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Study of Agricultural Land-Use Change in Nagari Harau, Harau Subdistrict, Lima Puluh Kota Regency, West Sumatra

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Abstract

Land-use change in rural agricultural landscapes represents a critical challenge for environmental sustainability and food security, particularly in areas experiencing tourism-driven development. This study aims to analyze the spatial and temporal dynamics of agricultural land-use change in Nagari Harau, Harau Subdistrict, Lima Puluh Kota Regency, West Sumatra, Indonesia, during the 2014–2024 period. A descriptive quantitative approach was applied using remote sensing and Geographic Information Systems (GIS). Multi-temporal Sentinel-2 imagery was interpreted and analyzed using ArcGIS, Google Earth Engine, and supporting spatial datasets. Land Change Rate (LCR) analysis was employed to quantify annual conversion trends. The results indicate a significant structural transformation of land use. Forest area declined by 11.81% (−1.18% per year), while paddy fields decreased by 10.55% (−1.05% per year), suggesting gradual but persistent conversion. In contrast, dry fields expanded sharply by 1,788.64% (+178.86% per year), accompanied by a 304.07% increase in shrubland (+30.47% per year). Settlement expansion was relatively minor (3.27%), indicating that agricultural restructuring rather than urbanization was the dominant driver of land transformation. The observed pattern reflects a transition from irrigated rice systems toward dryland agriculture and transitional land cover, influenced by biophysical constraints, irrigation limitations, market orientation, and spatial planning implementation challenges. These changes have important ecological implications, including increased erosion risk, altered hydrological regulation, and potential threats to long-term food production sustainability. The findings highlight the need for spatially explicit land management strategies to balance agricultural productivity, ecosystem stability, and tourism development in rural landscapes.

Keywords: agricultural conversion, dryland expansion, , ecosystem sustainability, GIS, West Sumatra

1. Introduction

Land-use change in agricultural areas has been widely recognized as a major driver of environmental degradation and declining agricultural productivity. The conversion of agricultural land to built-up areas contributes to increased carbon emissions, disruption of hydrological processes, and losses in biodiversity through landscape fragmentation and reduced ecosystem functioning (Lambin et al., 2020; Jiang et al., 2021). At broader spatial scales, agricultural land conversion has also been associated with reductions in ecosystem service provision, including food production, particularly in rapidly urbanizing regions (Zhang et al., 2023).

Nagari Harau, located in Harau Subdistrict, Lima Puluh Kota Regency, West Sumatra, represents an area with high agricultural potential that is increasingly subject to land-use change pressure. Tourism development associated with the Harau Valley has accelerated the expansion of built-up areas, particularly along major access corridors. Official statistics indicate that agricultural land in Nagari Harau declined from 3,245 ha in 2014 to approximately 2,875 ha in 2023, representing a reduction of about 11.4% over the last decade. Recent data from Badan Pusat Statistik (BPS) Kabupaten Lima Puluh Kota confirm that this trend persisted through 2024, indicating ongoing agricultural land conversion in the study area (BPS Lima Puluh Kota Regency, 2025).

Tourism development in Nagari Harau has increasingly become a significant factor influencing land-use dynamics, particularly due to the growing popularity of the Harau Valley as a major nature-based tourism destination. The area is predominantly characterized by ecotourism activities such as sightseeing, trekking, and landscape photography, complemented by emerging forms of agrotourism and rural tourism that utilize agricultural landscapes and local cultural resources. While these developments contribute positively to local economic growth, they also create pressure on agricultural land systems. The expansion of tourism infrastructure—including accommodations, access roads, and supporting facilities—often occurs in strategically located areas that were previously used for agriculture, particularly irrigated paddy fields. In addition, tourism growth indirectly encourages shifts in local livelihoods from farming to service-oriented activities, reducing the reliance on traditional agricultural practices (Syahza and Asmit, 2019). As a result, agricultural land is increasingly converted into non-agricultural uses or transformed into less intensive land covers. This interaction highlights the dual role of tourism as both an economic opportunity and a driver of land-use transformation, underscoring the need to better understand its spatial implications in rural agricultural landscapes.

