Rimba Torean Journal
Volume 02, Number 01, 2026 pp. 45-52
P-ISSN: 0000-00XX E-ISSN : 0000-00XX
Open Access: https://dx.doi.org/10.xxxx/xx

LAND USE CHANGES AND ITS IMPACT ON ECOSYSTEM BALANCE IN TROPICAL REGIONS

Nadila Juandti[1], Eriansyah Pratama[2], Nurul Faujia[3], Ika Gusnul Safitri[4]

[1,2,3,4] Pendidikan Geografi, Fakultas Keguruan dan Ilmu Peendidikan, Universitas Muhammadiyah Mataram, Kota Mataram, Indonesia

ARTICLE INFO

Article history:
Received April 08, 2026
Revised April 11, 2026
Accepted Mei 03, 2026
Available online Mei 25 2026

Kata Kunci:
perubahan penggunaan lahan;
ekosistem tropi;
keanekaragaman hayati,
perubahan iklim;
keberlanjutan.

Keywords:
land-use change; tropical ecosystems; biodiversity; climate change, sustainability

ABSTRAK

Perubahan penggunaan lahan di wilayah tropis merupakan fenomena yang semakin meningkat seiring dengan pertumbuhan penduduk dan perluasan aktivitas ekonomi. Studi ini bertujuan untuk menganalisis dampak perubahan penggunaan lahan terhadap keseimbangan ekosistem di wilayah tropis, dengan fokus pada aspek keanekaragaman hayati, siklus hidrologi, dan stabilitas iklim mikro. Metode yang digunakan adalah pendekatan kualitatif berdasarkan studi literatur dengan menganalisis berbagai publikasi ilmiah terkini yang relevan. Hasil penelitian menunjukkan bahwa konversi hutan menjadi lahan pertanian, perkebunan, dan kawasan permukiman menyebabkan penurunan keanekaragaman hayati yang signifikan dan mengganggu fungsi ekologis utama, termasuk penyerapan karbon dan pengaturan air. Selain itu, perubahan tutupan lahan juga berkontribusi pada peningkatan suhu lokal dan perubahan pola curah hujan. Dampak kumulatif dari perubahan ini berpotensi mengganggu keseimbangan ekosistem secara keseluruhan dan meningkatkan kerentanan terhadap bencana lingkungan. Oleh karena itu, strategi pengelolaan lahan yang berkelanjutan dan berbasis konservasi diperlukan untuk menjaga stabilitas ekosistem tropis.

ABSTRACT

Land-use change in tropical regions is a phenomenon that is increasing in tandem with population growth and the expansion of economic activities. This study aims to analyze the impacts of land-use change on ecosystem balance in tropical regions, focusing on biodiversity, the hydrological cycle, and microclimate stability. The method employed is a qualitative approach based on a literature review, analyzing various relevant recent scientific publications. The findings indicate that the conversion of forests into agricultural land, plantations, and residential areas leads to a significant decline in biodiversity and disrupts key ecological functions, including carbon sequestration and water regulation. Furthermore, changes in land cover also contribute to increased local temperatures and altered rainfall patterns. The cumulative impacts of these changes have the potential to disrupt the overall ecosystem balance and increase vulnerability to environmental disasters. Therefore, sustainable and conservation-based land management strategies are needed to maintain the stability of tropical ecosystems.

1. INTRODUCTION

Land use change is a dynamic process influenced by human activities such as urbanization, agriculture, and natural resource exploitation, which directly impacts the structure and function of ecosystems. In the tropical context, this change is particularly significant because tropical ecosystems possess high biodiversity and play a crucial role in the global carbon cycle and climate balance. According to (Ardi Kusumawati & Prayogo, 2019), land use change from forest to agricultural land can reduce carbon stocks and soil microbial activity, thus disrupting ecosystem balance. Furthermore, land use change is also closely linked to

*E-mail addresses: dilajuandti24@gmail.com

environmental degradation and the overall decline in ecosystem quality (Sanjesti & Silviana, 2025).

