JBKL
Jurnal Bisnis Kehutanan dan Lingkungan
JBKL 2(1): 1–16
ISSN 3025-4833

Institute for Advanced Science, Social and Sustainable Future
MORALITY BEFORE KNOWLEDGE

Analysis of land cover change in Magelang Regency And Magelang City over 15 years

Muhammad Nurhalik Nasir[1]*
[1] *School of Environmental Science, University Indonesia, Jl. Salemba Raya No. 4, Central Jakarta, DKI Jakarta, 10430, Indonesia.*
*Correspondence: muhammadnurhalik@gmail.com

Received Date: 24 May 2024 Revised Date: 23 June 2024 Accepted Date: 31 July 2024

ABSTRACT

Background: Land cover change is an ongoing phenomenon with significant impacts on the environment and human quality of life. An analysis of land cover change was conducted in the Magelang area, which includes both Magelang Regency and Magelang City, over a period of fifteen years from 2007 to 2023. This study aims to analyze these changes using spatial methods based on land cover maps from 2007 and 2023. **Method:** In this analysis, land cover was classified into five categories: settlements, dry fields, paddy fields, forests, and plantations, and then compared between the two years. **Result:** The analysis results demonstrate a significant increase in the area of settlements and dry fields, reflecting urban and rural development. On the other hand, there has been a decrease in the area of paddy fields and forests, which may be related to land conversion for industrial or infrastructure purposes. The change in the area of plantations was not significant, indicating continuity in the management of these lands. **Conclusion:** The findings of this study provide valuable insights into the dynamics of land cover change in the region and can serve as a basis for further actions to maintain a balance between development and environmental conservation. **Novelty/Originality of this study:** This study presents the first longitudinal spatial analysis of land cover changes over 15 years (2007–2023), revealing significant trends in urban and rural land use dynamics. This study provides a scientific basis for sustainable spatial planning by highlighting the urgency to balance development infrastructure with preserving farmland and forests.

KEYWORDS: Changes; Land Cover; Magelang.

1. Introduction

Land cover is a crucial aspect in understanding environmental changes and regional development (Derajat et al., 2020). Magelang Regency and Magelang City, two adjacent geographic entities in Central Java Province, Indonesia, have experienced rapid development over the past few decades. The land cover changes in this area result from the interaction of various factors, including population growth, urbanization, agriculture, industry, and infrastructure development. Analyzing land cover changes has significant impacts on ecosystems, environmental sustainability, and the quality of life of the residents. This study aims to investigate the land cover changes in Magelang Regency and Magelang City over a 15-year period from 2007 to 2022. The analysis aims to document, analyze, and interpret these changes, as well as to identify the factors influencing land cover changes.

Land cover change results from the complex interaction of various physical, social, economic, and policy factors. Some physical factors influencing land cover change include

Cite This Article:
Nasir, M. N. (2024). Analysis of land cover change in Magelang Regency And Magelang City over 15 years. *Jurnal Bisnis Kehutanan dan Lingkungan*, 2(1), 1-16. https://doi.org/10.61511/jbkl.v2i1.2024.837

topography, climate, and soil. Meanwhile, social and economic factors such as population growth, urbanization, and the demand for land for housing, agriculture, and industry also play significant roles in driving land cover change. Magelang Regency and Magelang City are geographically diverse areas. Magelang Regency, with a larger land area, is predominantly characterized by agricultural land, forests, and rural areas. On the other hand, Magelang City is more urbanized with a higher population density and a substantial amount of land used for residential, commercial, and industrial purposes. The differences in geographical characteristics between these two areas create unique dynamics in land cover change.

One of the important aspects of land cover change analysis is understanding the trends of these changes. Data and information obtained from various sources, including satellite imagery, can be used to identify land cover change trends. Additionally, spatial and temporal analysis can be employed to identify change patterns, both visually and through statistical methods.

The analysis of land cover change also involves identifying the factors that influence these changes. These factors can include population growth, the need for land for specific uses, and natural factors such as climate change. The importance of analyzing land cover change extends beyond understanding the physical environment; it also has significant social and economic implications. Land cover change can affect the availability of natural resources, such as water, soil, and forests. Additionally, these changes can impact residents' livelihoods, air and water quality, and various aspects of community well-being.

Over the past two decades, Magelang Regency and Magelang City have experienced rapid growth in both economy and population. This growth has triggered significant changes in land cover in these areas. Consequently, analyzing land cover changes has become increasingly important for planning and managing future developments. This research will employ various geospatial analysis methods based on satellite imagery data to interpret land cover changes in Magelang Regency and Magelang City from 2007 to 2022. Satellite imagery data, map data, and statistical data will be used to characterize land cover, identify change trends, and analyze the factors influencing these changes. The results of this study are expected to provide insights into the land cover changes occurring in Magelang Regency and Magelang City.

Furthermore, this study will discuss the key findings in the analysis of land cover change in Magelang Regency and Magelang City, including the main change trends, the factors influencing these changes, and their implications for environmental sustainability and regional development. Thus, this research will provide important contributions to the understanding and management of land cover change in Magelang Regency and Magelang City, and serve as a foundation for developing policies and actions that support sustainable regional growth in the future.

1.1 Magelang Regency and Magelang City

Magelang Regency and Magelang City are two entities that have a long history that is closely related. Magelang Regency is located in Central Java Province, Indonesia, with the capital in Mungkid City. This regency borders Temanggung Regency and Semarang Regency to the north, Semarang Regency, Boyolali Regency, and Klaten Regency to the east, Kulon Progo Regency, Sleman Regency (Special Region of Yogyakarta), and Purworejo Regency to the south, and Wonosobo Regency and Temanggung Regency to the west. This area is known as a mountainous/highland area with five main mountains, namely Mount Merapi, Mount Merbabu, Mount Sumbing, Mount Telomoyo, and the Menoreh Mountains. The history of Magelang Regency has strong roots with Hindu-Buddhist influences in the past, which is reflected in the existence of Borobudur Temple, one of the famous UNESCO World Heritage Sites.