Consequently, there remains a critical need for spatially explicit, multi-temporal analyses that integrate high-resolution satellite imagery to better capture fine-scale agricultural land-use dynamics and their implications for ecosystem services and food security. This need is particularly evident in Nagari Harau, where rapid tourism development associated with the Harau Valley has intensified pressure on agricultural land, yet detailed, site-specific evidence on the extent, patterns, and drivers of land conversion remains limited. Existing studies in Indonesia tend to emphasize regional-scale assessments, thereby overlooking localized interactions between tourism expansion, agricultural transformation, and environmental change. Therefore, this study aims to (1) analyze the spatial and temporal patterns of agricultural land-use change in Nagari Harau during the 2014–2024 period, (2) quantify the rate of land conversion using Land Change Rate (LCR) analysis, and (3) evaluate the implications of these changes for ecosystem sustainability and local food production systems. By providing high-resolution, location-specific insights, this research contributes to bridging the gap between macro-level land-use assessments and local land management needs, supporting more effective and evidence-based spatial planning in tourism-influenced rural landscapes.

2. Materials and Methods

This study was conducted in Nagari Harau, Harau Subdistrict, Lima Puluh Kota Regency, West Sumatra Province, Indonesia. Nagari Harau covers an area of approximately 53.7 km² and is located at coordinates 0°05'23"–0°09'41" S and 100°35'24"–100°41'09" E. The research will be carried out over a period of six months, from July 2025 to January 2026.

The tools used in this study include a laptop with a Ryzen 7 5000 processor, 16 GB RAM, and 1 TB storage, a GPS device for field surveys, and a digital camera for documentation. The software employed consists of ArcGIS Desktop 10.8, Google Earth Pro, and Google Earth Engine. The materials used in this study consist of Sentinel-2 imagery, Google Earth imagery, and ESRI Imagery, as well as secondary data on land use and spatial planning.

The research method employed in this study is a descriptive method using a remote sensing and geographic information system (GIS) approach, with the aim of identifying and describing changes in agricultural land use based on satellite image interpretation. The variables examined in this study include the area of agricultural land, changes in agricultural land use, types of land cover, and the rate of agricultural land conversion.

3. Results and Discussion

General condition

Nagari Harau is one of the nagari (traditional administrative villages) in Harau Subdistrict, Lima Puluh Kota Regency, West Sumatra Province. This nagari is bordered by Payakumbuh Subdistrict to the west, Sarilamak Nagari to the north, Taram Nagari to the east, and Solok Bio-bio Nagari to the south. Nagari Harau covers an area of approximately 80.68 km² and is situated at coordinates 0°05'23"–0°09'41" S and 100°35'24"–100°41'09" E. The physical environment of Nagari Harau is shaped by a close interaction between geological structure, soil development, and climatic conditions, which together determine land suitability and landscape stability. Geologically, the area forms part of the tectonically active zone of central Sumatra and is strongly influenced by the regional deformation associated with the Great Sumatran Fault system (Barber et al., 2005). Tectonic uplift and extensional faulting have produced an elongated intermontane valley, known as Harau Valley, bordered by steep rock escarpments. The subsidence of the valley floor relative to the surrounding blocks has created a distinct morphological contrast between the flat alluvial plains and the enclosing hills and cliffs (Sieh & Natawidjaja, 2000).

The dominant lithology consists of sedimentary rocks, primarily sandstone, siltstone, and conglomerate, which constitute the geological parent materials for soil formation. Variations in structural position and geomorphic processes have resulted in contrasting soil types across the landscape. On the valley floor, prolonged sediment deposition has led to the development of relatively deep Inceptisols, while the surrounding slopes and foothills are characterized by shallow and weakly developed Entisols (BBSDLP, 2015). These soils generally exhibit slightly acidic pH conditions and moderate natural fertility, making them suitable for rice cultivation and certain perennial crops where soil depth and water availability are sufficient. However, shallow soil depth and coarse textures on sloping terrain limit agricultural use and increase vulnerability to erosion.

Nagari Harau experiences a humid tropical rainforest climate, with annual rainfall ranging from 2,000 to 3,000 mm, mean air temperatures of 22–28°C, and relative humidity levels of 80–90% (BMKG, 2023). High rainfall promotes intensive weathering of parent materials and supports continuous soil formation processes, while also providing a stable supply of surface water that sustains irrigated rice fields on the valley plains. Conversely, the combination of steep slopes, shallow soils, and high rainfall intensity significantly increases the risk of soil erosion and mass movement in the surrounding uplands.

Overall, the interaction between tectonic structure, soil characteristics, and humid tropical climate has resulted in a landscape where agricultural activities are concentrated in the flat valley areas, while the surrounding steep terrain remains constrained by physical limitations. This integrated physical setting plays a crucial role in shaping land-use distribution, agricultural productivity, and environmental vulnerability in Nagari Harau.

