in West Sumatra, Indonesia, containing 77 traditional *Rumah Gadang*, sacred sites, and diverse clan settlements. Spatial datasets from satellite imagery, Digital Elevation Model (DEM), and official maps were overlaid with indigenous zoning to assess congruence between cultural principles and hazard avoidance strategies. Results show that flat and gentle slopes (0–8%) serve as the core zones for settlements and agriculture, while steeper slopes (8–15%) are preserved as protected forest or rubber plantations, functioning as ecological buffers against landslides. Flood-prone river plains are allocated for seasonal agriculture, while settlements are located on slightly elevated terrain. In conclusion, indigenous zoning closely aligns with physical hazard assessments based on slope, soil, geology, rainfall, and land use analysis, demonstrating that traditional planning offers a culturally grounded and hazard-aware model for community-based disaster risk reduction.

Key-words: *Disaster risk reduction, GIS, Indigenous knowledge, Land use planning, Nagari Sijunjung.*

1. INTRODUCTION

Indonesia ranks among the nations most vulnerable to a wide range of natural hazards, including earthquakes, volcanic eruptions, floods, and landslides. Data from the Indonesian National Board for Disaster Management (BNPB) 2022 indicate a consistent rise in disaster frequency, particularly in areas where land-use changes are misaligned with the physical and ecological characteristics of the landscape (Kegel et al., 2025). While modern, technology-driven mitigation strategies have been widely promoted, they often demand substantial financial, technical, and institutional resources, making them less applicable in communities with limited capacity. In contrast, numerous Indigenous communities across Indonesia have long relied on sophisticated systems of local knowledge as adaptive strategies to manage environmental risks (Asrawijaya, 2024; Karnoto et al., 2025). One prominent example is the customary spatial planning system, which not only regulates the arrangement of settlements, agricultural areas, and conservation zones but also inherently reduces disaster risks through nature-based and culturally embedded mechanisms (Lestari et al., 2025; Darmawan et al., 2022). These systems have evolved over generations, shaped by accumulated experience, continuous observation of environmental cues, and philosophical principles passed down orally or through customary law (Wiersum, 2004; Hiwasaki et al., 2014).

Administratively, the study focuses on the traditional settlement of *Nagari* (Indonesian: *Nagari*, abbreviated Village) **[2]**Sijunjung, located in Sijunjung Regency, West Sumatra Province, and traversed by the Batang Kuantan River. The Regency consists of 11 *Nagari*, including Sijunjung, Muaro, Paru, Pematang Panjang, Silokek, and Aie Amo. Topographically, most of the area comprises gentle slopes (2–8%), which are optimal for settlement and agriculture, while steeper slopes (8–15%) are designated as protected forest[3]. This topographical information was obtained from the slope classification generated through the Digital Elevation Model (DEM)/Shuttle Radar Topography Mission (SRTM) analysis conducted in this study.[4]

The traditional settlement of *Nagari* Sijunjung embodies the Minangkabau socio-ecological philosophy of *Alam Takambang Jadi Guru*, literally "Nature Unfolds to Be a Teacher" which guides the community in selecting settlement areas, determining farmland allocation, and designating conservation areas (Heider, 2011; Nasri et al., 2022; Lah et al., 2024). Empirical observations have shown that these settlements are often located on ridge lines or elevated terrain to avoid flooding, with building orientations adapted to prevailing winds and water flow. Traditional *Rumah Gadang* (Indonesian: *Rumah Gadang* abbreviated Big House)[5] houses are built on stilts, providing structural resilience against both inundation and seismic activity. However, rapid modernization, expanding infrastructure projects, and insufficient legal recognition of customary land rights have gradually altered these spatial configurations. Such shifts risk undermining the embedded disaster-mitigation functions of the traditional system (Sutanta et al., 2013). Consequently, this study integrates spatial slope analysis, indigenous settlement typology, and the Community-Based Disaster Risk Reduction (CB-DRR) framework to examine how the *Nagari* Sijunjung spatial system remains functional, adaptive, and relevant within the context of contemporary, risk-based spatial planning.

This study aims to examine how the traditional settlement of *Nagari* Sijunjung, guided by the Minangkabau philosophy of *Alam Takambang Jadi Guru*, aligns with the area's physical characteristics and functions as an inherent disaster risk reduction system. Specifically, it seeks to analyze the relationship between slope conditions, land use, and hazard potential, integrating indigenous spatial planning principles with modern risk-based spatial analysis using the Geographic Information System (GIS). This study offers a novel integration of GIS–based spatial hazard assessment with indigenous knowledge systems in the context of the traditional settlement of *Nagari* Sijunjung. By directly comparing scientifically mapped hazard zones with customary zoning patterns, the study demonstrates that traditional spatial arrangements can serve as an effective, culturally grounded model for contemporary disaster risk-sensitive land use planning.

2. STUDY AREA

The study was conducted in the traditional settlement of *Nagari* Sijunjung, a designated cultural heritage area that represents a well-preserved example of the traditional Minangkabau spatial arrangement. According to the West Sumatra Cultural Heritage Preservation Office (BPCB), the site covers approximately 157.1 ha and is home to nine major clans, namely Chaniago, Piliang, Malayu, Tobo, Bodi, Panai, Patopang, Bendang, and Malayu Tak Timbago. Within the area, 77 traditional *Rumah Gadang* remain in active use as centers of social, cultural, and customary activities, along with important heritage sites such as *Batu Tabonek* and *Tempat Berkaul Adat*, both of which hold significant spiritual value for the community. The heritage designation follows Law No. 11/2010 on Cultural Heritage, which mandates protection through rescue, security, zoning, maintenance, and restoration.

Nagari Sijunjung is situated in Sijunjung Sub-district, Sijunjung Regency, West Sumatra Province, Indonesia, at coordinates 100°55′30″–101°00′30″ E and 0°42′30″–0°38′30″ S, with elevations ranging from 120 to 930 meters above sea level (MASL). Its strategic location along a network of collector and local roads ensures high accessibility to the Sub-district center and neighboring *Nagari* such as Koto VII, Kamang Baru, and Tanjung Gadang. The Batang Kuantan River flows through the area, serving both as a natural boundary and the primary water source for the community (Prambudi et al., 2023). Beyond its ecological and economic functions, the river also holds deep cosmological significance in local cultural narratives, influencing settlement placement and land-use decisions. The combination of cultural heritage value, adaptive topography, and abundant natural resources makes *Nagari* Sijunjung an exemplary case for examining how indigenous knowledge systems can be integrated with spatial analysis in the context of disaster risk mitigation and risk-based spatial planning. More details can be seen in Figure 1 below.

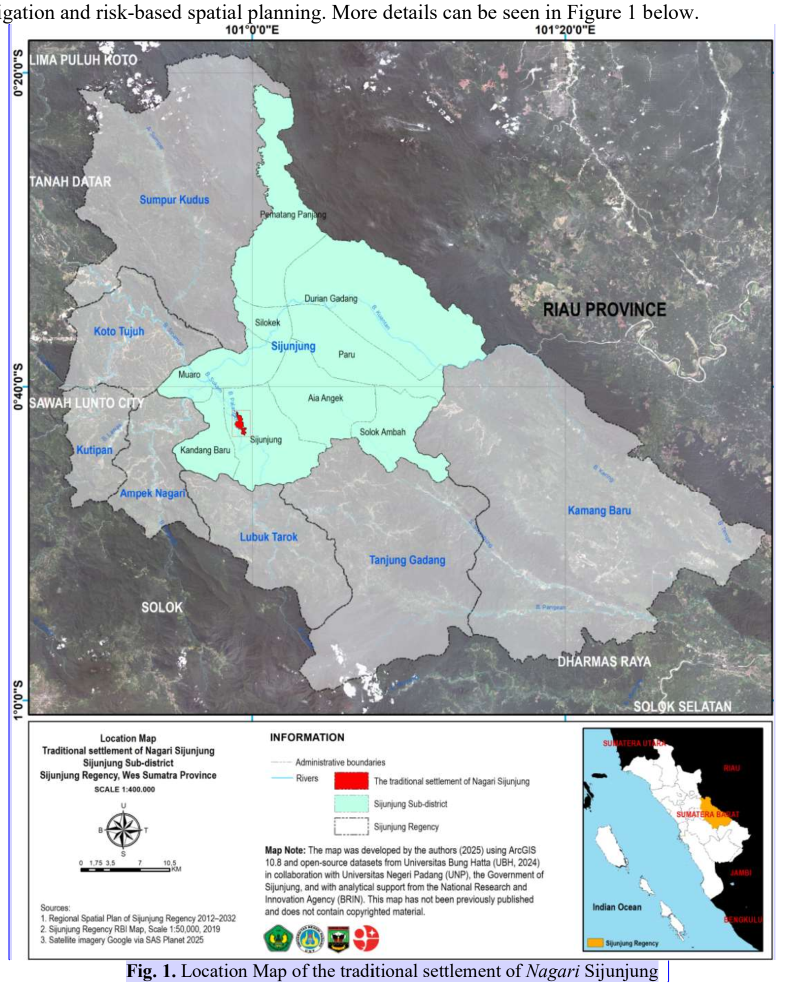

Fig. 1. Location Map of the traditional settlement of *Nagari* Sijunjung

[Hr6]3. METHODS

3.1 Spatial analysis approach

To ensure analytical accuracy, multiple spatial datasets were obtained from both authoritative and field-based sources. These included 1) High-resolution recent satellite imagery from Google, downloaded via SAS Planet 2025, for land cover mapping and settlement identification; 2) DEM/SRTM data for slope analysis; 3) Land use maps from the Geospatial Information Agency (BIG), used as a baseline for detecting land-use changes and complemented with field verification;

4) Hydrography data from the *Rupa Bumi Indonesia* (RBI) maps by BIG, detailing rivers, streams, and water bodies; 5) Rainfall statistics from the Meteorology, Climatology, and Geophysics Agency (BMKG) for hazard classification; and 6) Administrative boundary maps at the *Nagari*, Sub-district, and Regency levels, sourced from the Regional Spatial Planning (RSP) Sijunjung Regency. **[7]** Data processing was performed using ArcGIS software. Considering the integration of multiple raster and vector datasets, the use of a GEODATABASE structure is essential to ensure coherent data management and relational analysis (Nicoară & Haidu, 2011). **[8]**

Data processing was performed using ArcGIS software. Slope classification was generated from DEM/SRTM data, while land use classification was derived from satellite imagery and refined through ground validation. The slope analysis applied a 30 m resolution DEM/SRTM dataset. **[9]** Overlay analysis was then conducted to assess the spatial relationship between land use and hazard-prone zones, and buffer analysis was applied to delineate protective zones around critical natural features such as rivers, steep slopes, and natural evacuation corridors. Ground checks were carried out at 25 GPS points across settlement, agriculture, forest, and river zones to confirm land use classification. The classification accuracy reached 87%, with a Kappa coefficient of 0.82 (Chahkar et al., 2020), indicating strong agreement between the satellite-derived map and field conditions. Slope data derived from DEM/SRTM were compared with three ground-control transects, showing less than 5% deviation in slope class assignment. These validations ensure that the overlay and buffer analyses are methodologically robust. For landslide assessment, areas dominated by alluvial and latosol soils with loose texture showed higher susceptibility when combined with steep slopes and high rainfall, while zones underlain by volcanic and igneous formations demonstrated greater stability. For flood assessment, alluvial soils in river plains retained high water content and prolonged inundation, whereas andosol and lithosol soils in elevated zones allowed higher infiltration and reduced ponding. These factors strongly influenced the final hazard maps, explaining why some zones with similar slopes exhibited different hazard levels. **[10]** Landslide hazard assessment followed the parameter and weighting framework proposed by Paimin et al. (2009). The resulting hazard classifications were then compared with traditional Minangkabau zoning principles to determine the extent to which indigenous. The resulting hazard classifications were then compared with traditional Minangkabau zoning to determine the extent to which indigenous spatial arrangements align with scientific hazard assessments as outlined in Tables 1 and 2 below.