The history of Magelang Regency cannot be separated from the development of Magelang City. In 1812, Deputy Governor Sir Thomas Stamford Raffles appointed Raden Ngabehi Danukromo as the first Regent of Magelang with the title RAA Danuningrat I. This happened as a result of an agreement between England and the Yogyakarta Sultanate which

handed over the Kedu region to the British government. Furthermore, Danuningrat I became the first regent in Magelang Regency with the title Adipati Danuningrat I. Through Law No. 2 of 1948, the position of Magelang Regency was strengthened with the capital in Magelang City. Then, in 1950, Magelang City became a separate entity based on Law No. 13 of 1950 and was given the right to regulate its own household. On March 22, 1984, the southern part of Mertoyudan sub-district and the northern part of Mungkid sub-district were officially selected as the capital of Magelang Regency with the name Mungkid City (Ministry of Education and Culture, 2018).

Magelang City is the administrative and economic center of Magelang Regency. The city has a strong historical heritage related to the Dutch colonial period. Several historical buildings in Magelang City, such as those located on Jalan Pemuda, bear silent witness to its rich past. Initially, Magelang City began as the Mantyasih perdikan village, which is currently known as Kampung Meteseh in Magelang Village. Kampung Meteseh contains historical value with a stone mortar which is considered to be the place for the Sima or Perdikan determination ceremony. The Poh inscription, Gilikan inscription, and Mantyasih inscription are sources of inscriptions used to reveal the history of Magelang City (Priyatmoko et al., 2022).

Magelang Regency has a fairly large area. Its area includes beautiful lowlands and hills with a distinctive tropical climate with a total area of 1,806 km2. Magelang Regency consists of 21 sub-districts, 5 sub-districts and 367 villages and a population of 1,363,290 people in 2021. Thus, the population distribution in Magelang Regency is 1,255 people/km2 (BPS, 2007; BPS, 2023). Meanwhile, Magelang City, as the capital of the district, has a smaller area, which includes the administrative and urban centers with an area of 18.54 km2. Magelang City consists of 3 sub-districts and 17 sub-districts and a population of 121,610 people in 2021 (BPS, 2007; BPS, 2023).

1.2 Definition and basic concepts of land cover

Land cover is one of the basic concepts that is very important in geography, ecology, and environmental science (Latue, 2023; Bueren et al., 2012). This term refers to the type of land use and the physical or biological conditions of a particular geographic area. This definition of land cover provides an overview of how humans and nature utilize and interact with land, which is a key component in understanding the dynamics of ecosystems and the environment. Scientifically, land cover can be explained as a physical or biological characteristic that includes the type and quality of land use as well as the plants and physical structures on it (Sihombing, 2020). It covers various categories, including forests, agricultural land, urban areas, water, grasslands, and so on. Land cover also considers changes in the type of land use over time, such as deforestation, urbanization, or other land use transformations (Safitri et al., 2022; Parris, 2016).

One of the data sources that is often used in land cover analysis is satellite imagery. This satellite imagery provides a clear picture of land cover on a regional to global scale (achmadi et al., 2023). NASA (National Aeronautics and Space Administration) and ESA (European Space Agenc) are two agencies that provide satellite imagery data that is widely used in land cover monitoring and analysis. The use of the land cover concept has had a significant impact on various areas of life. In the context of ecology, land cover has a crucial role in influencing ecosystems and biodiversity, where land cover data helps scientists understand environmental changes to organisms and ecosystems, so they can develop more effective conservation strategies (Kelly-fair et al., 2022). From the field of spatial planning, understanding land cover is key to efficient land use management, urban management, and population growth control, where this information is very helpful in policies that support environmental sustainability (Wijayakusuma, 2023). In the context of climate change, changes in land cover such as deforestation have a significant impact on global climate change, where scientific research utilizes land cover data to understand the role of land in the carbon cycle and climate change which then becomes the basis for formulating related policies (Dewa and Sejati, 2019). Meanwhile, in terms of natural resource management, land

cover plays an important role in identifying potential environmental damage and enabling the creation of sustainable policies to maintain the sustainability of natural resources (Sari, 2021).

Land cover is a description of the type of land use and surface cover in a geographic area (Latue and Rakuasa, 2023; Achmadi et al., 2023; Marlina, 2022). Land cover types are diverse, and a deep understanding of these types is important for environmental monitoring, ecological science, and regional planning (Septory, 2023). Land cover types can be categorized into several distinct classifications that play crucial roles in our ecosystem. Forests, characterized by areas covered with tall vegetation including trees and plants, serve as vital reservoirs for biodiversity and carbon storage (Calambás-Trochez et al., 2023; Suni et al., 2023). Agricultural land encompasses areas dedicated to farming activities such as rice fields, corn plantations, and gardens, which are fundamental for food production (Rachmadiyanto et al., 2020). Urban areas comprise human settlements, including infrastructure, buildings, and other built-up zones that reflect human development patterns (Sari and Yuliani, 2021). Water bodies, including rivers, lakes, and oceans, form a critical component of land cover that sustains the hydrological cycle and aquatic ecosystems (Leal et al., 2022). Grasslands, characterized by grass vegetation and low-growing plants, are typically found in regions with limited rainfall (Ayunita et al., 2021). Wet zones encompass areas that experience frequent flooding, including diverse habitats such as swamps and mangroves (Mubarokah and Hendrakusumah, 2022). Finally, built-up land represents areas developed for human infrastructure like roads, airports, and industrial facilities, which can significantly impact environmental conditions (Sugandhi et al., 2022).

1.3 Factors influencing land cover change

Land cover change is a phenomenon that can have a significant impact on the environment, ecosystem, and society (Kaswanto et al., 2021). This change can occur due to various interrelated factors. The factors causing land cover change are divided into two, namely natural factors and anthropogenic factors. Natural factors include geomorphological processes such as earthquakes, which are natural events that can cause changes in land cover. Earthquakes can trigger landslides, landslides, and land subsidence (Sutikno, 2020). As a result, land may change from forest to bare land or submerged in water, depending on how deep the earthquake affects. Volcanic eruptions can change landscapes in dramatic ways. Volcanic ash and lava flows released during an eruption can cover fertile land and replace it with hard volcanic material (Sutikno, 2020). Erosion is a natural process that erodes soil and can change land topography (Mubarokah and Hendrakusumah, 2022). Erosion can cause loss of fertile soil layers and significant changes in land cover.