The socio-economic conditions of Nagari Harau are characterized by a rural agrarian community structure that has been developing into an agriculture–tourism area, with livelihoods still primarily dependent on the agricultural sector and service enterprises related to tourist visits in Harau Valley. Most residents of Harau work as farmers, particularly rice farmers and other agricultural commodity producers, so agriculture remains the backbone of household economies. Harau Subdistrict is also known as one of the important gambier-producing areas in West Sumatra Province, where this commodity serves as a strategic source of income for farmers in nagari such as Harau and its surroundings.

Land Use Characteristics

Land use in Nagari Harau remained predominantly forested in both 2014 and 2024; however, a substantial decline in forest cover was observed over the ten-year period. Forest area decreased from 7,543.8 ha in 2014 to 6,652.64 ha in 2024, representing a reduction of 11.81%. Although natural ecosystems continue to dominate the spatial configuration of the landscape, this trend indicates sustained pressure from land conversion processes. Similar patterns of gradual forest reduction driven by agricultural expansion, livelihood transformation, and land management adjustments have been widely documented in Indonesian rural landscapes, particularly outside formally protected areas (Juniyanti et al., 2021; Faoziyah et al., 2024).

Agricultural land use exhibited divergent trajectories, reflecting a structural transformation of the local farming system. Paddy fields declined from 219.91 ha to 196.72 ha (−10.55%), while dry fields expanded sharply from 16.28 ha to 307.47 ha, an increase of 1,788.64%. This pronounced shift suggests a transition away from irrigation-dependent wetland agriculture toward dryland cultivation systems that are more adaptable to limited water availability, lower infrastructure requirements, and variable climatic conditions. Comparable trends have been reported in several Indonesian regions, where declining irrigation reliability and changing socio-economic conditions have encouraged farmers to convert paddy fields into dryland agricultural uses (Barchia et al., 2022; Faoziyah et al., 2024).

Shrubland expansion was one of the most prominent land use changes, increasing from 204.99 ha in 2014 to 828.31 ha in 2024 (304.07%). The proliferation of shrubland is commonly interpreted as an indicator of land abandonment or degradation, often following reduced management intensity in former agricultural or forested areas. In Indonesia, such transitions are frequently associated with declining agricultural profitability, labor shortages, and shifting livelihood strategies, particularly in marginal or less accessible landscapes (Juniyanti et al., 2021). The expansion of shrub-dominated areas in Nagari Harau therefore reflects broader regional patterns of land extensification rather than direct urban encroachment.

In contrast, settlement areas expanded only marginally (3.27%), indicating that urbanization was not the dominant driver of land use change during the study period. This finding aligns with observations from other rural Indonesian contexts, where land use change is more strongly influenced by agricultural restructuring and land management decisions than by residential expansion (Faoziyah et al., 2024). Pond areas declined by 11.81%, suggesting a contraction of small-scale inland aquaculture activities, potentially linked to changes in land-use priorities and the reallocation of land and water resources. Similar reductions in traditional aquaculture systems have been observed in Indonesian rural areas undergoing environmental and agricultural transitions (Putra et al., 2025).

Overall, these land-use changes are driven by a combination of interrelated factors. Biophysically, variations in topography, soil depth, and water availability constrain the sustainability of irrigated agriculture, encouraging shifts toward more adaptable dryland systems. Socio-economically, changes in labor availability, rising production costs, and fluctuating commodity prices reduce the attractiveness of intensive farming, leading to extensification or land abandonment. In addition, the rapid development of tourism activities around the Harau Valley has increased land value and created alternative income opportunities outside agriculture, indirectly accelerating land conversion and livelihood transformation. Institutional factors, particularly the limited enforcement of spatial planning regulations (RTRW), further enable the conversion of agricultural and forest land into other uses. The interaction of these biophysical, socio-economic, and governance factors collectively explains the observed pattern of land-use transformation in Nagari Harau.

Land Use Change Pattern

The pattern of land use change in Nagari Harau during the 2014–2024 period shows a clear tendency toward the conversion of forest and paddy fields into dry fields and shrubland. This trend reflects broader land use dynamics commonly observed in rural areas of Indonesia, particularly in regions facing economic pressures and challenges in maintaining sustainable agricultural land (Gafuraningtyas, 2022; Listyarini et al., 2025).