Table 1

Landslide hazard assessment parameters

Parameter	Class/Category	Value	Weight
Soil type	Alluvial, Latosol, Grumosol (1); Mediterranean, Podsolic, Glei Humus (2); Regosol, Andosol (3)	1–3	1
Land use	Lake/Pond, River, Fishpond, Brackish Pond (0); Shrubland (2); Rice Field, Dry Field, Plantation, Mixed Garden (4); Settlement, Mining, Open Field (5); Swimming Pool (3)	0–5	2
Rainfall (mm)	2001–2500 (3); 2501–3000 (4); ≥3001 (5)	3–5	3
Slope (%)	0–2% (1); 2–8% (2); 8–15% (3)	1–3	4
Geology	Sedimentary, easily weathered (3); Volcanic, medium strength (2); Igneous/metamorphic, strong (1)	1–3	3

Source: Paimin et al. (2009).

Table 2

Landslide hazard classifications

Hazard Level	Score Range	Description
Low	1.5–2.3	Requires monitoring during the rainy season
Moderate	>2.3–3.1	Potential hazard during high rainfall or slope disturbance
High	>3.1–3.7	Very prone; requires mitigation and special handling

Source: Paimin et al. (2009).

Following the classification of landslide hazard levels presented in Table 2 above, the analysis was extended to assess flood hazard potential. This assessment applied a set of parameters that capture the influence of land use, rainfall intensity, elevation, slope, and soil type on flood risk. The criteria and scoring system, adapted from Şen (2018); Nguyen (2019) in Tables 3 and 4 below.

Table 3

Flood hazard assessment parameters

Parameter	Class/Category	Value	Weight
Land use	Lake/Pond, River, Mining, Open Land, Settlement, Swamp (5); Swimming Pool, Irrigated/Rain-fed Rice Field, Shrubland (4); Forest Plantation, Primary/Secondary Dryland Forest (3); Mixed Garden, Rubber/Oil Palm (2); Sandbar (1)	1–5	5
Rainfall (mm)	>3500 (5); 3001–3500 (4); 2501–3000 (3); 2001–2500 (2); <2000 (1)	1–5	4
Elevation (m)	0–25 (5); 26–50 (4); 51–100 (3); 101–250 (2); >250 (1)	1–5	3
Slope (%)	0–2% (1); 2–8% (2); 8–15% (3)	1–3	4
Soil type	Alluvial, Latosol, Grumosol (5); Regosol, Andosol (3); Mediterranean, Podsolic, Glei Humus (2); Lithosol (1)	1–5	4

Sources: Şen (2018); Nguyen (2019).

Table 4

Flood hazard classifications

Hazard Level	Score Range	Description
Very Low	2.4–3.0	Not significant
Low	>3.0–3.6	Light inundation potential
Moderate	>3.6–4.2	Moderate risk during heavy rain
High	>4.2–4.8	Very prone; requires mitigation

Sources: Şen (2018); Nguyen (2019).

3.2 Indigenous knowledge–spatial integration approach

This approach aimed to document, interpret, and integrate local wisdom that guides settlement planning and disaster mitigation in the Minangkabau tradition, with spatial analysis results. The emphasis is on how the philosophy of *Alam Takambang Jadi Guru* is embedded in settlement spatial arrangements and how these customary principles align with scientific hazard mitigation strategies. More details can be seen in Table 5 below.

Table 5

Description of the indigenous knowledge–spatial integration approach

Stages	Activities	Purposes
Data collection – indigenous knowledge	Conduct in-depth interviews with *Ninik Mamak* (Indonesian: abbreviated Customary Leaders), *Nan Tuo di Kampuang* (Indonesian: abbreviated Village Elders), Rumah Gadang, and community members to capture traditional norms, decision-making processes, and lived experiences.	Capture and document traditional norms, governance structures, and lived experiences related to settlement planning.
	Carry out participatory observation of building orientation, site selection for houses *Rangkiang* (Indonesian: abbreviated Rice Barns), ommunal facilities, and zoning based on customary land functions.	Document ecological adaptation patterns and local disaster risk mitigation strategies.
	Tambo (Indonesian: abbreviated Customary Manuscripts), historical, and traditional maps to identify the ecological, spiritual, and social values embedded.	Identify the cultural principles guiding spatial arrangements and resource use.
Spatial data analysis	Slope, land use, and hazard maps to assess the physical constraints and hazard exposure of the settlement area.	Understand topographical limitations and hazard.

Stages	Activities	Purposes
	Overlay hazard maps with customary zoning patterns to assess spatial congruence with hazard-prone areas.	Compare zoning decisions with mapped hazards.
Integration process	Perform data triangulation between indigenous narratives, field observations, and spatial analysis outputs to validate findings.	Accuracy of insights for both local and scientific.
	Identify effective customary zones for hazard mitigation, such as avoiding settlements at the foot of steep slopes or close to large rivers.	Highlight functional aspects of indigenous knowledge in disaster risk reduction.
	Develop narrative–spatial mapping to the relationship between indigenous principles and physical conditions.	Present integrated evidence of cultural–spatial alignment.
Expected outputs	Produce a spatial model of *Nagari* Sijunjung's traditional settlement functioning as a natural disaster mitigation system	Provide a culturally grounded planning framework.
	Create an integrated model combining local wisdom and spatial data for risk-based planning.	Strengthen evidence-based policy-making.
	Formulate policy recommendations for preserving spatial arrangements within the CB-DRR strategies.	Support sustainable disaster risk reduction.

By triangulating indigenous narratives, field observations, and mapping, this method not only validates the cultural logic of settlement patterns but also demonstrates their functional role in mitigating risks such as floods and landslides. The outputs, ranging from GIS-based models, offer a framework for integrating cultural heritage into sustainable CB-DRR planning.

RESULTS

4.1 Slope analysis based on the concept of *Nagari* formation

The slope analysis was conducted to examine how topographical gradients influence the spatial organization of the traditional settlement of *Nagari* Sijunjung. This analysis directly aligns with the Spatial Data Analysis stage outlined in the Indigenous Knowledge–Spatial Integration Approach, where slope data are processed and overlaid with customary zoning maps. Data were derived from a DEM with a resolution of 30 meters. This spatial dataset was then integrated with qualitative insights obtained from in-depth interviews and participatory observation, ensuring that the functional meaning of each slope class was interpreted through the lens of the philosophy of *Alam Takambang Jadi Guru*. More details can be seen in Table 6 below.

Table 6

Slope classification of the Traditional settlement of *Nagari* Sijunjung area

Class (%)	Area (Ha)	General function
0–2%	0.7	Fertile lowlands, suitable for wet rice cultivation and core settlement
2–8%	117.5	Gentle: traditional settlement areas, social activities, and agriculture
8–15%	38.67	Steep: protected forest, conservation, water sources, and reserve space

Source: Data analysis, 2025.

Based on Table 6 above, approximately 118.2 ha (0–8% slope) form the primary settlement and agricultural core of the *Nagari*. These zones host *Rumah Gadang*, *Balai Adat*, and irrigated rice fields, reflecting their suitability for stable structures and intensive farming. In contrast, steeper slopes (8–15%) covering 38.67 ha are reserved for protected forest or shifting cultivation, ensuring watershed protection and preventing erosion. According to interviews with *Ninik Mamak* and *Tuo Kampuang*, settlements are intentionally located away from steep slopes to avoid landslide risk. These practices align with the philosophy *Alam Takambang Jadi Guru*, which dictates that land use should harmonize with natural conditions and maintain the balance of upstream–midstream–downstream spaces. The designation of land functions also reflects a long-standing social consensus, in which customary leaders regulate land allocation to ensure intergenerational resource security and mitigate environmental degradation. For more details, see the map in Figure 2 below.

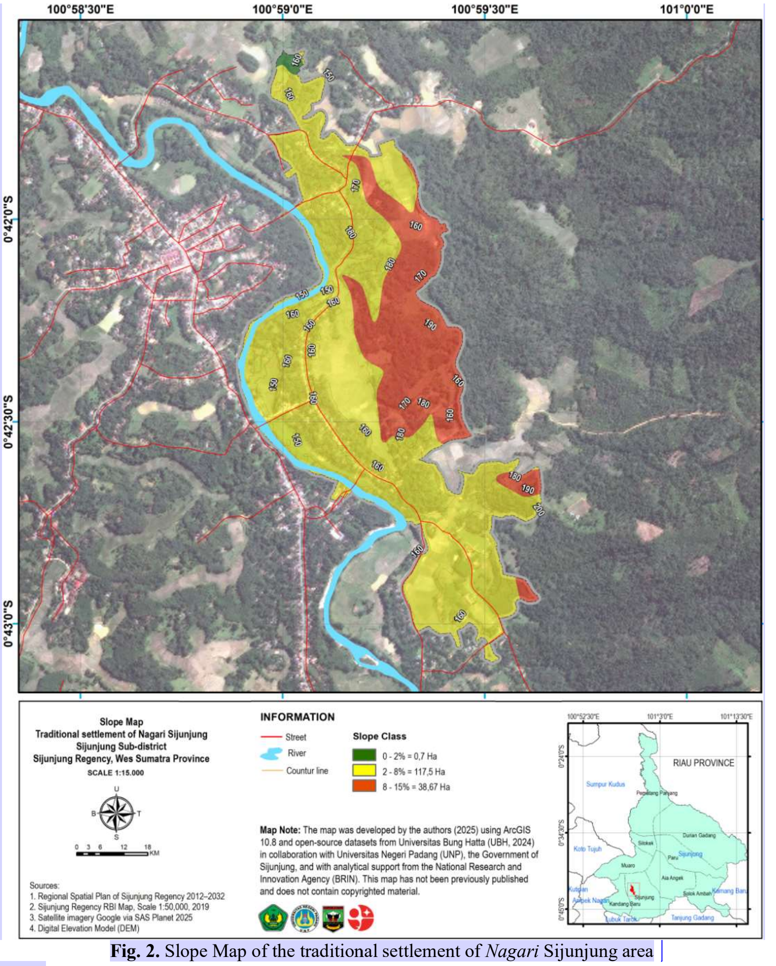

Fig. 2. Slope Map of the traditional settlement of *Nagari* Sijunjung area

[Hr11]

The analysis results indicate that traditional Minangkabau settlement patterns inherently incorporate disaster risk reduction strategies. The integration of scientific mapping with customary wisdom provides a replicable model for risk-sensitive land use planning in other cultural landscapes. Physically, gentle slopes of 0–8% reduce surface runoff velocity and provide more stable ground for buildings and rice fields, while steeper slopes of 8–15% increase gravitational force and erosion risk (Osman, 2018). This explains why settlements are concentrated in flat to gentle terrain, while forest vegetation is maintained on steeper slopes to prevent landslides and protect water sources.**[12]**

4.2 Hazard potential analysis for landslides and floods

The hazard potential analysis for the traditional settlement of *Nagari* Sijunjung area was conducted by integrating physical terrain characteristics with indigenous spatial planning principles. The methodology followed Paimin et al. (2009) for landslide hazard assessment, and Şen (2018); Nguyen (2019) for flood hazard assessment. This approach enabled the comparison between scientific hazard mapping and traditional settlement layouts, supporting the research objective of integrating local wisdom into DRR planning.

4.2.1 Landslide hazard potential

Landslide hazard analysis was performed using a weighted method (Paimin et al., 2009). Each parameter was assigned a score based on its class/category, and the cumulative value determined the hazard level classification. More details can be seen in Table 7 below.

Table 7

Landslide hazard potential and indigenous mitigation strategies

Hazard levels	Spatial zone	Area (Ha)	Total area %	Indigenous mitigation strategy
High (>8% slope; unstable geology)	Eastern and southern steep slope zones	150.8	24.2%	No permanent settlement; preserved as protected forest to maintain slope stability and water sources
Moderate (2–8% slope, transitional land)	Peripheral mid-slopes near mixed gardens	6.36	4.0%	Seasonal cultivation and erosion-control vegetation planting
Low (0–2% slope, stable soils)	Core settlement and paddy fields	-	71.8%	Settlement use and wet rice agriculture supported by traditional drainage systems
Total		157.1	100%**[13]**	

Source: Data analysis, 2025.