In terms of climate change, global climate change, such as global warming, can affect rainfall and temperature patterns. This can affect vegetation and ecosystem composition, resulting in broader land cover changes, including forest shifts, droughts, and changes in natural vegetation (Dewa and Sejati, 2019). Changes in seasonal cycles, such as longer dry seasons or excessive rainfall, can affect ecosystems and vegetation. This can trigger land cover changes such as reduced plant numbers, and even ecosystem transformation.

Regarding river and coast dynamics, shoreline changes are the result of erosion, sedimentation, and changes in river flow. This can change coastal land, replace mangrove forests with water areas or cover coral reefs with sediment (Sutikno, 2020). Rivers can change the shape of the land through water flow, flooding, and sedimentation. These changes can trigger changes in vegetation and land composition along the river (Sutikno, 2020).

As for anthropogenic factors, human population growth and urbanization have become major drivers of land cover change. Demand for settlements, infrastructure, and urban facilities has resulted in the conversion of agricultural land, forests, and open land into urban areas (Hidayat and Noor, 2021; Sari and Yuliani, 2021). This process, often referred to as "land conversion," can alter native landscapes and ecosystems. Deforestation is the

widespread clearing of forests and has a major impact on land cover. Anthropogenic factors such as timber exploitation, conversion of forest land to agricultural land, and opening of roads and mining in forests have reduced forest area in many areas (Kaswanto et al., 2021). This has a negative impact on biodiversity and causes climate change due to the loss of carbon stored in forests. Land cover changes are often related to agriculture. Conversion of agricultural land, changes in crop types, and unsustainable agricultural practices, such as pesticide use and overgrazing, can lead to land degradation and loss of agricultural productivity (Ayunita et al., 2021). Mining activities, especially open pit mining, affect land cover by changing land topography, creating hazardous waste, and disrupting natural ecosystems. Mining can cause significant erosion, water pollution, and habitat destruction (Sihombing, 2020). Infrastructure development, such as roads, bridges, dams, and ports, often involves significant changes in land cover (Mubarokah and Hendrakusumah, 2022). This development can change river flows, cause flooding, and affect freshwater ecosystems. Land use change is often related to the transformation of land from one use to another. For example, land that was originally used for agriculture can be converted into industrial or residential land. This has an impact on biodiversity, groundwater, and overall land use (Achmadi et al., 2023). Lastly, anthropogenic activities, such as greenhouse gas emissions, have an impact on climate change. This climate change can trigger changes in weather patterns, temperature, and rainfall, which in turn affect land cover such as forests, grasslands, and wetlands (Dewa and Sejati, 2019).

2. Methods

The study area is located in Magelang Regency and Magelang City, which are in Central Java Province. Magelang Regency is situated at an altitude between 153 and 3,605 meters above sea level and is surrounded by three mountains: Mount Merapi to the southeast, Mount Sumbing to the east, Mount Sumbing to the northwest, and the Menoreh Mountains to the southwest. Additionally, Magelang Regency borders Sleman Regency in Yogyakarta Province to the south, Purworejo Regency to the southwest, Wonosobo Regency to the west, Temanggung Regency to the north, and Boyolali Regency to the east. Magelang Regency comprises 21 districts, 5 urban villages, and 367 rural villages.

Meanwhile, Magelang City is located in the center of Magelang Regency, at an elevation of 350 meters above sea level, and is flanked by two major rivers, the Elo River to the east and the Progo River to the west. Magelang City consists of three districts: North Magelang, Central Magelang, and South Magelang. A unique feature of Magelang City is Mount Tidar, located at its center, which is known locally as the "nail of Java."

The analysis process begins with processing land use data from RBI maps to identify and classify land cover. Then, using the data from these RBI maps, land use maps are produced to represent the land cover in Magelang Regency and Magelang City for the years 2007 and 2023. These maps serve as the primary source for identifying land cover changes between 2007 and 2023 based on land use, supported by statistical data. Additionally, slope maps and soil type maps are used to support the identification of factors influencing land cover changes. The results of this analysis will provide deep insights into how factors such as population growth and the physical characteristics of the region affect land cover changes in Magelang Regency and Magelang City.

3. Results and Discussion

3.1 Population

The population in Magelang Regency and Magelang City has experienced growth over the period from 2007 to 2021. In 2007, Magelang Regency had a population of approximately 1,188,962 people, while Magelang City, the administrative and economic center, had a population of around 121,010 people. Twelve years later, in 2021, significant

population growth was observed in both areas, with Magelang Regency recording a population of about 1,305,512 people, and Magelang City reaching a population of around 121,526 people.

Table 1. Magelang population by sub-district

Sub-district	2007	2022
Salaman	67,700	74,429
Borobudur	55,816	62,576
Ngluwar	31,498	32,488
Salam	42,256	48,202
Srumbung	44,502	48,522
Dukun	43,741	46,706
Muntilan	73,741	80,050
Mungkid	70,038	74,959
Sawangan	55,838	57,827
Candimulyo	45,917	49,990
Mertoyudan	95,187	116,356
Tempuran	46,370	52,329
Kajoran	56,613	59,894
Kaliangkrik	54,847	59,884
Bandongan	53,959	61,479
Windusari	49,518	51,920
Secang	73,168	82,873
Tegalrejo	48,052	55,062
Pakis	54,170	54,689
Grabag	85,479	93,384
Ngablak	40,552	41,893
Total	1,188,962	1,305,512

These changes reflect various dynamics in the population of Magelang. Factors such as natural population growth, inter-regional migration, economic development, and changes in land use can provide relevant explanations. The population growth observed in Magelang Regency may indicate economic development that attracts people to the area, while in Magelang City, factors such as urbanization and urban investments might play a role in the relatively lower population growth.