The conversion of forest areas into dry fields and shrubland indicates ongoing land opening for dryland agricultural activities, which often results in changes to soil physical properties and increased environmental vulnerability (Listyarini et al., 2025). Concurrently, the reduction in paddy field area signifies the conversion of productive irrigated agricultural land, posing a potential threat to the sustainability of rice cultivation and local food security (Barchia et al., 2025; Yang et al., 2023).

Furthermore, the expansion of shrubland reflects land that is no longer managed intensively. Such conditions are commonly associated with land degradation processes and declining land productivity, which may further exacerbate environmental and socio-economic challenges in rural areas (Sanjesti and Silviana, 2022).

From a socio-economic perspective, these changes are closely linked to shifts in livelihood strategies and economic incentives. Declining profitability of irrigated rice farming—driven by rising input costs, unstable commodity prices, and labor shortages—has reduced farmers' capacity and willingness to maintain intensive paddy cultivation. As a consequence, many farmers transition to less labor-intensive dryland agriculture or leave land temporarily fallow, which subsequently develops into shrubland. At the same time, the growth of tourism activities around the Harau Valley has increased demand for land for non-agricultural purposes and created alternative income opportunities in the service sector. This shift encourages the reallocation of labor away from agriculture and raises land values, making agricultural use less competitive compared to tourism-related uses. Furthermore, younger generations tend to prefer employment outside the agricultural sector, accelerating the decline of traditional farming practices. As a result, socio-economic pressures not only drive direct land conversion but also indirectly contribute to land abandonment and extensification processes, reinforcing the expansion of dry fields and shrubland in Nagari Harau.

Land Change Rate (LCR)

Based on the LCR calculation, the rate of forest decline reaches approximately −1.18% per year, indicating a consistent but non-explosive deforestation process. Although the annual percentage appears moderate, sustained decline at this rate can cumulatively reduce watershed protection capacity, biodiversity stability, and hydrological regulation. Recent studies in Indonesian watersheds demonstrate that even gradual forest loss significantly alters runoff coefficients and increases hydrological vulnerability over time (Irawan & Setiawan, 2025). Similar findings show that persistent forest conversion contributes to landscape fragmentation and ecosystem instability in tropical regions (Rizqullah et al., 2025).

Rice fields experience a decline rate of −1.05% per year, reflecting gradual but continuous conversion of irrigated agricultural land. While the percentage is relatively small annually, sustained reduction may threaten long-term rice production sustainability and food security at the regional scale. Empirical studies in Indonesian irrigated systems confirm that incremental paddy field conversion can significantly reduce productive agricultural land within a decade (Barchia et al., 2022).

Conversely, dry fields show an exceptionally high increase rate of +178.86% per year, indicating rapid and large-scale expansion of dryland agriculture. This very large LCR value reflects a substantial structural shift in land use from irrigated systems toward more extensive, adaptive dryland farming. Recent spatial analyses in Indonesia identify dryland expansion as a dominant driver of land system transformation, often associated

with market-oriented cropping systems and reduced irrigation dependence (Rizqullah et al., 2025).

Shrubland also increased at a rate of +30.47% per year, indicating significant growth of transitional or semi-managed land cover. An increase of this magnitude typically suggests post-clearing land conditions, fallow expansion, or partial land abandonment. Research on land cover transitions in Indonesian rural landscapes shows that shrubland expansion frequently represents intermediate phases following forest conversion or agricultural restructuring (Rizqullah et al., 2025). Over time, such transitions may influence carbon dynamics, soil stability, and local hydrological responses (Irawan & Setiawan, 2025).