The high hazard zones are concentrated in the eastern and southern uplands with steep slopes and weaker geological formations, as identified through GIS-based slope and geology layers. Soil and geological conditions played a significant role in delineating hazard levels. Areas underlain by sedimentary rocks that are easily weathered showed higher susceptibility to mass movement, especially when combined with steep slope gradients (Permana et al., 2020; Triyatno et al., 2020). Similarly, soil types such as alluvial and latosol with relatively loose texture increased surface instability during high rainfall. Conversely, volcanic and igneous formations with stronger structural properties reduced susceptibility, explaining why certain upland zones with similar slopes exhibited different hazard levels (Rahmani et al., 2020). During high rainfall, loose-textured soils such as alluvial and latosol easily absorb water, become saturated, and lose stability, increasing the chance of slope movement (Sjamsiah et al., 2019). Sedimentary rocks that weather quickly also reduce slope strength, while volcanic or igneous rocks remain more stable. Vegetation, especially rubber plantations, plays an important role by binding the soil with deep roots and reducing runoff, which naturally lowers the risk of landslides**[14]**. Indigenous practice avoids these zones for settlement, designating them as protected forest, which acts as a natural landslide barrier. **[15]**The moderate zones are used for mixed agriculture with erosion control measures, while low zones coincide with the core settlement and paddy fields. This alignment confirms that local wisdom inherently incorporates slope stability considerations into spatial planning. For more details, see the map in Figure 3 below.

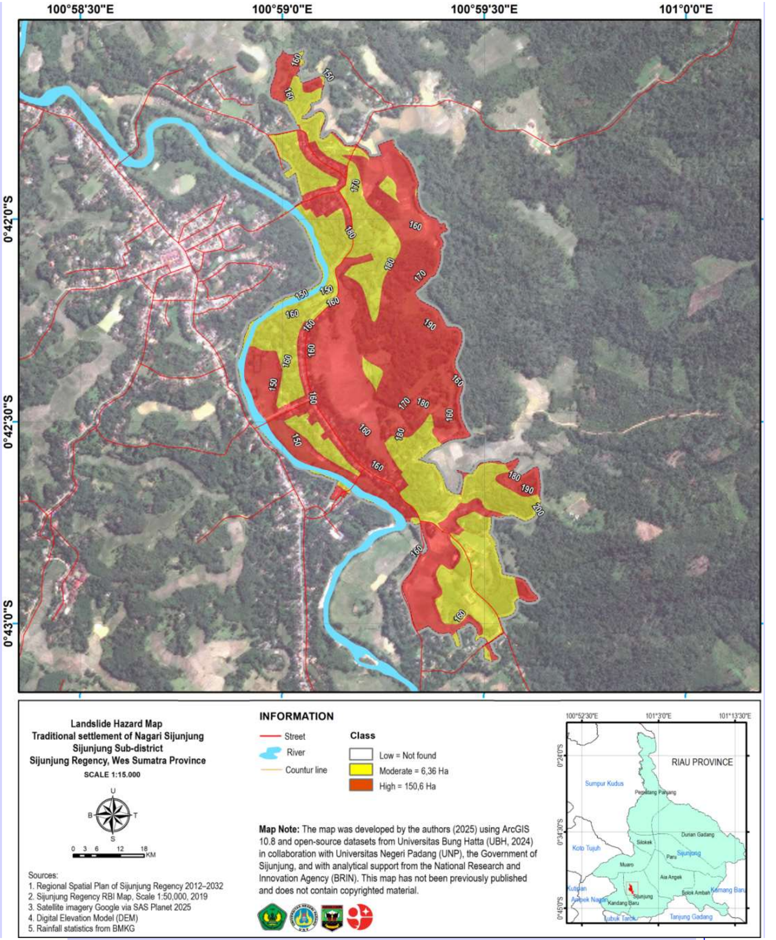

Fig. 3. Landslide hazard map of the traditional settlement of *Nagari* Sijunjung area

[Hr16]

4.2.2 Flood hazard potential

The flood hazard analysis followed the scoring by Şen (2018); Nguyen (2019). Each factor was weighted to generate the flood susceptibility data. More details can be seen in Table 8 below.

Table 8

Flood hazard potential and indigenous mitigation strategies

Hazard levels	Spatial zone	Area (Ha)	Total area %	Indigenous mitigation strategy
Very High (<250 m)	River floodplain in northern and central	117.4	74.8%	Avoid permanent housing; use for seasonal farming; preserve vegetation
High (within hydrological catchment)	Transitional areas between river and settlement	39.5	25.2%	Traditional stilt housing (*Rumah Gadang*), community-managed drainage channels

Hazard levels	Spatial zone	Area (Ha)	Total area %	Indigenous mitigation strategy
Low–Moderate (>250 m)	Elevated settlement areas	-	<0.5%	Maintain upstream water retention areas (*nan di hulu ditahan*)
Total		157.1	100%[17]	

Source: Data analysis, 2025.

In higher elevation zones with andosol or lithosol soils, infiltration capacity was greater, reducing flood accumulation despite heavy rainfall (Hermon et al., 2019; Hermon et al., 2024). Heavy rainfall on alluvial plains with low slope (<2%) causes water to accumulate because of low permeability, leading to prolonged inundation. In contrast, areas with andosol or lithosol soils at higher elevation allow faster infiltration, so flooding is less severe (Sjamsiah et al., 2019). Land use, like rainfed rice fields function as temporary water storage during peak rainfall to reduce the spread of floods toward settlements.**[18]** For more details, see the map in Figure 4 below.

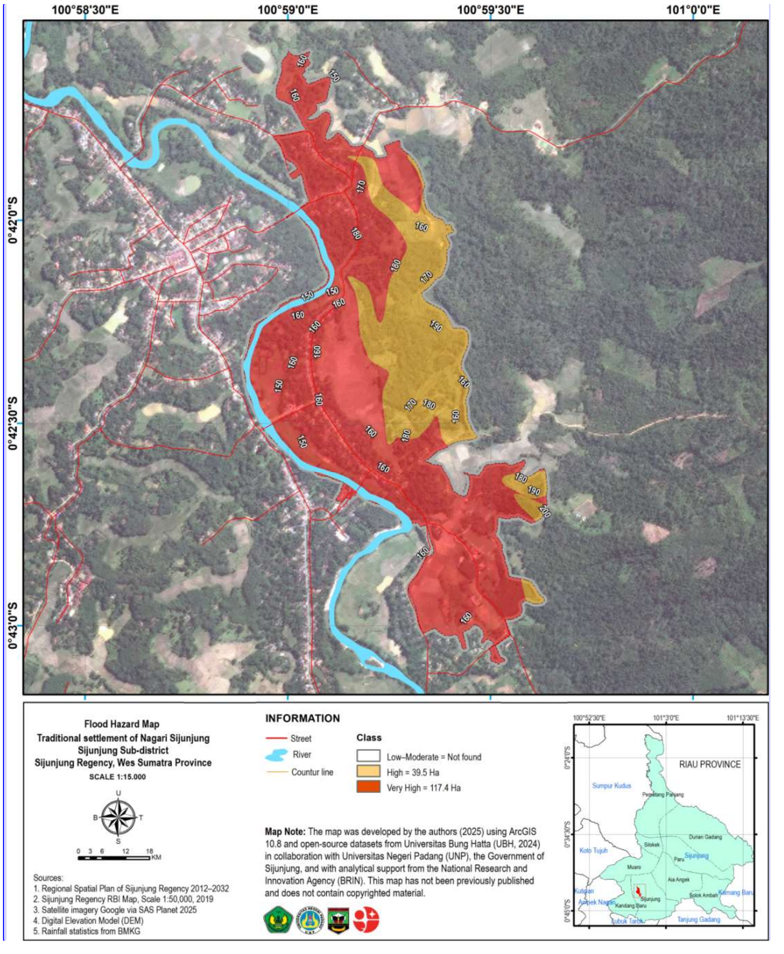

Fig. 4. Flood hazard map of the traditional settlement of *Nagari* Sijunjung area

[Hr19]

Indigenous settlement patterns avoid this floodplain for permanent housing, instead allocating it for rice cultivation and grazing during the dry season. The high-hazard zones are occupied by traditional elevated housing that reduces flood impact. This approach demonstrates a preventive spatial arrangement embedded in cultural norms. Overlaying the landslide and flood hazard maps reveals that 1) High landslide hazard zones are primarily located in elevated forested areas, while very high flood hazard zones are confined to low-lying river floodplains; 2) Indigenous spatial zoning ensures that core settlements are located in low landslide risk and low–moderate flood risk areas; and 3) The combined hazard-avoidance strategy aligns to integrate indigenous knowledge into CB-DRR frameworks. This spatial congruence between traditional planning and hazard mapping confirms that the philosophy of *Alam Takambang Jadi Guru* has practical risk reduction value and should be preserved in formal planning policies.

4.3 Land Use Analysis of the Traditional settlement of *Nagari* Sijunjung based on Slope Map

An overlay analysis between the land use map and the slope classification map of the Sijunjung Traditional Settlement reveals a strong alignment between spatial utilization and the area's physical characteristics. This pattern reflects the Minangkabau philosophy of *Alam Takambang Jadi Guru*, in which each spatial function is adapted to geographical conditions, resource potential, and disaster risks, such as floods and landslides. The indigenous community has long applied ecological adaptation principles in their spatial planning, ensuring that settlements occupy safe zones, seasonal agriculture is concentrated in lowlands, and steep slopes are preserved with vegetation to prevent soil degradation. More details can be seen in Table 9 below.

Table 9

Flood hazard potential and indigenous mitigation strategies

Land Use types	Area (Ha)	Notes
Settlement	13.69	Concentrated in central lowland areas and along riverbanks
Rubber Plantation	75.73	Dominates gentle to moderate slope zones
Rainfed Rice Field	46.30	Located in lowland areas adjacent to rivers
Mixed Garden	14.68	Distributed across the midland zones
Swamp	0.92	Situated near river channels
River	5.29	Primary hydrological feature of the landscape
Dry Field/Cropland	0.20	Minor extent, found in small open flat areas
Shrubland	0.14	Minor extent, functioning as natural vegetative cover

Source: Data analysis, 2025.

Based on Table 5 above, a spatial configuration of land use in Nagari Sijunjung that closely follows slope contours embodies disaster risk reduction principles rooted in local wisdom. This arrangement reflects a long-standing cultural understanding of how topography, hydrology, and soil stability interact to determine the most suitable allocation of land for settlements, agriculture, and conservation. He et al. (2017) found that communities in mountainous regions of China strategically adapt cropping and vegetation patterns to slope gradients to mitigate erosion and maintain soil productivity. Putra et al. (2025) similarly noted that agricultural development on gentle slopes is less vulnerable to erosion when combined with basic soil conservation measures. These findings align with Hermon et al. (2019), who demonstrated that perennial vegetation significantly improves slope stability in tropical regions, where perennial cover functions as a bioengineering measure for slope protection. Overall, the land use pattern shows how each element works physically, like rubber plantations on steep slopes stabilize the soil, rice fields in the floodplain act as retention areas to hold excess water, and *Rumah Gadang* on stilts in transitional zones allow communities to adapt to residual flood risk. **[20]**This strategy is consistent with the Minangkabau proverb *"Nan tanah tinggi dipakai rimbo, bukan untuk alun-alun kampuang"*.

Flood-prone areas are managed through a combination of zoning and ecological buffers. Settlements and croplands are generally located close to river channels but are set back from the immediate riverbank to reduce inundation risk during peak rainfall events. Swamps (0.92 ha) and low-lying open fields serve as natural buffer zones, absorbing excess surface water and attenuating flood peaks. In the lower plains, rainfed rice fields function as seasonal water retention areas, temporarily storing runoff and preventing prolonged flooding of settlement zones. For more details, see the map in Figure 5 below.