One of the driving factors behind the population growth in both Magelang Regency and Magelang City is their strategic position as a connector between the northern and southern parts of Java Island. The high mobility facilitated by the national road connecting Central Java with the Special Region of Yogyakarta, along with the influence of the Joglosemar (Jogja-Solo-Semarang) agglomeration, makes the Magelang area an attractive place to settle in the heart of Java Island.

3.2 Geographic conditions

Magelang Regency is located in Central Java Province, Indonesia, and features a diverse geography that includes geological aspects, morphology, slope gradients, rivers, geomorphology, and a strategic location. Geologically, this area consists of several geological formations, including sedimentary rocks and volcanic rocks that reflect a long geological history. The morphology of the region is characterized by basins surrounded by various mountains and hills. Therefore, the land morphology in Magelang Regency and Magelang City is greatly influenced by the surrounding volcanoes and the Menoreh Hills.

The diverse morphology of Magelang Regency and Magelang City is traversed by important rivers such as the Progo River and the Elo River, which play crucial roles in regional drainage and provide water for agriculture. Additionally, the geomorphology of this region affects soil conditions, erosion, and land use. The strategic location of Magelang Regency also plays a significant role in the area's development. Situated on the main route connecting important cities like Yogyakarta and Semarang, and close to famous historical

sites such as Borobudur Temple, the region holds significant tourism potential. The diverse geography, with its impressive mountains and natural variety, creates an attraction for both local and international tourists. Furthermore, the development of the Trans-Java toll road, which will stretch through Magelang from Bawen to Sleman, will impact the future of Magelang. The presence of this toll road will influence the development of the Magelang region moving forward.

3.3 Land cover of Magelang Regency and Magelang City in 2007

In 2007, Magelang Regency and Magelang City, located in Central Java Province, Indonesia, had diverse land cover reflecting the variety of economic activities and land uses in the region. Land cover is crucial for regional development, as it mirrors the state of the area. Land cover data were obtained from the 2008 Indonesian topographic map (RBI), with the total area of Magelang Regency and Magelang City covering 103,144 hectares.

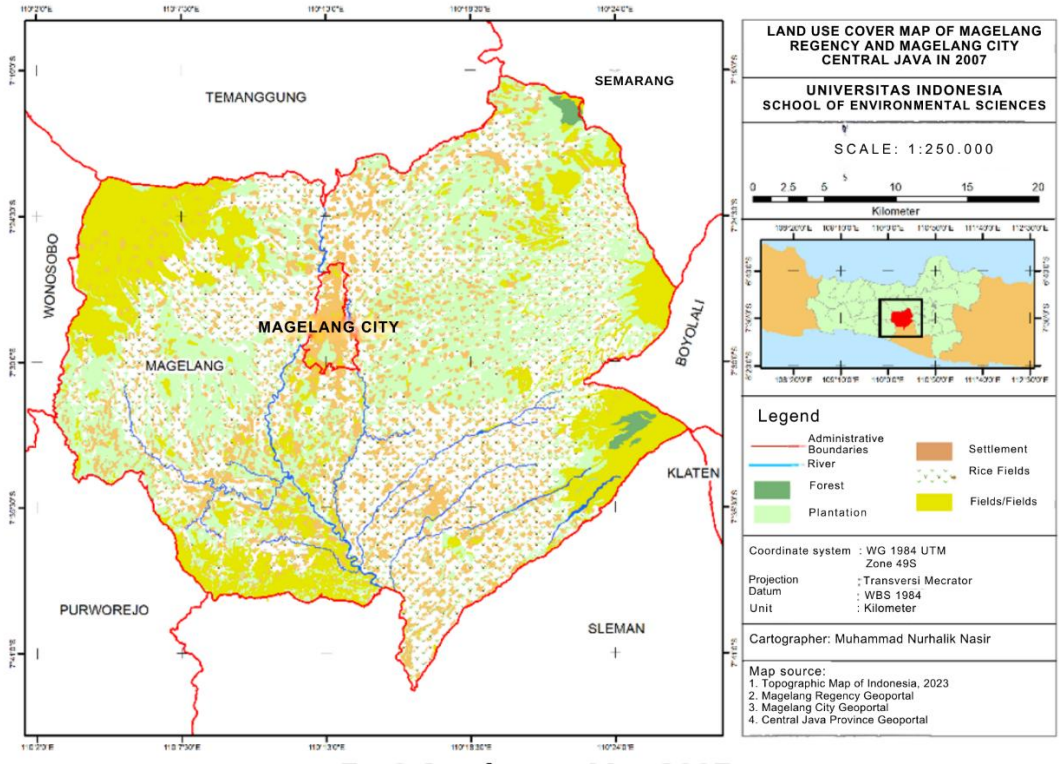

Fig 1. Land cover map of Magelang Regency and Magelang City, Central Java

Based on Figure 1, Magelang Regency and Magelang City have a total of 670 hectares of land used as forest. This forest plays a crucial role in maintaining environmental sustainability, including serving as wildlife habitat and natural resource. Meanwhile, plantations are a significant economic sector in this region, covering an area of 33,430 hectares. The crops commonly grown here include various types such as coffee, tea, rubber, and other agricultural products. Plantations make a substantial contribution to the local economy, creating jobs and income for the local community.

Settlements in Magelang Regency and Magelang City cover an area of approximately 19,132 hectares. This reflects population growth and urban development. These settlements are home to residents and are centers of economic, social, and cultural activities. Paddy fields, covering 42,344 hectares, are an essential component of the agricultural sector in this region. These fields are used for cultivating rice and other staple crops, supporting food security and the local economy. Additionally, there are 7,568 hectares of dry fields, often used for small-scale farming, such as vegetable and fruit plantations. This also contributes to meeting local food needs and providing income for farmers.