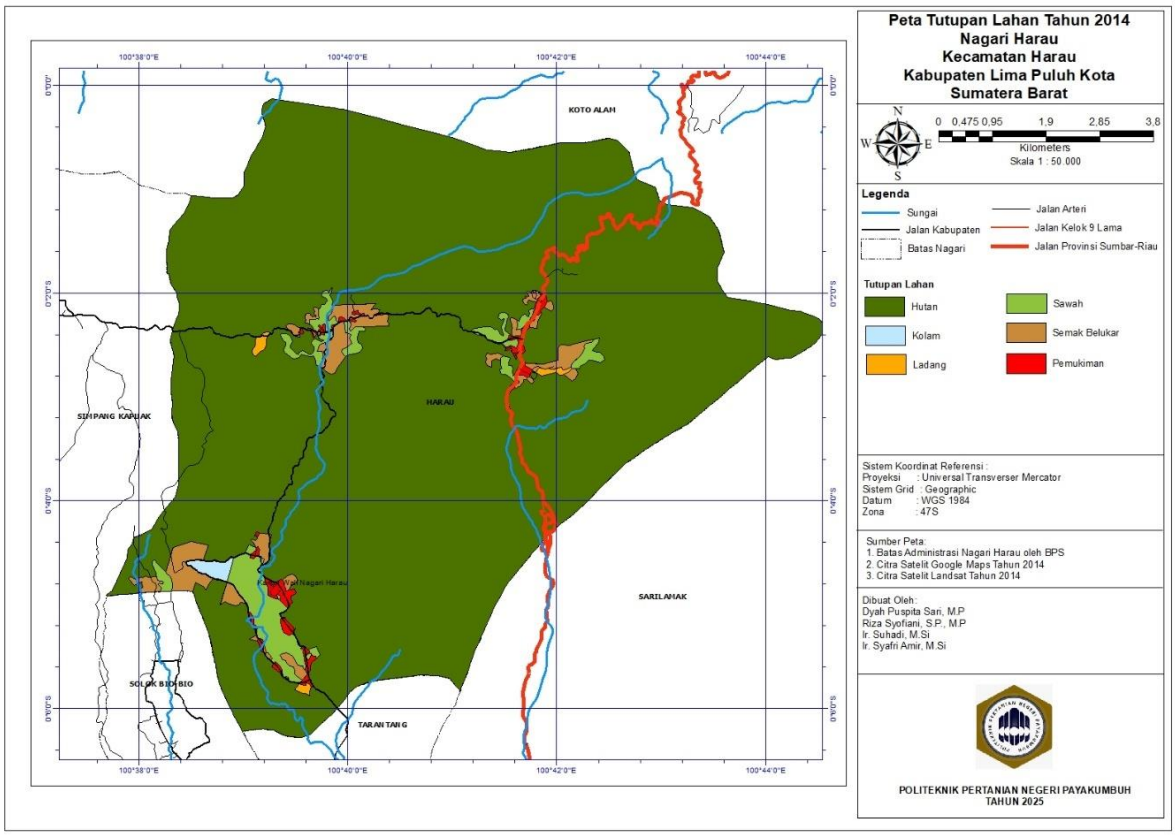


Figure 1. Land Cover Map of Nagari Harau in 2014

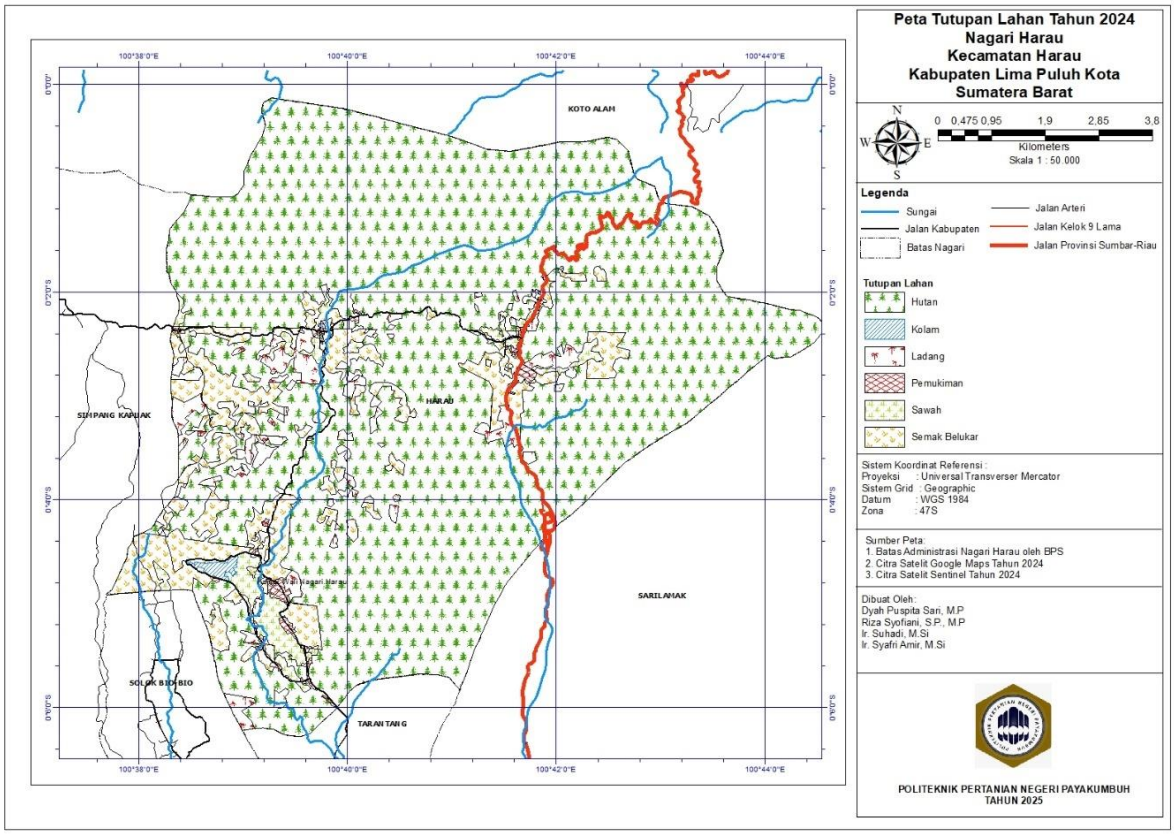


Figure 2. Land Cover Map of Nagari Harau in 2024

Table 1. Land Use Change in Harau 2014 – 2024

Land Cover	Areas (Ha)		% Change	LCR (%/year)
	2014	2024		
Forest	7,543.8	6,652.64	-11.81%	-1.18%
Dry Fields	16.28	307.47	1,788.64%	178.86%
Paddy Fields	219.91	196.72	-10.55%	-1.05%
Shrubland	204.99	828.31	304.70%	30.47%
Settlement Area	64.19	66.29	3.27%	0.32%
Ponds	19.81	17.47	-11.81%	-1.18%

Land Use Change Trends

The trend of land use changes in Nagari Harau during the 2014–2024 period is shown in Figure 3. The graph illustrates clear temporal dynamics in the area extent of each land cover category over the ten-year observation period. The pattern indicates systematic transitions rather than random fluctuations, suggesting structural land system change at the landscape scale.

The graphical interpretation demonstrates that forest and paddy field areas exhibit a consistent declining trend, whereas dry fields and shrubland show a sharp and continuous increase. This pattern reflects a shift from relatively stable forest and irrigated agricultural systems toward more extensive dryland agriculture and transitional land cover. Recent spatiotemporal land cover analyses in Indonesian rural regions confirm that dryland expansion is a dominant driver of landscape transformation, frequently occurring alongside forest reduction and agricultural restructuring (Rizqullah *et al.*, 2025). Moreover, studies on watershed-scale land use change indicate that even moderate but persistent forest decline can significantly

alter hydrological responses and runoff dynamics over time (Irawan & Setiawan, 2025).