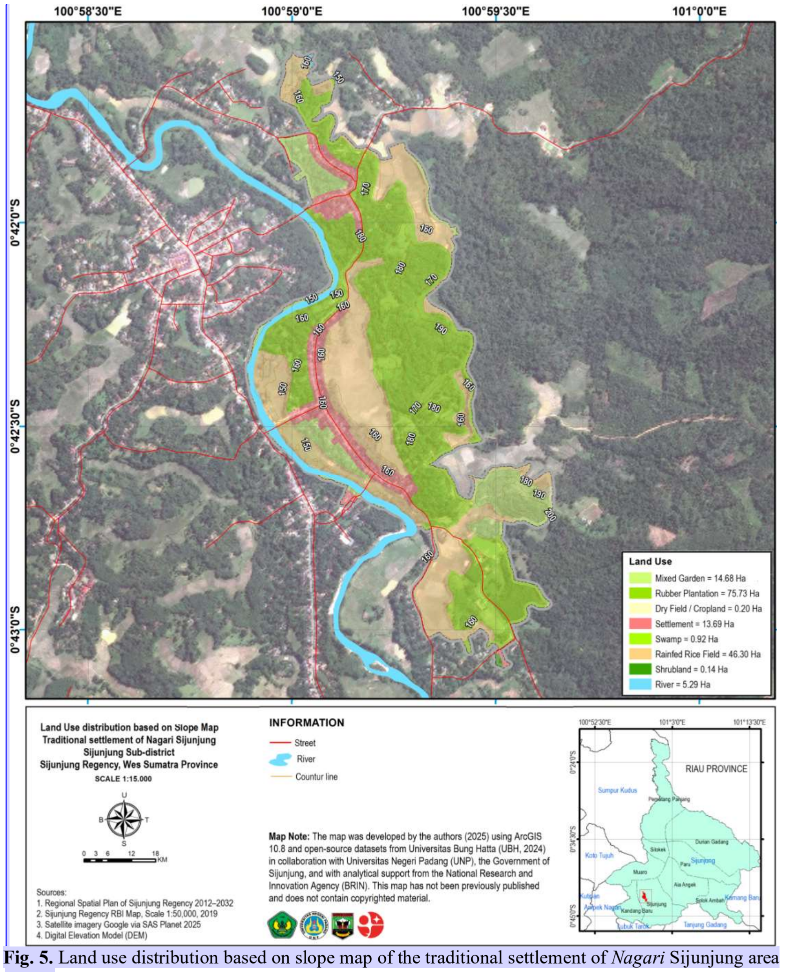

Fig. 5. Land use distribution based on slope map of the traditional settlement of *Nagari* Sijunjung area **[Hr21]**

This approach reflects the Minangkabau principle "Nan di hilia ndak ditabam, nan di hulu ditahan", which emphasizes source-based water management to safeguard downstream settlements. Barlian et al. (2024) demonstrated that hazard-based zoning and agricultural retention areas effectively reduce flood peaks, while Arora (2023) reported that Himalayan indigenous communities similarly align farmland with hydrological flow paths to retain water and protect villages. Overlay analysis between the land use map and slope map confirms that Sijunjung's indigenous spatial planning is closely aligned with natural conditions. This reflects the Minangkabau philosophy of *Alam Takambang Jadi Guru* as a practical framework guiding: 1) Placement of settlements in safe, stable zones; 2) Allocation of steep slopes for vegetative conservation; 3) Use of lowlands for seasonal agriculture and water storage; and 4) Preservation of rivers, swamps, and riparian vegetation as ecological infrastructure. This spatial logic is reinforced by another local saying, *"Bumi dipijak, langik dijunjuang; alam dibaco, Nagari dibangun"*. The resulting land use pattern represents a socio-ecological equilibrium where environmental processes and cultural norms converge to sustain both community resilience and landscape integrity.

4.4 Analysis of slope, land use, disaster potential, and local wisdom

This study analyzes the relationship between slope conditions, land use patterns, disaster potential, and the application of local wisdom in the traditional settlement of *Nagari* Sijunjung. The analysis was conducted by overlaying slope maps, land use maps, and disaster risk maps, then comparing them with indigenous knowledge documented through interviews, participant observation, and the review of traditional manuscripts (*Tambo*). The results of the analysis are presented in Table 10, formulated based on the indigenous knowledge–spatial integration approach, modified from the framework in Table 5 (see method).

Table 9

Results of integrating slope analysis, land use, disaster potential, and local wisdom

Analysis stage	Field findings	Ecological & social functions	Relation to local wisdom
Slope and land use	The 0–8% slope zone is utilized for settlements and agriculture (rainfed rice fields); the 8–15% slope zone is used for rubber plantations and mixed vegetation.	Optimizes fertile land and accessibility, reduces landslide risk in flat zones.	Principle of land use according to stable slope contours.
Vegetation-based landslide mitigation	Rubber plantations covering approximately 75.73 ha are located on steep slopes.	Deep root systems bind the soil, reduce erosion, and slow surface runoff.	Traditional proverb "*Nan tanah tinggi dipakai rimbo, bukan untuk alun-alun kampuang*".
Flood adaptation	Rice fields and wetlands are located in floodplains; settlements are set back to gentle slope zones.	Provides water absorption areas, reduces inundation risk in settlements.	Traditional proverb "*Nan di hilia ndak ditabam, nan di hulu ditahan*"
Philosophical reflection	Spatial function placement refers to the philosophy of *Alam Takambang Jadi Guru*.	Ensures ecological–social balance, maintains resource sustainability.	Placement of settlements, forests, and agricultural areas follows ecosystem logic.
Integration of modern and local data	Overlaying slope, land, and disaster risk maps with customary zoning.	Strengthens socio-ecological resilience and cultural identity.	Risk-based planning model rooted in local cultural values.

Source: Data analysis, 2025.

The synthesis of information shown in Table 6 reveals that the Sijunjung indigenous community has gradually shaped a land-use system that is both environmentally attuned and hazard-aware. Over time, settlement placement, agricultural zoning, and conservation areas have been organized in a manner that directly corresponds to the area's geomorphology. Flat and gently inclined lands are prioritized for housing and crop cultivation, while steeper slopes are purposefully maintained under protective vegetation cover. This approach supports the view of McDonald (1984) that contour-sensitive land allocation not only reduces ecological degradation but also sustains agricultural yield potential. The decision to utilize rubber plantations within high-susceptibility landslide areas demonstrates a deliberate application of natural slope-stabilization methods. Osman (2018) highlights that deep-rooted perennial crops can enhance slope stability and diminish runoff intensity, thereby lowering landslide risks. Similarly, Lele (2009) describes the dual role of perennial vegetation in watershed management, combining economic value with ecosystem services, which mirrors the function of rubber trees in Sijunjung.

In managing flood hazards, the community adopts a zoning pattern that designates floodplain zones for paddy fields and wetlands, while positioning settlements on slightly elevated ground. This method preserves natural flood absorption capacity and reduces structural vulnerability during peak rainfall. Comparable adaptive zoning practices are documented by Gurung (2024) in rural Nepal, where settlement relocation combined with water flow-aligned agriculture significantly mitigated flood losses. Long et al. (2020) further emphasize that integrating natural buffer zones into spatial plans is a critical element of flood-resilient settlement design. The embedding of the philosophy of *Alam Takambang Jadi Guru* into these spatial decisions reflects the deep interdependence between cultural identity and environmental stewardship. Rani et al. (2025) argue that blending traditional ecological knowledge with modern ecosystem-based planning produces context-specific adaptation strategies that are both sustainable and socially legitimate. The case of Sijunjung also resonates with the CB-DRR framework described by King et al. (2016), wherein community wisdom becomes the cornerstone for hazard-informed land-use policy.

4.5 Hazard potential, land use, and local wisdom in the formation of *Nagari*

This study examines the application of the philosophy *Alam Takambang Jadi Guru* in the spatial planning of *Nagari* Sijunjung, with a particular focus on managing landslide and flood risks. The analysis draws upon slope maps, land-use maps, and field observations, which are then compared with the principles of Minangkabau local wisdom. A summary of the findings is presented in Table 11, which is structured based on the indigenous knowledge–spatial integration framework outlined in Table 5, but modified to reflect field-based results.

Table 11

Integration of hazard potential analysis, land use, and local wisdom in *Nagari* Sijunjung

Analysis stage	Field findings	Ecological & social functions	Link to local wisdom
Application of *Alam Takambang Jadi Guru*	Settlements placed on gentle slopes; agriculture follows slope gradient; forest preserved in hazard-prone areas.	Maintains ecosystem balance, minimizes disaster risks.	Proverb "*Alam Takambang Jadi Guru*" as spatial guideline.
Landslide Analysis – Steep Slopes (8–15%)	Dominated by rubber plantations; some areas near settlements; risk increases if vegetation cover is removed.	Rubber roots stabilize soil; vegetation loss heightens landslide susceptibility.	Proverb"Nan tanah tinggi dipakai rimbo".
Flood Analysis – Flat/Gentle Slopes (0–8%)	Main settlements near rivers; high flood risk due to sedimentation and reduced infiltration zones.	Natural floodplains absorb runoff; natural drainage must be maintained.	Proverb "Nan di hilia ndak ditabam, nan di hulu ditahan".
Spatial Suitability	Mostly consistent with customary principles; some modern interventions, such as roads and housing, encroach into hazard zones.	Reduces effectiveness of natural protection if expansion is uncontrolled.	Partial alignment with *Alam Takambang Jadi Guru*.

Analysis stage	Field findings	Ecological & social functions	Link to local wisdom
Spatial Planning Recommendations	Riparian conservation, steep-slope rehabilitation, conservative farming, restriction of expansion into hazard zones.	Enhances disaster resilience and environmental sustainability.	Restores land-use patterns to customary philosophy.

Source: Data analysis, 2025.

The synthesis of information shown in Table 6 reveals that, despite the accelerating influence of contemporary development, the guiding principles of *Alam Takambang Jadi Guru* still underpin how land is allocated in *Nagari* Sijunjung. Land-use zoning in the area demonstrates a deliberate relationship between terrain characteristics and functional land designation. Steeper slopes are retained under vegetation with protective value, while flatter land is prioritized for settlements and crop production, an arrangement consistent with the ecosystem-based disaster risk reduction model described by Estrella & Saalismaa (2012), where spatial choices are made to reduce hazard exposure while maintaining livelihoods.

The use of rubber plantations on slopes classified as highly susceptible to landslides reflects a proactive bioengineering approach to slope stabilization. As noted by Asbjornsen et al. (2014), deep-rooted perennial crops play a vital role in reinforcing soil structure and mitigating erosion in tropical environments. However, where vegetation buffers are reduced or cleared, the stability benefits diminish, increasing vulnerability. In low-lying floodplain areas, settlement placement and agricultural zoning aim to preserve hydrological function. Paddy fields and wetland zones serve as natural retention areas, slowing and absorbing runoff before it reaches settlement areas. This mirrors the floodplain conservation strategies discussed by Hartanto & Rachmawati (2017), who argue that maintaining undeveloped flood storage capacity is critical for both disaster prevention and ecological health. While the prevailing land-use pattern generally aligns with Minangkabau spatial ethics, the encroachment of infrastructure and plantation activities into high-risk zones signals the need for targeted policy control. King et al. (2016) emphasize that such interventions are crucial for ensuring that community-based hazard knowledge is effectively translated into enforceable land-use regulation. The proposed measures, namely riparian zone preservation, reforestation of steep slopes, and adoption of soil-conserving agricultural practices, offer dual benefits of ecological sustainability and cultural continuity. Geetha et al. (2025) underscore that combining indigenous environmental knowledge with appropriate modern tools enhances adaptive capacity, creating spatial systems that are both risk-informed and locally grounded.

6. CONCLUSIONS

The spatial organization of *Nagari* Sijunjung reflects a deep integration of geomorphological realities, ecological functions, and Minangkabau local wisdom, particularly the philosophy of *Alam Takambang Jadi Guru*. Slope analysis shows that flat and gently sloping areas (0–8%) are primarily used for settlements, social infrastructure, and intensive agriculture, while steeper slopes (8–15%) are preserved under vegetation, mainly rubber plantations and customary protected forest. This configuration minimizes landslide risks, optimizes fertile land use, and safeguards upstream water resources. Hazard mapping confirms that indigenous land allocation inherently avoids high-risk zones. Landslide-prone areas with unstable geology are excluded from permanent settlements, serving instead as ecological buffers. Rubber plantations on these slopes function as natural bioengineering systems, stabilizing soil and reducing runoff. In flood management, river floodplains are reserved for seasonal agriculture and grazing, while settlements are strategically placed on slightly elevated terrain. These arrangements preserve natural flood absorption capacity, reduce structural vulnerability, and maintain hydrological balance. Overlaying slope, land use, and hazard maps demonstrates a high degree of spatial congruence between indigenous zoning and scientific disaster risk assessments. Such alignment indicates that traditional planning is not only culturally rooted but also hazard-aware, offering a practical framework for CB-DRR. Despite this resilience, modern development pressures such as road construction and plantation expansion into hazard-prone zones pose emerging threats to ecological stability and cultural integrity. Targeted interventions, including riparian conservation, steep-slope rehabilitation, and soil-conserving agricultural practices, are essential to maintain both environmental sustainability and socio-cultural identity. The *Nagari* Sijunjung case illustrates how integrating indigenous knowledge with modern spatial analysis can produce adaptive, risk-sensitive land use models. Preserving and formalizing these practices within planning policy can strengthen resilience, protect ecosystems, and ensure that cultural values remain central to sustainable landscape management.