3.4 Land cover of Magelang Regency and Magelang City in 2023

The land cover in Magelang Regency and Magelang City for the year 2023 is based on the 2023 Indonesian topographic map (RBI), with the total area of Magelang encompassing both Magelang Regency and Magelang City, covering 126,200 hectares. The land cover data are categorized into six classifications: forest, plantation, settlement, paddy field, and dry field, as presented in Figure 1.

In 2023, Magelang Regency and Magelang City have a varied land area across different categories. The forest area of 644 hectares is a valuable asset for maintaining ecosystems and biodiversity, as well as providing crucial ecological and social benefits. The preservation and conservation of forests are essential to prevent environmental degradation and natural damage, which impact communities amidst climate change issues.

The plantation area of 33,281 hectares highlights the importance of the agricultural sector in the local economy. Plantations typically include crops such as coffee, cocoa, tea, salak, and other tropical plants. This sector can provide employment and income for local residents. Settlements covering 38,148 hectares signify the growth and development of the region. This category includes homes, infrastructure, government buildings, educational institutions, and public facilities.

Paddy fields covering 42,265 hectares are a vital asset in the agricultural sector and for food security. The rice production from these fields is crucial for meeting local and national food needs. Proper management of paddy fields and the use of modern technology can enhance productivity and ensure sustainable food security. Dry fields covering 11,862 hectares are typically used for seasonal crops or livestock farming.

3.5 Soil types of Magelang Regency and Magelang City

Magelang Regency and Magelang City in Central Java Province have a variety of soil types that affect land use and soil fertility. The four main soil types dominating this region are latosol, regosol, alluvial, and lithosol. Soil type data were obtained from the Soil Research Institute in 2011, with the soil type map shown in Figure 2.

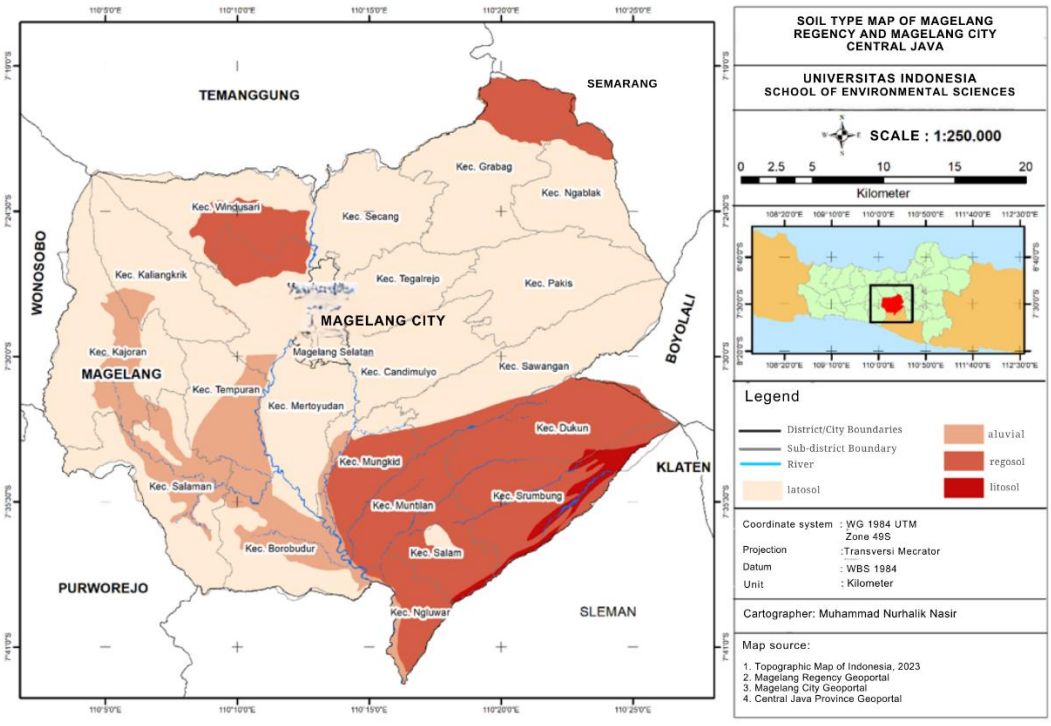

Fig 2. Soil type map of Magelang Regency and Magelang City, Central Java

In the Magelang area, there are several types of soil with different characteristics, namely latosol, regosol, alluvial, and lithosol. Latosol is the dominant type of soil, covering about 60% of the total land area. This red soil is rich in organic matter and minerals, making it very suitable for agriculture, especially for crops such as rice, corn, and vegetables. The advantages of latosol lie in the availability of nutrients and good drainage, although its fertility can decrease due to deforestation and unsustainable land use. In addition, regosol is a type of soil that is poorer in organic matter and minerals, formed due to volcanic activity. This soil is often found in sloping areas and is less suitable for agricultural intensification due to its low resistance to erosion. However, regosol can still be used for conservation-based agriculture, such as cover crops or agroforestry, to reduce the risk of erosion. Meanwhile, alluvial soil is formed from sedimentation of rivers or water bodies, so it has a good texture and high nutrient content. This land is very fertile and supports the growth of various plants such as rice, vegetables, and fruits, and is often used for settlements and infrastructure because of its sufficient thickness and easy access to clean water sources. Finally, lithosol is a type of infertile soil with a thin layer of soil, often found in rocky areas, especially in the southeastern part of Magelang Regency. The existence of lithosol is influenced by the volcanic activity of Mount Merapi, so this land is less suitable for agricultural intensification. However, it can be used for conservation-based agriculture such as dry crops, agroforestry, or livestock, by implementing soil and air conservation efforts to maintain its fertility.

3.6 Slopes of Magelang Regency and Magelang City

Slope gradient is an important factor in determining land use suitability in Magelang Regency and Magelang City. This area features a variety of slope gradients that can influence land cover in both Magelang Regency and Magelang City. Based on Figure 3, slope gradient plays an important role in determining land use in an area. On slopes with a gradient of 0-8%, relatively flat conditions allow land use for intensive agriculture, especially crops such as rice, corn, and vegetables.