The observed trend also confirms that land use change is not merely spatial but strongly temporal and cumulative. Progressive annual conversion, even at modest rates, can generate substantial long-term ecological impacts, including reduced ecosystem resilience, altered carbon dynamics, and declining soil–water regulation capacity. Research on irrigated agricultural systems in Indonesia highlights that gradual paddy field conversion may threaten long-term production sustainability and landscape ecological balance if not accompanied by adaptive land management strategies (Barchia *et al.*, 2022). Therefore, without sustainable land management policies, the cumulative effect of these trends may intensify environmental vulnerability in Nagari Harau over the coming decades.

Factors Influencing Land Use Change

Land use change in Nagari Harau reflects patterns that have been empirically documented in West Sumatra over the past decade. The decline in paddy fields is consistent with findings from Solok District, where spatial modelling shows that irrigated rice fields are increasingly converted due to accessibility factors, land suitability limitations, and regional development pressures (Umar & Arif, 2023). In addition, watershed-based assessments in western Sumatra indicate that gradual land conversion, particularly from forest and wet agricultural land to other uses, has altered hydrological responses and landscape stability (Irawan & Setiawan, 2025).

The expansion of dry fields and transitional land cover in Nagari Harau also mirrors broader land cover dynamics observed in upland areas of West Sumatra, where farmers adapt to topographic constraints and limited irrigation networks by shifting toward more flexible dryland systems. Such structural transitions are commonly linked to market orientation and livelihood adjustments in rural landscapes (Rizqullah *et al.*, 2025). From an institutional standpoint, inconsistencies between spatial plan allocation (RTRW) and actual land utilization—documented in several Indonesian regions, including Sumatra—help explain how weak conformity control can facilitate agricultural and forest land conversion (Sutaryono *et al.*, 2022).