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"Model of the Traditional Village of Nagari Sijunjung: "Study of Disaster Typology and Mitigation Based on Local Wisdom"

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5

1. Background

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Indonesia is one of the countries with a high level of vulnerability to natural disasters, such as earthquakes, volcanic eruptions, floods, and landslides. According to BNPB (2022) data, the frequency of disasters in Indonesia continues to increase, particularly in areas experiencing land-use changes that are inconsistent with the physical characteristics of the area. In this context, technology-based mitigation approaches often require significant resources and may not be appropriate for local conditions.

Conversely, many indigenous communities in Indonesia have long developed local knowledge systems as a means of adapting to environmental risks. One form of this local knowledge is the customary spatial planning system, which not only functions to regulate the structure of settlements, agricultural land, and conservation areas, but also plays a crucial role in naturally and sustainably reducing disaster risk. This system is formed through the accumulation of experience, observation of nature, and a philosophy of life passed down through generations (Wiersum, 2004; Hiwasaki et al., 2014; Haryani, 2020).

The Sijunjung Traditional Village in West Sumatra reflects traditional Minangkabau spatial planning, rich in social and ecological values. The sustainability of this traditional village is determined not only by sociocultural aspects but also by the region's preparedness to face geospatial risks such as floods and landslides. Therefore, slope analysis (a physical aspect) is crucial for understanding potential risks and determining safe and sustainable spatial utilization zones.

In Minangkabau society, the principle*"Nature is a teacher"*serves as the foundation for village spatial planning. This principle teaches communities to read natural signs when selecting residential locations, cultivating crops, and determining protected areas. Studies by Iskandar (2010) and Haryani (2020) show that traditional Minangkabau settlements are generally built on ridges or highlands to avoid flooding, with houses oriented according to wind direction and water flow. The construction of stilt houses also serves as an adaptation to flooding and earthquakes.

Hiwasaki et al. (2014), Haryani (2020) stated that the customary spatial planning system can function as*early warning system* and disaster mitigation strategies that are resource-efficient because they do not require high technology. This system is part of the approach*Community Based Disaster Risk Reduction* (CBDRR) relies on local capacity to identify, assess, and respond to disaster risks. In this context, customary spatial planning is a crucial tool in strengthening communities' socio-ecological resilience to environmental disturbances.

However, along with social change, development pressures, and weak recognition of indigenous peoples' rights, traditional spatial planning structures have shifted. Modernization processes often ignore local principles and replace them with technocratic approaches that may not be appropriate.

with local cultural and environmental contexts (Saptomo, 2010; Sutanta et al., 2013). This research is crucial for exploring and assessing how customary spatial planning systems, such as those found in the Nagari Sijunjung Traditional Village, are maintained and utilized as a form of adaptation to disaster risks. It also aims to explore the relevance of these systems in the context of modern risk-based spatial planning and disaster impact reduction.

2. Research methods

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This research uses a qualitative and quantitative descriptive approach with integration between spatial analysis and local wisdom approaches (*indigenous knowledge).* The aim is to understand how the structure and pattern of Minangkabau traditional spatial planning in the Nagari Sijunjung Traditional Village reflects a disaster mitigation strategy based on local wisdom and the biophysical conditions of the region.

1. Spatial Approach

A spatial approach is used to map, analyze, and evaluate the relationship between customary spatial structures and physical environmental characteristics such as topography, slope, and potential disaster risk. The stages in this approach include:

a. Spatial data collection: Satellite imagery (Landsat/Sentinel), Elevation data (DEM/SRTM), Slope, geology, and land cover maps, Administrative map of Sijunjung Traditional Village.
b. Spatial data processing using QGIS software:
    - Slope analysis to assess land suitability for flood and landslide risks.
    - Overlay between the land use map of traditional villages and disaster prone zones.
    - Buffering against important natural features such as rivers, cliffs, and natural evacuation routes.
c. Spatial analysis:
    - Suitability room based on principle mitigation disaster (e.g., settlements on hill ridges).
    - Correlation between the distribution of traditional houses in traditional villages with the contour and direction of water flow.
    - Landslide Disaster Risk Assessment Parameters

No	Parameter	Class/Category	Mark	Weight
1	Soil Type	Aluvial, Latosol, Grumosol	1	1
		Mediterranean, Podsolik, Glei Humus	2	1
		Regosol, Andosol	3	1
2	Land Use	Lakes, Rivers, Ponds, Fish Ponds	0	2
		Check the Bushes	2	
		Rice fields, fields, plantations, Mixed Garden	4	
		Settlements, Mines, Fields	5	
		Swimming pool	3	
3	Rainfall	2001–2500 mm (Low)	3	3
		2501–3000 mm (Medium)	4	
		3001–3500 mm (Height)	5	
		>3500 mm (Very High)	5	
4	Slope	0–2%	1	4
		2–15%	2	
		15–25%	3	

		25–40%	4	
		>40%	5	
5	Geology	Sedimentary rocks (easily weathered: clay, conglomerate, shale)	3	3
		Volcanic rocks (medium strong: tuff, breccia, lava)	2	
		Igneous/metamorphic rocks (strong: granite, basalt, marble)	1	

Source: BNPB (2019), Paimin et al. (2017)

Landslide Susceptibility Classification

Class Vulnerability	Interval Shoes Landslide	Information
Low	1.5 – 2.3	Not too prone, but still necessary supervision during the rainy season
Currently	>2.3 – 3.1	Potential for landslides if rainfall is heavy high or there is slope interference
High	>3.1 – 3.7	Very prone to landslides, mitigation measures are needed and special handling

- Flood Disaster Risk Assessment Parameters

No	Parameter	Class/Category	Score	Weight
1	Land Use	Lakes, ponds, rivers, mines, Open Land, Settlements, Swamps	5	2
		Swimming Pool, Irrigated Rice Fields, Rice Fields Wetlands, Shrubs/Brushes	4	
		Plantation Forest, Dryland Forest Primers/Seconds	3	
		Mixed Gardens, Rubber Gardens, Coconut Palm oil	2	
		River Basin	1	
2	Rainfall	>3500 mm (Very High)	5	3
		3001–3500 mm (Height)	4	
		2501–3000 mm (Medium)	3	
		2001–2500 mm (Low)	2	
		<2000 mm (Very Low)	1	
3	Height	0–25 meters above sea level	5	2
		26–50 meters above sea level	4	
		51–100 meters above sea level	3	
		101–250 meters above sea level	2	
		>250 meters above sea level	1	
4	Slope	0–2%	5	1
		2–15%	4	
		15–25%	3	
		25–40%	2	
		>40%	1	
5	Soil Type	Aluvial, Latosol, Grumosol	5	2
		Regosol, Andosol	3	
		Mediterranean, Podsolik, Glei Humus	2	
		Lithosol	1	

Source: Mustofa (2016), Wulan & Hidayati (2018)

Flood Vulnerability Classification

Vulnerability Class	Flood Score Interval	Information
Very Low	2.4 – 3.0	Not significant
Low	>3.0 – 3.6	Potential for light flooding
Currently	>3.6 – 4.2	Moderate risk during heavy rain
High	>4.2 – 4.8	Very vulnerable, needs mitigation

2. Local Wisdom Approach

This approach aims to explore and understand local knowledge which forms the basis for decision-making in the spatial planning of traditional villages, through the following methods:

a. In-depth interviews with Ninik mamak (traditional leaders), Tuo kampuang (village elders), residents of the traditional house and local community.
b. Participatory observation; directly observing the orientation patterns of traditional buildings, the selection of locations for houses, barns, and communal facilities, and spatial planning systems based on traditional functions (houses, rice fields, forbidden forests).
c. Documentation studies, through traditional books, tambo, or local narratives related to village history, traditional maps or sketches of traditional spaces, narrative analysis, to interpret the ecological, spiritual, and social values inherent in Minangkabau traditional spatial planning (philosophy)*"Nature is a teacher"*and a ban on clearing land in vulnerable areas).

3. Integration Analysis

Spatial approaches and local wisdom are analyzed in a complementary manner through:

a. Data triangulation, by comparing the results of spatial analysis with the results of interviews and observations.
b. Identification of traditional spatial function zones that have proven effective in disaster mitigation based on scientific studies and local understanding.
c. Narrative-spatial mapping that describes how customary values are reflected in the spatial configuration of the village (e.g., prohibitions on building at the foot of steep hills or near large rivers).

Expected results

a. The spatial planning model of the traditional village of Nagari Sijunjung which functions as a natural disaster mitigation system.
b. An integrative model between local knowledge systems and spatial data in risk-based traditional village spatial planning.
c. Recommendations for policies on preserving customary spatial planning as part of a disaster risk reduction (DRR) strategy.

3. Literature Review

a. Risk-Based Spatial Planning and Local Cultural Values

Risk-based spatial planning (*risk-based spatial*) is an approach that prioritizes the identification, mapping, and mitigation of natural disaster risks in spatial planning and management processes. This approach aims to reduce the vulnerability of regions and communities to disaster threats by considering physical spatial characteristics such as slope, land cover, soil type, and the socio-cultural aspects inherent in an area (BNPB, 2021).

A risk-based approach is crucial to prevent the use of space that endangers the safety of communities in traditional villages, such as traditional traditional houses and barns, which hold significant cultural value. Spatial analysis using GIS (Geographic Information Systems) tools enables mapping of risk zones and supports safer and more sustainable spatial planning decisions.

One of the main elements in this approach is the integration of spatial data that includes: a) slope, which determines the potential for hazards such as landslides or flash floods, b) land cover, which affects the rate of surface flow (runoff), erosion, and environmental resilience to disasters. The results of the spatial analysis are in the form of potential disaster zones, which are developed through spatial analysis using geographic information systems (GIS) and risk modeling. One method commonly used in risk-based spatial planning is the integration of Geographic Information Systems (GIS) to overlay regional physical data with regional vulnerability and capacity data. Through this approach, accurate disaster-prone area zoning can be formulated and can be used as a basis for spatial planning decisions (Mileti, 1999).

Recent research developments show that the effectiveness of spatial planning (especially traditional villages) is not only determined by the accuracy of spatial data and technical analysis, but also by the extent to which the spatial planning accommodates local values that have long been practiced by the community, including traditional spatial planning and customary settlement patterns.

According to Saptomo (2010), spatial planning that ignores local social and cultural dimensions often fails in implementation. In various regions of Indonesia, indigenous communities have developed spatial planning systems based on local wisdom and ecological principles. These systems, while not always formally documented, have proven adaptive to long-term environmental risks.

Spatial planning will be more effective if it is adapted to traditional settlement patterns and spatial planning systems based on local culture. In the Indonesian context, indigenous communities have spatial systems that have been passed down through generations and have proven adaptive to environmental risks (Saptomo, 2010). This local wisdom encompasses not only knowledge of the place itself, but also the environment.

safe and unsafe to live in, but also includes how to build, choose building materials, and form communities that look after each other.

Philosophy public Minangkabau, that is the principle of "nature takambang "Become a teacher" implies that nature is a source of knowledge that must be used as a basis for building settlements and managing space. This is reflected in the placement pattern of traditional houses, which avoid steep slopes, are close to water sources, but still maintain a distance from potential floods and landslides. The Minangkabau people apply the principle of "alam takambang jadi guru" as a philosophy of life that makes nature a source of knowledge. This philosophy reflects the close relationship between society and its environment, including in the careful selection of settlement locations based on topography, resource availability, and disaster risk considerations.