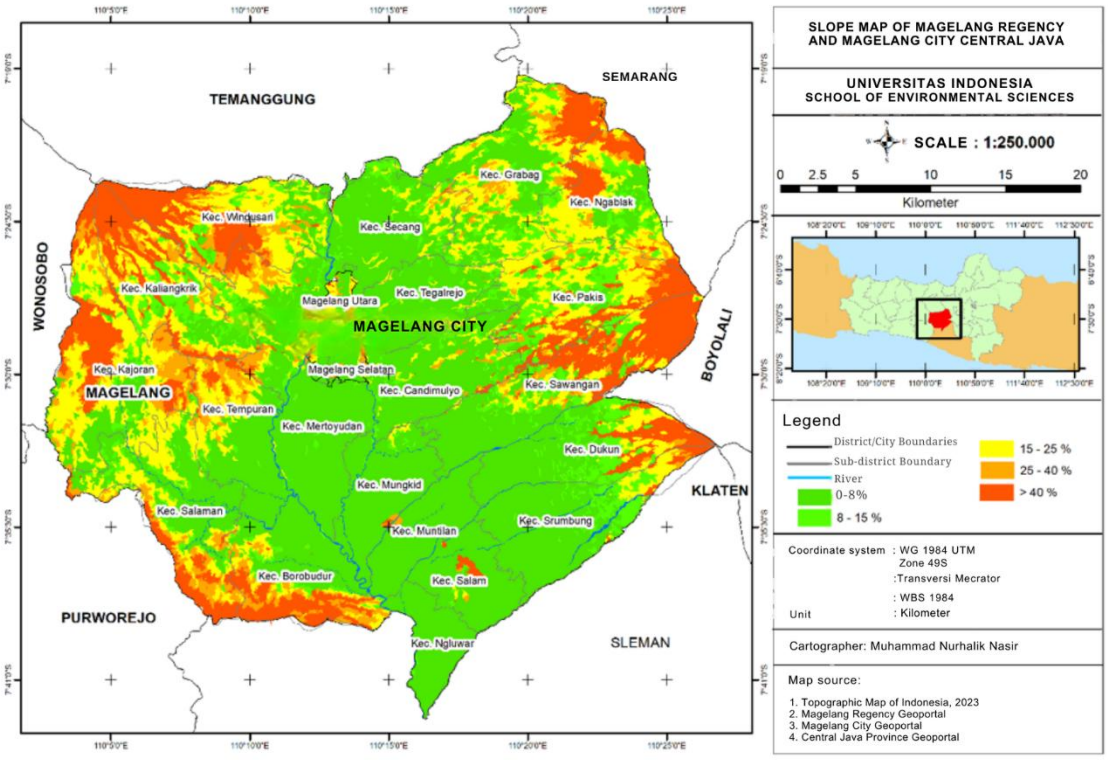

Fig 3. Slope map of Magelang Regency and Magelang City, Central Java

In addition, this area is also often used for settlements and infrastructure development due to high soil stability. Meanwhile, slopes with a gradient of 8-15% are more suitable for non-rice agriculture such as plantations and gardens, where plants that require good drainage, such as coffee, cocoa, and fruits, can grow optimally. On slopes with a gradient of 15-25%, land use is more directed at nature conservation, such as protected forests and nature parks, to reduce the risk of erosion and maintain biodiversity. Several conservation-based agricultural practices, such as agroforestry and ground cover crops, can be applied to maintain slope stability. Steeper slopes with a gradient of 25-40% have limitations in land use and are more suitable for conservation areas. The soil in this area is susceptible to erosion, so it is important to maintain natural vegetation and prevent deforestation to protect ecosystem stability. Meanwhile, slopes with a gradient of more than 40% are classified as very steep and less suitable for intensive land use. This area is generally used as a nature conservation and environmental protection area to maintain ecosystem balance and prevent natural disasters such as landslides and land degradation.

3.6 Land cover change analysis

Land cover change is a highly relevant phenomenon in the context of regional development, environmental conservation, and food security. Magelang Regency is one of the regions in Indonesia that has experienced significant land cover changes. In this analysis, based on land cover maps, the focus is on forests, plantations, settlements, rice fields, and dry fields.

3.6.1 Forest

Forests play a crucial role in maintaining environmental sustainability and ecosystems in the Magelang region of Central Java. This area is renowned for its extraordinary natural diversity, including lush forests that thrive around the mountains that shelter the region. These forests are not only essential elements of Magelang's natural landscape but also have a significant impact on the environment, the livelihoods of the local population, and various aspects of life.

One of the most important ecosystem services provided by these forests is water management. The forests in the Magelang area function as natural water reservoirs and ensure water availability. They act as "water nurseries," helping to regulate river flow patterns and maintain water quality. This directly impacts water security for surrounding communities. A reduction in forest area can lead to increased soil erosion and irregular river flow, which in turn can affect the water supply for settlements and agriculture downstream.

Forests also provide economic benefits to the local community. Forestry products such as timber, bamboo, and non-timber forest products like forest fruits serve as sources of income and livelihoods for many residents in the area. Additionally, these forests support ecotourism. Tourist visits to forest areas help boost the local economy and provide incentives to preserve the natural beauty and environment.

The factors contributing to the decline in forest area over this period are complex. One major factor is land encroachment for infrastructure development, agriculture, and settlement purposes. In some cases, forests have been cleared or converted into agricultural land or settlements to meet the needs of the rapidly growing population. The increase in settlements is a sign of significant population growth and urbanization in the region. This reflects demographic changes that impact land use and the need for residential land. The impact of the decline in forest area in the Magelang region is substantial. The loss of forests can threaten biodiversity, affect water availability, worsen soil erosion, and damage local ecosystems. Therefore, these changes must be managed wisely to protect the environmental sustainability and biodiversity of the Magelang region.

3.6.2 Plantatio

Plantations are an integral component of the economy and agriculture in Kabupaten Magelang and Kota Magelang. The region is known for producing a variety of commercial crops, including coffee, tea, rubber, salak, and cloves, which significantly impact farmers' incomes and the local economy. Between 2007 and 2023, data shows a slight decrease in the area of plantations, from 33,430 hectares to 33,281 hectares. Although this decline is not drastic, it has important implications for agriculture and the environment in Magelang.