Taken together, evidence from West Sumatra supports the interpretation that land use dynamics in Nagari Harau are driven by interconnected socio-economic pressures, biophysical constraints related to terrain and irrigation, and governance challenges in spatial planning implementation, all of which cumulatively influence long-term landscape sustainability.

Impacts of Land Use Change on Ecosystems

Land use change in Nagari Harau has direct implications for declining ecosystem quality, particularly in terms of soil and hydrological stability. The conversion of forest into dry fields and shrubland increases land exposure and reduces vegetative cover, thereby accelerating surface runoff and soil erosion. Empirical studies in Indonesian watersheds demonstrate that forest loss and expansion of dryland agriculture significantly increase erosion susceptibility and contribute to declining soil physical quality, including reductions in soil organic matter and aggregate stability (Irawan & Setiawan, 2025). Similar findings from agricultural land conversion in Sumatra indicate that reduced vegetation cover intensifies land degradation processes, particularly in sloping terrain.

The reduction of paddy fields and forest area also disrupts the hydrological cycle, especially the landscape's capacity to store, infiltrate, and gradually release water. Spatial analyses in West Sumatra show that declining irrigated land and forest cover are associated with altered runoff coefficients and increased peak discharge, heightening the risks of flooding during the rainy season and water shortages during the dry season (Umar & Arif, 2023). These hydrological imbalances reflect cumulative land cover transitions that weaken watershed regulation functions.

In addition, changes in land cover reduce natural habitats for flora and fauna, thereby lowering biodiversity and diminishing ecosystem services. Spatiotemporal land cover studies in Indonesia reveal that forest fragmentation and expansion of transitional land cover types such as shrubland are linked to declining ecological integrity and reduced landscape sustainability indices (Rizqullah et al., 2025). Furthermore, weak spatial planning conformity, as highlighted by Sutaryono et al. (2022), may exacerbate these ecological impacts by allowing continued conversion beyond designated land-use allocations. Collectively, these processes suggest that ongoing land transformation in Nagari Harau poses significant risks to soil conservation, hydrological balance, and long-term ecosystem service sustainability.

4. Conclusion

Land use changes in Nagari Harau (2014–2024) show conversion of forest (−1.18%/year) and paddy fields (−1.05%/year) to dry fields (↑178.86%/year) and shrubland (↑30.41%/year), reflecting a shift from wet to dry agriculture due to socio-economic, biophysical factors, and weak spatial control. Impacts include soil degradation, hydrological disruption, reduced biodiversity, and ecosystem services. Integrated management through strengthened sustainable land use policies is needed to maintain ecosystem and local food production sustainability.

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References

[1] Badan Besar Sumber Daya Lahan Pertanian (BBSDLP). (2015). Soil map and land resource database of Indonesia. Ministry of Agriculture, Indonesia.

[2] Badan Meteorologi, Klimatologi, dan Geofisika (BMKG). (2023). Climate data of West Sumatra Province. BMKG.

[3] Barchia, M.F., Budianta, D., Sulistyo, B., Hardiansyah, D., Suhartoyo, H. and Novanda, R.R. (2022) 'Land use change threat to paddy cultivation sustainability on irrigated rice fields in Bengkulu Province, Indonesia', Indonesian Journal of Geography, 54(3), pp. 389–395. https://doi.org/10.22146/ijg.73304

[4] Barber, A. J., Crow, M. J., & Milsom, J. S. (2005). Sumatra: Geology, resources and tectonic evolution. Geological Society of London. https://doi.org/10.1144/GSL.MEM.2005.031.01.01

[5] BPS Lima Puluh Kota Regency (2023) Lima Puluh Kota Regency in Figures 2023. Sarilamak: Central Statistics Agency of Lima Puluh Kota Regency.