Several studies have shown that land-use changes in tropical regions have a significant impact on the biophysical aspects of the environment. (Ilmi et al., 2026) found that land-use changes in tropical peatlands cause changes in soil carbon dynamics, which have implications for increased carbon emissions. Furthermore, research (Ardiansyah et al., 2025) shows that plantation expansion and mining activities cause changes in land cover that threaten the sustainability of local ecosystems. Another study by (Rafly et al., 2025) also revealed that land-use changes in watersheds cause ecological degradation and impact the socioeconomic conditions of communities.

Other research highlights the link between land-use changes and biodiversity decline.

(Rahmawati A. Damiti et al., 2025) state that human activities such as deforestation and infrastructure development accelerate tropical forest degradation and lead to biodiversity loss. (Agnesia & Ade Fitri, 2025) also explain that environmental changes, including land-use changes, contribute to ecosystem instability and increase the risk of environmental disasters. In addition, global research shows that changes in tropical ecosystems are correlated with declines in ecological functions such as nutrient cycling and energy balance.

From a hydrological and environmental quality perspective, land use change also impacts water management systems and soil fertility. Land use change in peat areas affects the region's hydrological response (Ilmi et al., 2026). (Utami, 2019) added that this change also impacts soil carbon content and ecosystem stability. Meanwhile, (Ardi Kusumawati & Prayogo, 2019) demonstrated a decline in soil quality due to the conversion of forest land to cultivated land.

Other research also shows that land use change is closely related to increasing anthropogenic pressures. (Ardiansyah et al., 2025) revealed that urbanization and economic expansion are the main factors causing land cover change. (Angraini Fopy et al., 2020) emphasized that community activities in land use contribute to environmental degradation. (Irwan Saputra Pajerih, 2023) also added that these changes impact not only the environment but also the socio-economic resilience of communities surrounding the ecosystem.

In general, these various studies indicate that land-use changes in tropical regions have multidimensional impacts, ranging from soil degradation, carbon cycle disruption, hydrological degradation, and biodiversity loss. (Agnesia & Ade Fitri, 2025) emphasize that these changes exacerbate ecosystem imbalances and increase vulnerability to climate change. Therefore, land-use change is a major factor influencing the sustainability of tropical ecosystems.

Based on this description, it can be concluded that although numerous studies have examined the impacts of land-use change, there are still gaps in the integration of analyses between biophysical, social, and ecosystem balance aspects holistically, particularly in tropical regions. This research takes a comprehensive approach that links land-use change to overall ecosystem balance. Therefore, this study aims to analyze land-use change and its impact on ecosystem balance in tropical regions.

2. METHOD

This research uses a quantitative approach supported by Geographic Information Systems (GIS)-based spatial analysis to systematically and measurably examine land use changes and their impact on ecosystem balance in tropical regions. This quantitative approach was chosen because it has the ability to process numerical data objectively and produce

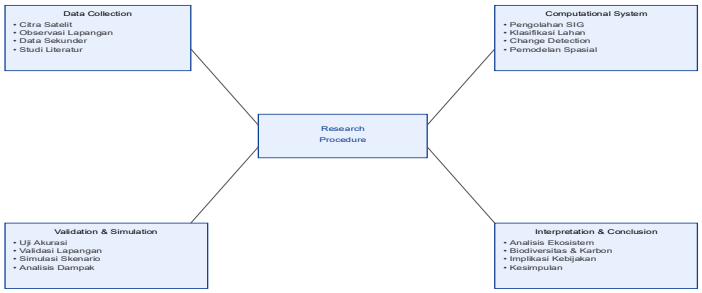
empirically testable findings. In the context of this research, the data analyzed is not only numerical but also spatial data depicting the condition of the Earth's surface in the form of maps and satellite imagery, allowing for accurate analysis of land use change over time (Rafly et al., 2025). Thus, this approach allows researchers to obtain more accurate and scientifically reliable analysis results, particularly in understanding the dynamics of land use change (Lambin & Geist, 2006).