Several factors influence the changes in plantation area in Magelang Regency and Magelang City during the observed period. First, land use and spatial planning policies play a significant role in regulating land use structure. Changes in land ownership, land tenure regimes, and infrastructure development policies, such as roads and housing, can affect the size of plantation areas (Hidayat and Rofiqoh, 2020). The conversion of land for other purposes, such as residential, industrial, or infrastructure use, can also lead to the reduction of plantation areas. Second, climate factors are crucial in influencing plantation productivity. Climate variability, including changes in rainfall patterns and temperature, can impact the growth and health of plantation crops. Unfavorable climate conditions can reduce harvest yields and overall plantation productivity (Mubarokah and Hendrakusumah, 2022). Long-term climate changes, such as more frequent droughts or rising average temperatures, can also affect land use structure and the types of crops that can be successfully cultivated. Third, socio-economic changes can play a role in altering plantation areas. Migration of farmers to other sectors, such as industry or services, can lead to a decline in the active farming population in the plantation sector. This can result in a reduction of intensively managed and cultivated land. Additionally, changes in social and economic conditions can influence farmers' land use preferences. If farmers opt to switch to other ventures perceived as more profitable, the plantation area may decrease.

Based on various literature sources (Sihombing, 2020; Sari and Yuliani, 2021; Mubarokah and Hendrakusumah, 2022; Ilham et al., 2018), a significant reduction in plantation area in Magelang Regency and Magelang City has the potential to impact various aspects of the region. From an economic perspective, plantations have long been a sector that makes a major contribution to the local economy. A decrease in plantation area can lead to reduced production and income, which ultimately impacts the welfare of farmers and communities who depend on this sector as a source of livelihood. In addition, from an environmental perspective, reduced plantation land can increase pressure on forest areas and other natural ecosystems, especially if there is uncontrolled land conversion. This has the potential to cause deforestation, habitat degradation, and increase the risk of soil erosion. From a food security perspective, a reduction in plantation area can disrupt the production of commodities such as coffee, tea, and snake fruit, which are not only part of local consumption but also contribute to global trade. This decrease in production can have an impact on the stability of food supply and an export-based economy. Meanwhile, from the aspect of land use patterns, changes in plantation area can trigger the shift of land function into organizational or industrial areas. This shift can have implications for changes in regional spatial planning that require appropriate policy planning to maintain a balance between development and environmental poverty.

3.6.3 Ricefield

The paddy fields in the Magelang region are a vital component of the agricultural structure and food security in the area. Data obtained between 2007 and 2023 reveal significant changes in the area of paddy fields in Kabupaten Magelang and Kota Magelang, with a decrease from 42,344 hectares to 42,265 hectares. This change has profound implications for the local agricultural sector and environment. Paddy fields are a type of agricultural land specifically used for growing rice, which requires regular and controlled irrigation to meet the water needs during the plant's growth period (Firmansyah et al., 2021; Hasanah et al., 2021). Changes in land cover reflect shifts in land use, indicating a

decrease in the available paddy field area. This reduction signifies a shift in agricultural practices or land use in the region, possibly due to a complex set of factors.

At a basic level, changes in the area of paddy fields can be attributed to various factors affecting spatial planning and land use in Magelang. Firstly, population growth and urbanization are major contributors to the conversion of paddy fields into residential or industrial zones (Ayunita et al., 2021). As cities expand, agricultural land is often sacrificed to meet the demands for housing and industry, conflicting with the original function of paddy fields as a food source.

Additionally, climate change and rainfall patterns can also impact the productivity and sustainability of paddy fields. Changes in temperature and unstable rainfall patterns can alter the planting and harvest seasons, affecting the productivity of paddy fields. In some cases, more frequent floods or droughts can damage rice crops and reduce the productivity of paddy land.

3.6.4 Tegalan/dry fields

Tegalan, or dry fields, are a common form of agricultural land use in Kabupaten Magelang, Central Java, and constitute an important part of the local farming system. These fields are typically planted with seasonal or annual crops such as rice, corn, vegetables, and legumes. Farming practices on these lands align with the primary livelihood of the residents in this region, who are predominantly farmers. Between 2007 and 2023, there has been a significant change in land cover in the Magelang area. Collected data indicates that the area of tegalan has seen a substantial increase, from 7,658 hectares in 2007 to 11,862 hectares in 2023. This change reflects a significant shift in the structure of agricultural land use in the region.

Land use involving tegalan or dry fields is more prevalent in Kabupaten Magelang compared to Kota Magelang. In this context, the use of tegalan/ladang refers to common agricultural practices where the land is planted with seasonal or annual crops such as rice, corn, vegetables, and legumes, aligning with the primary occupation of the residents, who are mostly farmers.

Changes in the land cover of dry fields (tegalan) have multifaceted impacts. The most obvious positive impact is the increase in food production, which can support food security in the region. Tegalan fields are a primary source for producing staple crops such as rice, corn, and vegetables, which are crucial for meeting the food needs of the population. However, changes in land cover can also have negative impacts that need to be considered. One potential negative impact is soil erosion. The expansion of agricultural land, especially in sloped or contoured areas, can increase the risk of soil erosion, which can degrade land fertility and reduce soil quality. Additionally, these changes can affect the surrounding environment, particularly if they lead to deforestation or the conversion of natural land. This can reduce natural habitats and potentially threaten biodiversity. Therefore, wise and sustainable management of agricultural practices on tegalan is key to maximizing economic benefits while protecting the environment and ensuring the sustainability of agricultural land in Magelang. Practices such as efficient water management, erosion prevention, and the preservation of natural habitats should be prioritized to maintain a balance between productive agriculture and a sustainable environment.