The principle of "nature as a teacher" is the basis for spatial planning that harmonizes with natural conditions. This philosophy encourages communities to consider environmental elements when constructing settlements: site selection, house orientation, distance from rivers or slopes, and the relationship between social function and the spatial location of traditional houses, prayer rooms, rice fields, and forests.

Saptomo (2010) emphasized that traditional spatial planning systems, such as those found in the Sijunjung Traditional Village, are not the result of chance, but rather the result of long-term adaptation to environmental threats. These patterns are often more efficient in reducing disaster risk than modern spatial planning systems that ignore local context.

The concept of cultural landscape, as developed by UNESCO (2003), emphasizes the importance of the reciprocal relationship between humans and nature. Within this framework, space is viewed not only as a physical object but also as a social and cultural entity with symbolic and historical value. Therefore, risk-based planning needs to consider the preservation of cultural landscapes as part of a comprehensive community protection system.

The theory related to risk-based spatial planning and local cultural values is as follows.

1. Resilience Thinking (Walker & Salt, 2006)

   This approach emphasizes the importance of building socio-ecological resilience through adaptation to change and risk. Integrating local values into spatial planning is part of the effort to build community-based resilience.

   Walker and Salt's (2006) concept of socio-ecological resilience provides a framework for understanding how indigenous communities like those in Sijunjung build systems that can absorb disturbances while maintaining their primary functions. Traditional houses are constructed with earthquake-resistant architecture (flexible joinery), residential areas are defined by natural elements such as streams and forest slopes, and land management is carried out collectively based on the sako-pusako (heritage system).

2. Theory of Place Attachment (Altman & Low, 1992)

   Explaining that space holds emotional meaning and cultural identity for its inhabitants. Therefore, spatial planning that considers the community's attachment to traditional spaces will be more easily accepted and implemented. Community attachment to space plays a crucial role in the success of planning and policy implementation. Spatial planning that ignores local values often faces resistance because it conflicts with the community's collective identity.

In the context of Sijunjung, the community's attachment to the traditional house (rumah gadang), traditional hall, and tapian (traditional bathing place) is not only a social symbol, but also an instrument for risk management. For example, rumah gadang is traditionally not built on steep slopes or flood plains, demonstrating a form of local wisdom in risk avoidance passed down through generations.

This reinforces the notion that spatial planning cannot be separated from its cultural context. Risk-based planning that fails to accommodate local place attachments and values has the potential to fail socially because it is perceived as disrupting established systems.

3. Cultural Landscape Theory (UNESCO, 2003)

Stating that cultural landscapes are living heritages that reflect the interaction between humans and nature. Risk-based spatial planning requires respecting and preserving cultural landscapes as part of a proven mitigation system. Traditional spatial planning is the result of historical interactions between humans and nature, resulting in living spaces that are not only functional but also rich in symbolic meaning. The Sijunjung Traditional Village can be categorized as a living cultural landscape because it still serves ecological and social functions to this day.

Integration of local cultural values into risk planning impacts a) zoning designs that take into account historical sites and traditional areas, b) disaster mitigation models based on local knowledge (*local knowledge*) and c) higher community participation due to the alignment between technical and cultural planning.

- Area zoning can be adjusted to the boundaries of customary areas and traditional land use systems.
- Community-based disaster mitigation is easier to implement because it draws on historically proven local knowledge.
- Preserving cultural landscapes is part of a long-term adaptation strategy to environmental risks.

Based on the theories above, the conceptual framework used in this study is that the structure and spatial patterns of traditional villages not only reflect local social and cultural systems but also represent a form of ecological adaptation to natural hazards. Therefore, analysis of house typology, residential zoning, and spatial relationships between functions within the village must be interpreted through the lens of cultural resilience and spatial adaptation to risks.

Thus, the integration of a spatial-rational approach (disaster data, slope, land cover) with a cultural-participatory approach (customary values, local practices, and social order) is very important for understanding and formulating a sustainable spatial management model.

b. Local wisdom in choosing village locations

Many indigenous communities in Indonesia, including the Minangkabau people, have traditionally demonstrated local wisdom in selecting village locations that take into account geomorphological conditions and the risk of natural disasters. One prominent adaptive strategy is selecting village locations on highlands or hill ridges that are relatively safe from the dangers of flooding, waterlogging, and landslides. This position allows for natural control of rainwater flow while also providing protection against land and settlement damage due to erosion or surface water runoff (Iskandar, 2010; Syarif et al., 2016).

Indigenous communities typically choose their village (nagari) sites not haphazardly, but through ecological, spiritual, and social considerations. Minangkabau traditional villages are generally built on stable, elevated ground, such as hill ridges or slopes with slight to moderate gradients. This is evident in the traditional village of Nagari Sijunjung, where the placement of traditional houses (rumah gadang) follows the topographic contours, avoiding steep valleys, and maintaining a safe distance from main rivers and tributaries (Yulizal Yunus, 2002; Fitriani et al., 2018).

The stilt houses, a hallmark of Minangkabau architecture, also serve as a form of disaster mitigation, such as flooding and surface water flow. Stilt houses, supported by wooden pillars, minimize the risk of flood damage and allow air circulation and water flow beneath the house (Nasrul, 2011). Furthermore, the orientation of traditional buildings often follows cosmological principles and the direction of water flow. Rumah gadang typically faces the street or town square (square), while the rear faces a water source or agricultural land, demonstrating the integration of ecological and social functions (Alfisyah et al., 2021).

Spatial zoning in traditional village areas also shows a clear division between residential areas, agricultural land, and protected areas or prohibited forests (*forbidden forest*or *forbidden jungle*These forest areas are typically located upstream or on steep slopes that are not cleared for cultivation, serving as water catchment areas and ecosystem buffers. This spatial planning model reflects local wisdom that considers water flow direction, wind patterns, land slope, and soil and water conservation (Zulfi et al., 2015; Salim & Yonariza, 2017).

c. The traditional village spatial planning system as an early warning system and disaster mitigation strategy based on local wisdom.

The spatial planning system of traditional villages is the result of accumulated experience, traditional ecological knowledge, and long-term adaptation of local communities to their environmental conditions. In the context of Minangkabau Traditional Villages, including Nagari Sijunjung, the division of space, which includes the traditional house (rumah gadang), courtyard (yard or courtyard), agricultural land (rice fields and fields), and forest and river areas, is not only based on functional needs, but also contains implicit disaster risk mitigation principles.

The selection of residential locations that tend to be on sloping land and far from areas prone to landslides or flooding reflects a form of*early warning system* based on the environment and inherited experiences. Indigenous communities recognize natural signs (such as changes in animal behavior, changes in water color, or shifts in vegetation) as indicators of potential danger, so their spatial planning naturally avoids high-risk locations (Hiwasaki et al., 2014; Mercer et al., 2009).

Unlike modern systems that rely on high-tech devices and electronic sensor systems, traditional spatial planning systems are more resource-efficient because they don't require complex infrastructure. Their reliability lies in the harmony between humans and their environment through local wisdom passed down through generations. This makes them sustainable and easily implemented by the wider community.

Local wisdom such as philosophy*"Nature is a teacher"*Minangkabau culture emphasizes learning from nature as the basis for spatial decision-making. This principle encourages communities to read natural signs as a guide in building homes, clearing land, and protecting forest areas as a natural buffer against disasters such as flash floods or droughts (Nasrullah, 2020; Haryani et al., 2018).

Research by Hiwasaki et al. (2014) shows that integrating local knowledge into disaster risk reduction systems significantly contributes to community resilience, particularly in developing countries. This strategy not only strengthens risk awareness but also builds autonomous and contextualized local capacity.

It can be concluded that the spatial planning system of traditional villages not only has social and cultural functions, but also plays an important role in regional resilience. It functions as*non-electronic early warning system*and ecosystem-based disaster mitigation strategies that are efficient, inclusive, and rooted in local wisdom.

d. Disaster Mitigation, Spatial Planning, Local Wisdom, and Spatial Adaptation

Disaster mitigation requires not only a technocratic, high-tech approach but also recognizes the importance of a spatially and culturally based approach. In many traditional villages, traditional village spatial planning systems have long integrated disaster risk mitigation principles through the creation of spatial patterns responsive to local biophysical conditions. Placing traditional houses on flat land away from steep slopes, separating cultivated areas from protected forest or river zones, and establishing open spaces in the center of the village are forms of structural mitigation born from a deep understanding of the characteristics of the surrounding natural environment.

This approach is in line with the concept*land-based disaster risk reduction* which emphasizes the importance of using spatial planning as a primary tool for reducing disaster risk (UNDRR, 2015). The customary spatial planning system, in this case, functions as a form of ecosystem-based mitigation, which utilizes natural environmental conditions as a risk buffer. Customary forest areas are maintained as*forbidden jungle*, for example, ecologically functions as a landslide barrier and rainwater absorber, thereby reducing the risk of seasonal flooding and drought (Haryani et al., 2018).

This approach also contains dimensions*local wisdom* which is the basis for forming sustainable spatial adaptation. The principle*nature takambang becomes a teacher*In Minangkabau culture, knowledge serves as an ethical and epistemological framework for communities to interpret natural signs and adaptively manage their living spaces. This knowledge encompasses understanding land morphology, wind direction, water sources, and vegetation dynamics, all of which inform spatial decision-making. In other words, these local practices have formed a mitigation system that is holistic, contextual, and historically proven (Hiwasaki et al., 2014; Mercer et al., 2009).

In the context of modern regional planning, it is crucial to accommodate these local wisdom-based mitigation strategies through an integrative approach. This can be achieved by combining spatial data generated by technologies such as GIS/GIS (Geographic Information Systems) and satellite imagery with local knowledge to identify disaster-prone zones, redesign spatial zoning, and develop community-based contingency plans. This integration will strengthening regional resilience while ensuring that mitigation strategies do not neglect local values that have proven effective.

Thus, disaster mitigation based on customary spatial planning in Nagari Sijunjung demonstrates that regional planning based on spatial adaptation and local wisdom is not only relevant but also crucial for building sustainable community resilience. Moving forward, recognition of local knowledge must be incorporated into formal policies for regional planning and disaster risk reduction.

4. Results and Discussion

6 The area of the Nagari Sijunjung Traditional Village Cultural Heritage Area by the West Sumatra Cultural Heritage Preservation Center (BPCB) is 157.1 hectares in which there are 77 traditional houses inhabited by 9 main tribes namely, Chaniago, Piliang, Malayu, Tobo, Bodi, Panai, Patopang, Bendang, and Malayu Tak Timbago. In addition, there are also Batu Tabonek and the Traditional Vow Place which are also
7 designated as cultural heritage areas. The determination of an area as a cultural heritage area is accompanied by the process of protection, development and
7 utilization. The area is in accordance with the Cultural Heritage Law no. 11 of 2010.
8 According to the Law of the Republic of Indonesia Number 11 of 2010, protection is
2 defined as efforts to prevent and overcome damage, destruction, or destruction by means of Rescue, Security, Zoning, Maintenance, and Restoration of Cultural Heritage.

1. Slope Analysis with the Concept of Nagari Formation

From the analysis of the slope map of the Sijunjung Traditional Village area, it can be classified into three slope classes based on the percentage of slope, namely it can be classified into 3 slope groups.

a. 0–2% (green/flat) covering an area of 0.7 Ha

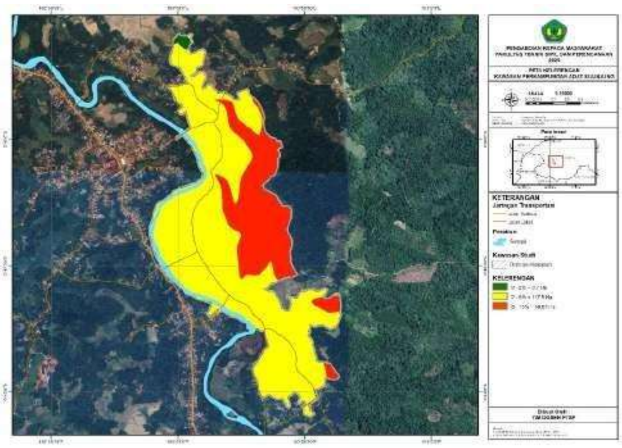
b. 2–8% (yellow/sloping) covering an area of 117.5 Ha

c. 8–15% (red/fairly steep/hilly) with an area of 38,67 Ha

From the classification of the slope map, it is linked to the concept of nagari formation. It is necessary to link the typology of traditional villages with physical geographical conditions, especially slopes, because this influences the choice of location, spatial planning, and socio-cultural functions of a nagari in Minangkabau.