The use of Geographic Information Systems (GIS) in this research serves as the primary tool for processing and analyzing geospatial data. GIS enables the integration of various types of data, such as multi-temporal satellite imagery, land use maps, and topographic data, into a single, structured and comprehensive system (Longley et al., 2015). Through this process, researchers can conduct spatial analysis that includes the identification, classification, and visualization of land use changes in greater depth. The advantage of GIS lies in its ability to display data in informative visual forms, thus facilitating interpretation of the phenomena being studied. Furthermore, remote sensing technology integrated into GIS enables continuous and accurate monitoring of land use change (Jensen, 2016).

The spatial analysis approach used in this study was used to identify patterns, directions, and intensity of land use change in tropical regions. This analysis was conducted by comparing land use data from several different time periods to identify trends in change. Furthermore, spatial analysis also allows researchers to examine the relationship between land use change and environmental factors, such as regional accessibility, proximity to centers of economic activity, and the region's biophysical conditions. Therefore, this research focuses not only on identifying land use change but also on understanding the causal factors and implications of such change (Turner et al., 2007).

A quantitative GIS-based approach was also used to analyze the impact of land-use change on ecosystem balance. This impact was assessed through several environmental indicators, such as changes in vegetation cover, water infiltration capacity, erosion potential, and carbon sequestration capacity. This analysis was conducted by linking land-use change data with environmental conditions derived from spatial data interpretation. Thus, this study was able to explain the causal relationship between human activities in land use and changes in ecosystem conditions, which have been shown to impact environmental systems globally (Foley, 2005).

The use of a quantitative approach supported by GIS-based spatial analysis in this study provides the advantage of producing comprehensive, accurate, and scientifically based information. This method allows for the integration of spatial and environmental analysis, thus depicting the complex relationship between land-use change and ecosystem balance. Furthermore, the research results obtained through this approach can be used as a basis for formulating sustainable environmental management policies. Thus, this approach not only contributes to the development of science but also has practical implications for efforts to maintain ecosystem sustainability in tropical regions (Longley et al., 2015).



Gambar 1. Research procedure

Land use change is a dynamic process influenced by human activities such as urbanization, agriculture, and natural resource exploitation, which directly impacts the structure and function of ecosystems. In the tropical context, this change is particularly significant because tropical ecosystems possess high biodiversity and play a crucial role in the global carbon cycle and climate balance. According to (Ardi Kusumawati & Prayogo, 2019), land use change from forest to agricultural land can reduce carbon stocks and soil microbial activity, thereby disrupting ecosystem balance. Furthermore, land use change is closely linked to environmental degradation and a decline in overall ecosystem quality (Normasyhuri & Rohadi, 2022).

Several studies have shown that land use change in tropical regions has a significant impact on the biophysical aspects of the environment. (Ardli Swardana, 2022) found that land-use changes in tropical peatlands cause changes in soil carbon dynamics, which have implications for increased carbon emissions. Furthermore, research (Ardiansyah et al., 2025) shows that plantation expansion and mining activities cause changes in land cover that threaten local ecosystems. Another study by (Rafly et al., 2025) also revealed that land-use changes in watersheds cause ecological degradation and impact the socio-economic conditions of communities.

Other research highlights the link between land-use changes and biodiversity decline. (Irwan Saputra Pajerih, 2023) states that human activities such as deforestation and infrastructure development accelerate tropical forest degradation and lead to biodiversity loss. (Ameliyah et al., 2025) also explain that environmental changes, including land-use changes, contribute to ecosystem instability and increase the risk of environmental disasters. Furthermore, global research shows that changes in tropical ecosystems are causing extinction due to the decline in ecological functions such as nutrient cycling and energy balance.

From a hydrological and environmental quality perspective, land-use changes also impact air quality systems and soil fertility. (Normasyhuri & Rohadi, 2022) found that land-use changes in peat areas affect the region's hydrological response. These changes also impact soil carbon content and ecosystem stability. Meanwhile, (Ardi Kusumawati & Prayogo, 2019) showed a decline in soil quality due to the conversion of forest land to cultivated land.