[6] Faoziyah, U., Rosyaridho, M.F. and Panggabean, R. (2024) 'Unearthing agricultural land use dynamics in Indonesia: Between food security and policy interventions', Land, 13(12), 2030. https://doi.org/10.3390/land13122030

[7] Gafuraningtyas, D. (2022) 'Tren penelitian tentang perubahan penggunaan lahan dan lahan pertanian pangan berkelanjutan di Indonesia', Jurnal Pertanahan, 12(2), pp. 107–122. https://doi.org/10.53686/jp.v12i2.180

[8] Irawan, P. & Setiawan, J., 2025. Forecasting the long-term impacts of land use and cover changes on runoff coefficient and flood hydrograph: a case study of the Upper Citanduy Basin, Indonesia. Journal of Degraded and Mining Lands Management, 12(3), pp.7417–7429. https://doi.org/10.15243/jdmlm.2025.123.7417

[9] Jiang, S., Chen, X., Smettem, K.R.J. and Wang, T. (2021) 'Climate and land use influences on changing spatiotemporal patterns of mountain vegetation cover in southwest China', Ecological Indicators, 121, 107193. https://doi.org/10.1016/j.ecolind.2020.107193

[10] Juniyanti, L., Purnomo, H., Kartodihardjo, H. and Prasetyo, L.B. (2021) 'Understanding the driving forces and actors of land change due to forestry and agricultural practices in Sumatra and Kalimantan: A systematic review', Land, 10(5), 463. https://doi.org/10.3390/land10050463

[11] Lambin, E.F., Meyfroidt, P., Rueda, X., Blackman, A., Börner, J., Cerutti, P.O., Dietsch, T., Jungmann, L., Lamarque, P., Lister, J., Walker, N.F. and Wunder, S. (2020) 'Effectiveness and synergies of policy instruments for land use governance in tropical regions', Global Environmental Change, 62, 102060. https://doi.org/10.1016/j.gloenvcha.2020.102060

[12] Listyarini, D., Endriani, E., Syamsudin, A.H. and Khabibi, J. (2025) 'Kajian beberapa sifat fisik tanah akibat konversi hutan menjadi lahan pertanian di Desa Mukai Pintu Kabupaten Kerinci', Jurnal Silva Tropika, 9(1), pp. 85–96. https://doi.org/10.22437/jurnalsilvatropika.v9i1.45896

[13] Putra, A.N., et al. (2025) 'Utilizing remote sensing and random forests to identify optimal land use scenarios and address increasing environmental risks in Indonesian watersheds', Sustainability, 17(9), 4227. https://doi.org/10.3390/su17094227

[14] Rizqullah, M.F., Prasetyo, L.B., Rushayati, S.B. & Siregar, I.Z., 2025. Spatiotemporal dynamics of land cover changes and Local Sustainability Index of Cianjur Regency, West Java. Journal of Natural Resources and Environmental Management, 15(5), p.844. https://doi.org/10.29244/jpsl.15.5.844

[15] Sanjesti, W. and Silviana, A. (2022) 'Dampak alih fungsi lahan pertanian menjadi lahan kering', Legal Standing: Jurnal Ilmu Hukum, 9(2). https://doi.org/10.24269/ls.v9i2.11650

[16] Sieh, K., & Natawidjaja, D. (2000). Neotectonics of the Sumatran fault, Indonesia. Journal of Geophysical Research: Solid Earth, 105(B12), 28295–28326. https://doi.org/10.1029/2000JB900120

[17] Sutaryono, S., Rachmawati, R., & Haryono, E. (2022). Evaluating spatial plan conformity and land use change dynamics in Indonesian regions. Land Use Policy, 119, 106176. https://doi.org/10.1016/j.landusepol.2022.106176

[18] Syahza, A. and Asmit, B. (2019) 'Development of tourism and its impact on agricultural land conversion in West Sumatra, Indonesia', IOP Conference Series: Earth and Environmental Science, 347, 012090. https://doi.org/10.1088/1755-1315/347/1/012090

[19] Umar, I., & Arif, D. A. (2023). Spatial models of rice fields change and sustainable agriculture in Solok District, West Sumatra Province. Journal of Degraded and Mining Lands Management, 11(1), 4875–4885. https://doi.org/10.15243/jdmlm.2023.111.4875

[20] Yang, A., Barus, B. and Tjahjono, B. (2023) 'Ancaman konversi lahan sawah terhadap kecukupan beras di Kabupaten Musi Rawas', Journal of Regional and Rural Development Planning, 7(1), pp. 42–57. https://doi.org/10.29244/jp2wd.2023.7.1.42-57

[21] Zhang, Z., Ghazali, S., Miceikienė, A., Zejak, D., Choobchian, S., Pietrzykowski, M. and Azadi, H. (2023) 'Socio-economic impacts of agricultural land conversion: A meta-analysis', Land Use Policy, 132, 106831. https://doi.org/10.1016/j.landusepol.2023.106831