The concept of forming a nagari as a Minangkabau traditional settlement unit has the following considerations/requirements.

a. Proximity to natural resources such as the availability of clean water, fertile land for agriculture or the availability of forest products.
b. Accessibility and connectivity (especially by roads and rivers).
c. Supportive topography: flat or sloping areas are preferred because they are safe from disasters such as landslides and make it easier to build traditional houses and communal facilities.
d. Cosmological and customary considerations; site selection is also based on local beliefs, relationships with ancestors, and spatial symbolism.



From the analysis of the slope map of the Sijunjung Traditional Village area in relation to the concept of Nagari formation, the following analysis can be carried out.

1. Flat-sloping zone (0–8%, green and yellow)

   The flat-sloping zone, approximately 118.2 hectares in size, is the most ideal area for establishing traditional settlements. Rumah Gadang (Gadang House) and Balai Adat (Custom Hall) are generally built here due to easy access and development. Rice paddy fields are also abundant in this area. In accordance with the principles of Nagari formation, the main settlements are built on flat to gently sloping land to ensure security, social function, and cosmological significance.
2. Hilly zone (8–15%, red)

   The hilly zone, approximately 38.67 hectares in size, is a more rugged area, typically located outside of settlement centers. It is more suitable for secondary uses such as restricted forests, shifting cultivation, or conservation areas. In customary contexts, this zone can store natural resources or form part of the natural boundaries of the village. While this location is not prioritized for primary settlement, it remains important within the overall spatial structure of the village.
3. Linkages to rivers and road networks

   The river flows in the western part of the area, surrounded by flat to gently sloping areas. Local and collector roads are concentrated in the gently sloping areas, reinforcing the location of settlements and socio-economic activities. The river serves not only as a water source but also as a cosmological and symbolic reinforcement of natural boundaries within the nagari structure.

Based on the slope classification and the concept of nagari formation, the majority of the Sijunjung Traditional Village area is located in a gentle zone (2–8%), supporting the formation of a settlement center. The steep/precipitous zone (8–15%) functions as a buffer or protective zone, not the main settlement area. The spatial layout of the Sijunjung Traditional Village demonstrates consistency with cosmological principles and is adaptive to physical geographical conditions and is in line with the theory of nagari formation in Minangkabau.

From the analysis of the slope map of the Sijunjung Traditional Village area by linking the concept of the formation of Minangkabau nagari as a whole, especially according to the principle of alam takambang jadiguru which is a Minangkabau philosophy meaning that humans must learn and organize life by imitating and adapting to the natural order. In the context of nagari formation, this means that the Minangkabau people choose locations and organize space based on natural suitability, not forcing their will on nature. This philosophy is reflected in the following principles.

- Utilize land according to its slope (do not build on steep areas).
- Maintaining a balance between the upstream-middle-downstream space.
- Combining natural elements such as rivers, plains, and forests as one living entity.
- Placing settlements, agricultural land and forests hierarchically and functionally.

From the analysis of the slope map of the Sijunjung Traditional Village area by linking the concept of the formation of nagari in Minangkabau, especially according to the principle of nature takambang jadi guru.

1. Philosophical Context: Nature Becomes a Teacher

The Minangkabau philosophy, "alam takambang jadi guru," means that humans must learn and organize their lives by imitating and adapting to the natural order. In the context of nagari formation, this means that Minangkabau people choose locations and organize spaces based on natural suitability, rather than imposing their will on nature. This philosophy is reflected in the following principles:

- Utilize land according to its slope (do not build on steep areas).
- Maintaining a balance between the upstream-middle-downstream space.
- Combining natural elements such as rivers, plains, and forests as one living entity.
- Placing settlements, agricultural land and forests hierarchically and functionally.

2. Spatial Interpretation of Slope Maps

Based on the map, the Sijunjung traditional village area is divided into three slope classes.

Slope Class	Color	Area (Ha)	General Function (based on customs & philosophy) Minangkabau)
0–2%	Green	0.7 Ha	Fertile plains, ideal for wet rice fields and core settlements
2–8%	Yellow	117.5 Ha	Sloping zone: traditional settlements, social activities, and agriculture
8–15%	Red	38.67 Ha	Steep slopes: protected forests, conservation, water resources, space reserves

3. The Concept of Nagari Formation

The structure of the Minangkabau nagari was formed by taking into account:

- Friendly topography, especially slopes <8% for settlements.
- Access to water (rivers, springs) as a vital element of life.
- Social and physical connectivity through roads and rivers.
- Cosmological and customary considerations (hierarchical location of the traditional house, traditional hall, rice fields and forests).

From the topographic analysis in the Sijunjung traditional village, it shows that:

- Traditional settlements are concentrated in the sloping zone (2–8%), which is very much in accordance with the principles of nagari formation.

- Limited flat zones (0–2%) are used efficiently, perhaps for major buildings or intensive areas.
- Steep zones (8–15%) are not used as primary settlement locations, but rather function as ecosystem and resource protectors (such as customary forests or "rimbo larangan").

4. Synthesis: Integration of Minangkabau Slope, Custom, and Philosophy
The formation of nagari in Minangkabau, especially in this area, shows harmony between humans and the environment:

- Nagari was formed not only based on ease of access, but also considering ecological stability and traditional values.
- The structure of the nagari space does not stand alone, but is the result of reading nature, as the philosophy of nature takambang jadi guru teaches us to:*"Walk in the steep valley, rice fields in the fertile plains, live on the banks of the river, village in the beautiful site" (*walking in a sloping valley, rice paddies in a fertile plain, housing by the river, a village on a good site).

In other words, nature teaches people to live in balance: building in suitable places, protecting forests, and honoring water.
The conclusion drawn from the analysis of the slope map of the Sijunjung Traditional Village area shows that the spatial structure of this nagari is aligned with the Minangkabau philosophical principle (nature is the teacher) and the technical conceptualization of nagari formation according to Haryani. Spatial zoning has taken into account slope factors, ecological functions, and the socio-cultural aspects of the community. This proves that traditional nagari spatial planning is a form of local wisdom.*(local wisdom*) which is adaptive to local geographical and spiritual conditions.

2. Analysis potential for landslides and floods with the Concept of Nagari Formation/Minangkabau Philosophy

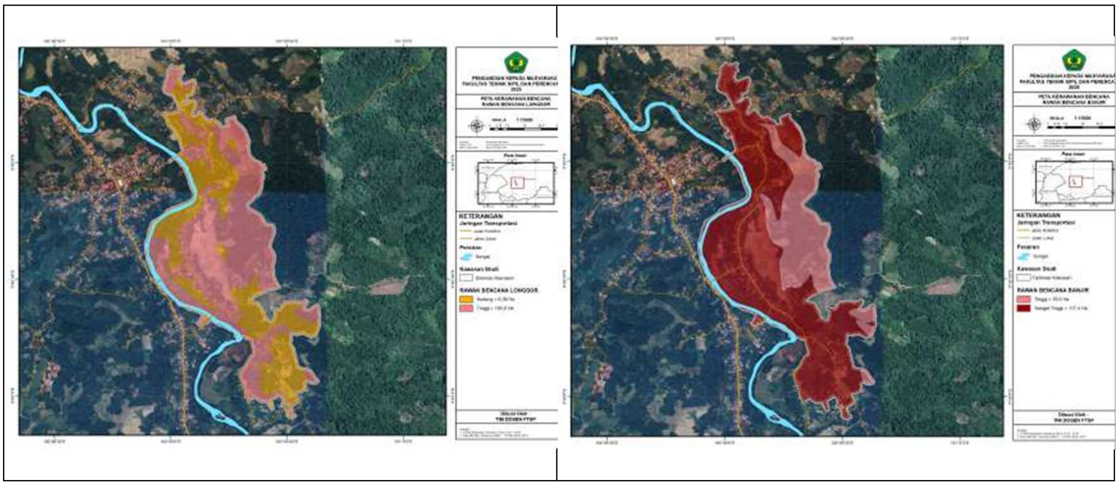
The relationship between the concept of nature as a teacher and the potential for landslides and floods in the Sijunjung Traditional Village based on slope maps in the context of disaster mitigation is as follows.
The philosophy of "Alam Takambang Jadi Guru" as an adaptive strategy for disasters. The Minangkabau philosophy of alam takambang jadi guru emphasizes that humans must:

- Reading and understanding the signs of nature,
- Adapting development and living activities to the natural character of the environment, and
- Placing the function of space according to its potential and risks.

In the context of vulnerability to disasters such as floods and landslides, this philosophy serves as a local framework for risk mitigation. Indigenous communities adapt and shape space by considering biophysical conditions, including topography and water flow.
Based on the slope map, the potential for landslide disasters in the Sijunjung Traditional Village can be classified as follows.

- Zones with a slope of 8–15% (red) are landslide-prone areas, especially if the vegetation cover is damaged or there is interference from human activity.
- Philosophy *nature takambang becomes a teacher*teaches: "Don't build on slippery ground, don't disturb the buffer forest."

In the Sijunjung Traditional Village, the red zone is not used as a residential area by the indigenous community, but rather is protected as a forbidden forest (rimbo melarang) as a reserve. This demonstrates local wisdom in avoiding landslide risks, in line with the principles of environmental adaptation.
Meanwhile, based on spatial analysis of flood potential based on topographical location and river flow, a large river flows along the western side of the village, with a flat to gently sloping area (0–8%) surrounding it. This area is vulnerable to waterlogging and seasonal flooding, especially if upstream vegetation is damaged.



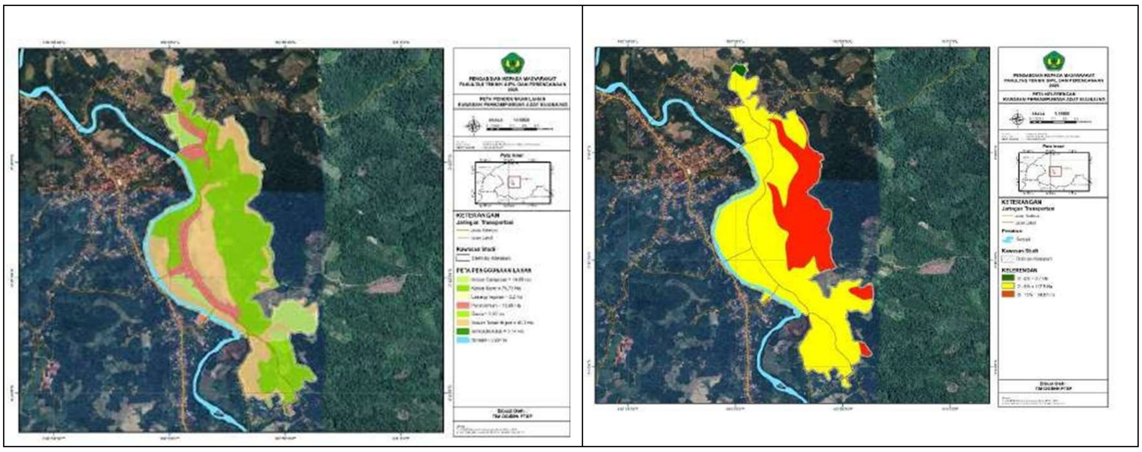
However, the people of the Sijunjung Traditional Village have proven to have adapted to their environment. The main settlements are not located directly on the riverbank, but on slightly higher and more stable land. Traditional drainage systems such as ditches and tapians also strengthen flood resilience. The adage says: "Nan di hilia ndak ditabam, nan di hulutahan" (Those downstream are not retained, those upstream are not retained). This means that water management has been traditionally understood to prevent excessive flooding by maintaining the upstream, not cutting down slopes, and wisely regulating the use of lowlands. The integration of local wisdom in risk mitigation efforts in the Sijunjung Traditional Village is as follows.