Other studies also show that land-use changes are closely related to increasing anthropogenic pressures. (Ardiansyah et al., 2025) revealed that urbanization and economic expansion are the main factors causing land cover change. (Nur, 2023) emphasized that community activities in land use contribute to environmental degradation. (Irwan Saputra Pajerih, 2023) also added that these changes impact not only the environment but also the socio-economic resilience of communities surrounding the ecosystem.

In general, these studies indicate that land-use changes in tropical regions have multidimensional impacts, ranging from soil degradation, carbon cycle disruption, hydrological degradation, and biodiversity loss. (Ameliyah et al., 2025) emphasizes that these changes worsen ecosystems and increase vulnerability to climate change. Therefore, land-use change is a major factor affecting tropical ecosystems.

Based on this description, it can be concluded that although numerous studies have examined the impacts of land-use change, there is still a gap in the analysis of the integration of biophysical, social, and ecosystem balance holistically, particularly in tropical regions. This new research takes a comprehensive approach that encompasses land-use change and ecosystem

balance as a whole. Therefore, this study aims to analyze land-use change and its impact on ecosystem balance in tropical regions.

3. RESULT AND DISCUSSION

Result

The analysis of land use change indicates significant dynamics in the study area during the observation period. Multi-temporal satellite imagery interpretation revealed a significant decrease in forest cover, much of which was converted to agricultural land and settlements. Furthermore, the increase in built-up areas indicates intensifying anthropogenic pressure on the environment. This pattern of change indicates that human activity is a major factor driving land use transformation in tropical regions, consistent with previous research findings that economic expansion and population growth are the primary drivers of land use change (Lambin & Geist, 2006).

Further spatial analysis revealed uneven distribution of land use change. Areas with high accessibility, such as those near main roads and centers of economic activity, experienced changes more rapidly than relatively remote areas. Furthermore, the land use classification results demonstrated a high level of accuracy based on the confusion matrix test, thus the resulting data can be considered valid for further analysis. This pattern reinforces the assumption that location and accessibility factors play a significant role in determining the intensity of land use change (Wulder, 2018).

The impact of land use change on ecosystem balance is evident in the decline in environmental quality, as indicated by several indicators. The analysis results indicate an increased potential for soil erosion in deforested areas, as well as a reduction in water infiltration capacity due to the increase in impermeable surfaces. Furthermore, changes in vegetation cover also reduce the ecosystem's ability to absorb carbon, which has implications for increased greenhouse gas emissions. These findings align with research suggesting that land-use change contributes to disruptions in the hydrological and carbon cycles (Foley, 2005).

The land-use change simulations conducted in this study indicate that if land conversion trends continue, ecosystem balance will be further disrupted in the future. The simulation model predicts a significant increase in built-up land and a decrease in natural vegetation area in the coming decades. This situation has the potential to lead to the loss of natural habitat, a decline in biodiversity, and increased vulnerability to environmental disasters such as floods and landslides. These results reinforce the importance of sustainable land-use management to maintain ecosystem stability.

Overall, the research results indicate that land-use change is strongly linked to the decline in ecosystem balance in tropical regions. The integration of spatial analysis and simulations provides a comprehensive picture of the impacts, both in the short and long term. These findings emphasize that mitigation and control efforts for land use change need to be carried out in a planned manner and based on scientific data, in order to maintain the sustainability of ecosystem functions and environmental balance in tropical regions.

Discussion

The research results show that land use change in tropical regions is dominated by the conversion of forests to agricultural and residential areas. This phenomenon reflects strong anthropogenic pressures due to economic needs and population growth. Theoretically, this finding aligns with the land use change framework proposed by (Lambin & Geist, 2006), which states that socio-economic factors are the primary drivers of landscape transformation.

Furthermore, this change also indicates a shift from ecological land functions to economic functions, potentially reducing the environment's capacity to optimally provide ecosystem services.

The uneven spatial distribution of land use change indicates that accessibility and proximity to activity centers play a significant role in determining the intensity of change. Areas with good transportation access tend to experience land conversion more rapidly than those with less accessible access. This reinforces the spatial interaction theory, which states that proximity to centers of economic growth increases pressure on land use. Therefore, spatial aspects are a crucial factor to consider in spatial planning to minimize negative impacts on the environment.

The impact of land use change on ecosystem balance is clearly evident in the decline in environmental quality, particularly in hydrology and soil stability. Deforestation reduces the soil's ability to absorb water, increasing the risk of erosion and flooding. Furthermore, reduced vegetation cover also reduces carbon sequestration capacity, contributing to climate change. These findings are consistent with research (Foley, 2005) which states that land-use change is a major factor influencing the global environmental system.

Simulation results showing the potential for increased built-up land and decreased natural vegetation in the future confirm that without appropriate intervention, ecosystem balance will be increasingly disrupted. This simulation provides important predictive insights for environmental planning, particularly in anticipating the long-term impacts of land-use change. Therefore, land management policies based on sustainability principles are needed, such as controlling land conversion and implementing environmentally sound development concepts.

Overall, this discussion confirms that land-use change impacts not only the physical aspects of the environment but also the stability of the ecosystem as a whole. The interrelationships between human factors, spatial conditions, and ecosystem dynamics demonstrate that this issue is complex and multidimensional. Therefore, an integrative approach that combines spatial analysis, environmental policy, and community participation in land-use management is necessary. Thus, the results of this study provide an important contribution in strengthening the understanding of the relationship between land use change and ecosystem balance in tropical regions.

4. CONCLUSION

Based on the research results and discussion, it can be concluded that land use change in tropical regions exhibits significant dynamics, primarily in the form of forest conversion to agricultural land and settlements. This change is influenced by anthropogenic factors such as population growth and economic activity, as well as spatial factors such as regional accessibility. The analysis shows that land use change has a significant impact on the decline in ecosystem balance, characterized by increased erosion, disruption of the hydrological cycle, and decreased carbon sequestration capacity.

Furthermore, simulation results indicate that if the trend of land use change continues unchecked, ecosystem conditions will become increasingly degraded in the future. Therefore, sustainable land management efforts based on scientific data are needed to maintain ecosystem balance. This research also emphasizes the importance of an integrative approach in understanding the relationship between land use change and ecosystem dynamics in tropical regions.

5. ACKNOWLEDGE

The author would like to express his gratitude to the various parties who have supported this research. Special thanks are extended to the geospatial data providers and scientific

information sources who assisted in providing the data necessary for the research analysis. This support was instrumental in ensuring the smooth running of the data collection and processing process.

Furthermore, the author would like to thank his academic colleagues and all parties who provided input, suggestions, and moral support during the research and writing of this article. These contributions are significant in improving the quality of research and thus contributing to the development of science, particularly in the field of environmental geography.

6. REFERENCES

Agnesia, Y., & Ade Fitri, J. (2025). Perubahan Iklim Dan Dampaknya Pada Kesehatan Lingkungan. *Biomedical and Environmental Health Technology*, *2*(1), 19–25. https://doi.org/10.35328/fe7x8s11

Ameliyah, F. K., Iskandar, E. K., Nurhayyizah, N., & Suryanda, A. (2025). Dampak Perubahan Iklim terhadap Ekosistem Hutan Tropis di Indonesia. *Biocaster : Jurnal Kajian Biologi*, *5*(1), 1–6. https://doi.org/10.36312/biocaster.v5i1.336

Angraini Fopy, Selpiyanti Siska, & Walid Ahmad. (2020). Dampak alih fungsi lahan terhadap degradasi lingkungan: studi kasus lahan pertanian sawah menjadi lahan non pertanian. *Jurnal Swarnabhumi*, *5*(2), 35–42. https://jurnal.univpgri-palembang.ac.id/index.php/swarna/article/view/4741

Ardi Kusumawati, I., & Prayogo, C. (2019). Impact of Land Use Change at UB Forest on Microbial Biomass Carbon and Total Bacterial Population. *Jurnal Tanah Dan Sumberdaya Lahan*, *06*(01), 1165–1172. https://doi.org/10.21776/ub.jtsl.2019.006.1.15