Potential Disaster	Area Based on Map	Traditional Strategy (Takambang Nature Becomes Teacher)
Landslide	Red zone (8–15%)	Not used as a settlement, maintained as a forest, avoid logging on slopes
Flood	Flatlands & riverbanks (0–2%, 2–8%)	Settlements are somewhat moved away from the riverbank; community-based water management and local wisdom

From the analysis above, the relationship between the potential for landslides and floods is linked to the Principle*nature takambang becomes a teacher*It serves not only as a philosophical guide, but also as a framework for disaster mitigation based on local wisdom. The indigenous people of Sijunjung Village have traditionally identified landslide and flood-prone zones based on natural observations, adapted spatial use, and developed an ecologically and culturally based mitigation system. This pattern can be used as a model for disaster risk management based on local wisdom, combining modern spatial data (slope maps) with traditional Minangkabau values.

3. Analysis Land use of Sijunjung Traditional Village with slope map

The results of the analysis of land use maps with slope maps are then linked to the concept of "alam takambang jadi guru" and the potential for floods and landslides in the Sijunjung Traditional Village, resulting in the following results.
Utilization of existing land based on natural characteristics can be seen in the following table.



Type of Land Use	Map Color	Area (Ha)	Notes
Settlement	Pink	13,69	Spread across the central plains and riverbanks
Rubber Plantation	Light green	75,73	Dominates areas with gentle to medium slopes
Rainfed Rice Fields	Bright green	46,3	Located in the lowlands and by the river
Mixed Garden	Light brown	14,68	Distributed in the central zone
Material	Greenish blue	0,92	Located near the river
river	Light blue	5,29	The main elements of the landscape
Farm, Bush/Bow	Very small	<1	Scale mines

Associated with the previous slope map, the results obtained are:

- Area flat (0–2%) And sloping (2–8%) majority used for settlements, rice fields and gardens.
- The steep zone (8–15%) is not used as a residential area, but is covered with rubber plantations or left as an area of shrubs and vegetation cover.

Analysis of land use suitability to slopes shows that indigenous communities have read the natural character well where:

- Settlements and rice fields are placed in safe and flat zones, avoiding the risk of landslides.
- Sloping land is used as a garden (especially rubber), which has strong roots to stabilize the slope.

This is very much in line with the values*"where the land is wet, there are rice fields, where the land is flat, there is a village."*
Furthermore In relation to the potential for landslides, slope zones >8% (red zones on the slope map) are not used as residential areas or rice fields but are instead used for rubber plantations which function as soil binders and natural landslide mitigation. This illustrates the principle:*"The high ground is used for the forest, not for the village square.*
Many settlements and rice fields are located near rivers. However, the layout pattern shows that settlements are not directly on the riverbank, but rather are moved slightly inland as a flood adaptation strategy. The presence of swamps and open fields near rivers allows them to function as buffer zones (absorbing seasonal flooding). Rain-fed rice fields are located in the lower reaches as natural water reservoirs, not permanent areas.
In this context,*nature takambang becomes a teacher*not just a slogan, but a practical basis for the community in determining the location of spatial functions (settlements, agriculture, conservation) as well as traditional ecological guidelines for natural and sustainable disaster mitigation.
Integration of spatial patterns (slope, water flow, land use) proves that the community maintaining resilience area to landslide And flooding, adapting economic activities (farming, gardening) without damaging soil stability, and respecting ecological boundaries by maintaining vegetation cover in vulnerable areas. Land use and slope maps demonstrate the consistent patterns of adaptation of the Sijunjung indigenous people to the natural environment. This pattern aligns with the following values:*"The earth is trampled, the sky is raised, nature is read, the country is built.* The concept of nature as a teacher is not only reflected in philosophical values, but is also manifested in the spatial structure and ecological practices of the nagari in a concrete manner.

4. Analysis slope, land use, disaster potential, and local wisdom

1. Slope Analysis and Land Use
Based on the overlay of slope and land use maps, it appears that the spatial use in the Sijunjung Traditional Village demonstrates a fairly high level of ecological suitability. Residential areas and primary agricultural land, such as rain-fed rice fields, are generally located in areas with slopes of 0–8%, which are classified as flat to gentle. Meanwhile, areas with steep slopes (8–15%) are not utilized for settlements, but rather function as rubber plantations or are left as mixed vegetation.
This utilization reflects the adaptive capacity of the Sijunjung Traditional Village community in adjusting spatial activities to topographic characteristics. This confirms that traditional communities have long recognized the risks inherent in the landscape and regulated spatial functions to minimize ecological and social losses.

2. Landslide Disaster Potential and Vegetation-Based Mitigation
4 Landslide-prone zones are generally located in areas with slopes >8%, specifically in the central and eastern parts of the study area. However, overlay results indicate that this area is not used for settlements, but rather serves as a rubber plantation (approximately 75.73 ha). Rubber plants, with their deep fibrous roots, help bind the soil and resist erosion, and therefore can be considered a vegetative-based disaster mitigation strategy.

13 This reflects the ecological value of the Minangkabau philosophy of "alam takambang jadi guru," which guides people to interpret natural phenomena and wisely organize spatial patterns. "Highlands are used for jungles, not for village squares."*Land in high places for forests, not for settlements*).

3. Flood Potential and Adaptation of Traditional Spatial Planning
The Sijunjung Traditional Village area is crossed by a large river that acts as a natural boundary on the west side. Areas with slopes of 0–2%, which are prone to flooding during the rainy season, are used as rain-fed rice fields and swamps, rather than as permanent settlements. Settlements are moved to slightly higher, gentler areas, creating a natural buffer against water runoff.
The presence of rice fields and swamps in this flat area allows for seasonal water storage and protects the core area of the village from the risk of flooding. This pattern further reinforces the principle of*nature takambang becomes a teacher*which emphasizes adaptation to natural conditions, not conquest. "What is in the lowlands is not planted, what is in the upstream is held back."*The water downstream is not dammed, the water upstream must be controlled).*

4. Philosophical Reflection: “Takambang Nature Becomes a Teacher” as a Spatial Strategy
The concept of "Nature Takambang Jadi Guru" (Nature Becomes a Teacher) in the context of village spatial planning is a form of ecological wisdom that integrates customary values, local knowledge, and an understanding of the natural landscape. In practice, this concept results in traditional spatial planning principles such as a) Settlements are placed in sloping and stable zones, b) Steep land is conserved as forests or vegetative gardens, c) Lowlands are utilized for agriculture and water reservoirs, and d) River flows are maintained as dynamic elements in the village spatial system. This strategy has proven adaptive in the context of disaster mitigation and can become a model for culturally and sustainably based spatial planning.
Indigenous approaches to topography and land use demonstrate that local wisdom can act as a natural, resource-efficient, and value-based disaster mitigation system. This is crucial in the context of risk-based spatial planning that integrates modern spatial data with local cultural values.

5. Disaster Potential Analysis, Land Use with Local Wisdom/Nagari Formation

Based on the analysis of the two slope maps and land use maps of the Sijunjung Traditional Village, in relation to the concept of "Alam Takambang Jadi Guru" and the potential for landslides and floods, it can be explained as follows.

a. The concept of "Nature Becomes a Teacher"
12 In Minangkabau philosophy, "Alam Takambang Jadi Guru" teaches that humans must learn from nature, understand its signs, and live in harmony with it. This means that settlements should follow the shape and characteristics of nature, land use should take into account environmental carrying capacity and risks, and space use should not disrupt the balance of the ecosystem.
b. Landslide and Flood Potential Analysis
By combining slope and land use maps, several risk indications were identified.

a) Steep Slope Area (8–15%)

The Red Zone on the Slope Map is spread across the central-eastern part of the region. Part of this zone intersects rubber plantations and fields/dry fields, and some is close to residential areas. The potential for landslides is high if the vegetation is unstable or there is excessive land clearing.

b) Flat & Sloping Zone (0–8%)

Settlements are predominantly located in flat areas, particularly near rivers and residential areas (central to southern). Flood risk increases in these areas, primarily due to proximity to rivers and reduced water catchment areas due to dense settlements.

c. Suitability of Spatial Planning to Local Wisdom

The concept of "nature as a teacher" ideally directs:

a) The settlement is on sloping land and not too close to rivers or cliffs.
b) Gardens and fields are placed on slopes, but with a terracing or erosion control system.
c) Forest or check as buffer area vulnerable landslide and water runoff control.

However, according to the map, modern interventions in the form of roads and settlements have entered steep slope zones. Some rubber plantations extend onto steep slopes without natural vegetation buffers.

4. Risk of Violating Takambang's Natural Principles

If residential and road development continues to encroach on the red zone (steep slopes), landslides can occur, especially during extreme rainfall. The lack of green open spaces and catchment areas in flat zones near rivers increases the risk of local flooding.

5. Recommendations Based on Local Wisdom

a. Settlements;Concentration in lowlands with natural drainage arrangements.
b. Steep slope areas; Vegetation rehabilitation, prohibition of new land clearing.
c. Riverbanks; Riparian conservation (riverbank vegetation), river boundaries are maintained.
d. Land use; Implement conservative farming systems (terracing, agroforestry).

5. Conclusion on Land Suitability and Disaster Mitigation Based on Local Wisdom in the Sijunjung Traditional Village

1. Land Use Suitability Based on Slope

The overlay results between slope maps and land use maps show that the Sijunjung Traditional Village community has implemented land use principles appropriate to topographic conditions. Residential areas and primary agricultural land, such as rain-fed rice fields, are generally located in zones with slopes of 0–8%, which are classified as flat to gentle. Meanwhile, zones with steep slopes (8–15%) are not used for settlements, but rather function as rubber plantations or are left as mixed vegetation.

The adaptive capacity of communities to adjust spatial activities to topographical characteristics. This confirms that traditional communities have long recognizing the risks inherent in the landscape and managing spatial functions to minimize ecological and social losses.

2. Landslide Disaster Potential and Vegetation-Based Mitigation

4 Landslide-prone zones are generally located in areas with slopes >8%, specifically in the central and eastern parts of the study area. However, overlay results indicate that this area is not used for settlements, but rather serves as a rubber plantation (approximately 75.73 ha). Rubber plants, with their deep fibrous roots, help bind the soil and resist erosion, and therefore can be considered a vegetative-based disaster mitigation strategy.

14 The results of this analysis reflect the ecological values of Minangkabau philosophy.*nature takambang becomes a teacher*, which guides people to read natural phenomena and organize spatial patterns wisely. This philosophy teaches that nature is a source of knowledge and guidance for life, including disaster mitigation.

3. Flood Potential and Adaptation of Traditional Spatial Planning

The Sijunjung Traditional Village area is crossed by a large river that acts as a natural boundary on the west side. Areas with slopes of 0–2%, which are prone to flooding during the rainy season, are used as rain-fed rice fields and swamps, rather than as permanent settlements. Settlements are moved to slightly higher, gentler areas, creating a natural buffer against water runoff.

The presence of rice fields and swamps in this flat area allows for seasonal water storage and protects the core area of the village from the risk of flooding. This pattern further reinforces the principle of*nature takambang becomes a teacher*which emphasizes adaptation to natural conditions, not their conquest.

4. Philosophical Reflection: "Takambang Nature Becomes a Teacher" as a Spatial Strategy

Draft *nature takambang becomes a teacher*In the context of village spatial planning, it is a form of ecological wisdom that integrates customary values, local knowledge, and an understanding of the natural landscape. In practice, this concept produces traditional spatial planning principles such as:

- Settlements are placed in sloping and stable zones.
- Steep lands are conserved as forests or vegetative gardens.
- Lowlands are used for agriculture and water reservoirs.
- The river flow is maintained as a dynamic element in the village spatial system.

This strategy has proven adaptive in the context of disaster mitigation and can serve as a model for culturally and sustainably based spatial planning. Local Minangkabau cultural values play a positive role in resilience and disaster preparedness.

Indigenous approaches to topography and land use demonstrate that local wisdom can act as a natural, resource-efficient, and value-based disaster mitigation system. This is crucial in the context of risk-based spatial planning that integrates modern spatial data with local cultural values.