Ardiansyah, A., Pratama, Y. B., Wahyuzi, Z., Pramudyantoro, A., & Irwan, A. G. (2025). Identifikasi Pola Perubahan Tutupan Lahan (Land Cover) Akibat Penggunaan Lahan (Land Use) Menggunakan Algoritma Random Forest Di Kabupaten Bangka Tengah. *Journal Sains Student Research*, *3*(6), 1138–1148. https://ejurnal.kampusakademik.co.id/index.php/jssr/article/view/7072

Ardli Swardana. (2022). Dinamika Perubahan CadanganKarbon Akibat Perubahan Penggunaan Lahan di Kesatuan Hidrologis Gambut (KHG) Pulau Rangsang. *JAGROS Journal of Agrotechnonogy and Science*, *6*(2), 115–124.

Foley, J. A. (2005). Global Consequences of Land Use. *Science*.

Ilmi, R., Hermansah, Yulnafatmawita, & Yasin, S. (2026). Dampak Penggunaan Lahan Terhadap Stok Karbon Di Tanah Gambut. *Jurnal Tanah Dan Sumberdaya Lahan*, *13*(1), 1–10. https://doi.org/10.21776/ub.jtsl.2026.013.1.1

Irwan Saputra Pajerih. (2023). Dampak Perubahan Iklim pada Ekosistem Hutan Tropis di Kalimantan Timur: Analisis Krisis Lingkungan. *Jurnal Thengkyang*, *8*(2), 80–87.

Jensen, J. R. (2016). *Introductory Digital Image Processing: A Remote Sensing Perspective* (4th ed.). Pearson.

Lambin, E. F., & Geist, H. J. (2006). *Land-Use and Land-Cover Change: Local Processes and Global Impacts*. Springer.

Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2015). *Geographic Information Systems and Science* (4th ed.). Wiley.

Normasyhuri, K., & Rohadi, E. (2022). Strategi Pengelolaan Zakat , Infaq dan Sedekah (ZIS) Terhadap Pemberdayaan Ekonomi Umat Dalam Pencapaian Sustainable Development Goals (SDGs) pada Masa Covid-19. *Jurnal Ilmiah Ekonomi Islam*, *8*(02), 1947–1962. https://www.jurnal.stie-aas.ac.id/index.php/jei/article/view/5793/2396

Nur. (2023). Community Land Use Activities and Environmental Degradation. *Environmental Research Journal*.

Rafly, M., Nurdin, F., Nur, R. A., Sumange, L., Rahman Syafar, A., & Nasir, A. (2025). Analisis Perubahan Penggunaan Lahan Dan Pemanfaatan LahanOleh Masyarakat Di Das Pamukkulu. *Eco Forest*, *1*(1), 1–8. https://ecoforest.fapertauim.ac.id/index.php/ecoforest

Rahmawati A. Damiti, Parid Pakaya, Mawardi Heru Prasetyo, Dewi Wahyuni K. Baderan, & Ramli Utina. (2025). Stabilitas Ekosistem Hutan Indonesia dalam Menghadapi Deforestasi dan

Kerusakan Lingkungan: Tinjauan Literatur. *Botani : Publikasi Ilmu Tanaman Dan Agribisnis*, *2*(2), 176–188. https://doi.org/10.62951/botani.v2i2.343

Sanjesti, W., & Silviana, A. (2025). Dampak Alih Fungsi Lahan Pertanian Menjadi Lahan Kering. *Legal Standing : Jurnal Ilmu Hukum*, *9*(2), 420–435. https://doi.org/10.24269/ls.v9i2.11650

Turner, B. L., Lambin, E. F., & Reenberg, A. (2007). The emergence of land change science for global environmental change and sustainability. *Proceedings of the National Academy of Sciences*, *104*(52), 20666–20671. https://doi.org/10.1073/pnas.0704119104

Utami, D. N. (2019). Kajian Dampak Perubahan Iklim Terhadap Degradasi Tanah. *Jurnal Alami : Jurnal Teknologi Reduksi Risiko Bencana*, *3*(2), 122. https://doi.org/10.29122/alami.v3i2.3744

Wulder, M. A. (2018). Advances in Remote Sensing for Land Use Analysis. *Remote Sensing of Environment*.