In areas like Kabupaten Magelang, Central Java, slope gradient and soil type play important roles in land cover changes. Slope gradients ranging from 0 to 8% are relatively flat and more suitable for intensive agriculture, such as rice, vegetable, and fruit farming. Here, access is easier, and land use can efficiently include settlements and infrastructure. However, soil and water conservation practices must be implemented to avoid erosion and environmental degradation. Slope gradients between 8 and 15% present more challenging conditions for land use. Such lands are often used for plantations and non-rice agriculture, such as coffee, cocoa, and rubber. These conditions allow for better drainage, which is crucial for crops that require good water flow. Conservation practices are also important to maintain soil fertility here.

Soil type also plays a role in land use. Latosol, rich in minerals and nutrients, is suitable for agriculture, especially food crops. Regosol, although less developed, can still be used for agriculture with wise soil management. Meanwhile, fertile alluvial soils are often used for intensive agriculture, especially vegetable and fruit crops.

The combination of slope gradient and soil type creates interesting variations in land use in areas like Magelang. These factors play a key role in shaping the diversity of the agricultural landscape in this region. Areas with low slope gradients, often dominated by fertile latosol soils, provide an ideal backdrop for productive rice farming. Farmers here take advantage of the gentler topography to cultivate rice, corn, and soybeans. The abundant harvests meet local food needs and contribute significantly to the rice supply in the region.

Conversely, areas with steeper slopes and regosol soils open up opportunities for thriving plantations. Crops such as coffee and rubber grow well in these soils, which have good drainage and ideal conditions for deep-rooted plants like coffee. Farmers here have adapted to the more contoured topography by creating agricultural terraces that allow plantation crops to grow optimally. The result is the production of high-quality coffee and rubber, which are important sources of income for local communities. Meanwhile, areas with alluvial soils, often found along rivers flowing through Magelang, support intensive agriculture that includes a variety of crops. The fertile alluvial soils, rich in organic matter, create ideal conditions for growing various vegetables, fruits, and food crops. Here, farmers use advanced irrigation systems to ensure an adequate water supply, supporting sustainable production throughout the year. The result is a diverse and abundant market that meets the varied food needs of the region.

4. Conclusions

Based on Based on the analysis of land cover changes in Magelang Regency and Magelang City, Central Java Province, there are several key findings that reflect the dynamics of land use in the region. One of the most striking changes is the alarming deforestation, with forest area decreasing from 670 hectares in 2007 to only 644 hectares in 2023. This trend is a serious concern considering the role of forests in maintaining ecosystem balance, reducing carbon emissions, and preserving biodiversity. This deforestation is most likely triggered by plantation expansion, settlement expansion, and illegal activities such as illegal logging.

In addition, significant growth in settlements and plantations is also a major phenomenon, with settlements reaching 38,148 hectares and plantations 33,281 hectares in 2023. This increase indicates rapid urbanization, which can have positive economic impacts, but also poses challenges in environmental management and adequate infrastructure. Meanwhile, the increase in rice fields and dry land areas indicates efforts to meet the increasing need for food. Rice fields remain the main source of rice and other staple food production, while dry land plays a role in diversifying agricultural products. With continued population growth, maintaining agricultural productivity is a top priority to ensure food security in the region.

Acknowledgement

The author would like to extend sincere appreciation to the IASSSF team for their invaluable support and assistance throughout the research and writing process. Their guidance, feedback, and resources have been instrumental in shaping this work and ensuring its completion. We are grateful for their dedication and commitment to advancing scholarly endeavors.

Author Contribution

M.N.N contributed fully to the conception, design, research, analysis, interpretation of data, drafting, and revising of this article. M.N.N approved the final version to be published and are accountable for all aspects of the work.

Funding

This research received no external funding.

Ethical Review Board Statement

Not available.

Informed Consent Statement

Not available.

Data Availability Statement

We encourage all authors of articles published in this journal to share their research data. This section provides details regarding where data supporting reported results can be found, including links to publicly archived datasets analyzed or generated during the study. A statement is still required when no new data are created or unavailable due to privacy or ethical restrictions.

Conflicts of Interest

The authors declare no conflict of interest.

Open Access

References

Achmadi, P. N., Dimyati, M., Manesa, M. D. M., & Rakuasa, H. (2023). Model perubahan tutupan lahan berbasis CA-Markov: Studi kasus Kecamatan Ternate Utara, Kota Ternate. *Jurnal Tanah dan Sumberdaya Lahan, 10*(2), 451–460. https://doi.org/10.21776/ub.jtsl.2023.010.2.28

Ayunita, K. T., Widiati, I. A. P., & Sutama, I. N. (2021). Pengendalian alih fungsi lahan pertanian pangan berkelanjutan. *Jurnal Konstruksi Hukum, 2*(1), 160–164. https://doi.org/10.22225/jkh.2.1.2987.160-164

Badan Pusat Statistik (BPS). (2007). *Kabupaten Magelang Dalam Angka*.

Badan Pusat Statistik (BPS). (2023). *Kota Magelang Dalam Angka.*

Bueren, E.V., Bohemen, H.V., Itard, L., Vischer, H. (2012). *Sustainable Urban Environments: An Ecosystem Approach*. New York: Springer.

Calambás-Trochez, L. F., Velazco, S. J. E., Hoffmann, P. M., Gurski, E. M., Brum, F. T., & Carlucci, M. B. (2021). Climate and land-use changes coupled with low coverage of protected areas threaten palm species in South Brazilian grasslands. *Perspectives in Ecology and Conservation, 19*(3), 345–353. https://doi.org/10.1016/j.pecon.2021.03.010

Derajat, R. M., Sopariah, Y., Aprilianti, S., Candra Taruna, A., Rahmawan Tisna, H. A., Ridwana, R., & Sugandi, D. (2020). Klasifikasi Tutupan Lahan Menggunakan Citra Landsat 8

Operational Land Imager (OLI) di Kecamatan Pangandaran. *Jurnal Samudra Geografi*, *3*(1), 1-10. https://doi.org/10.33059/jsg.v3i1.1985

Dewa, D. D., & Sejati, A. W. (2019). Pengaruh perubahan tutupan lahan terhadap emisi GRK pada wilayah cepat tumbuh di Kota Semarang. *Jurnal Penginderaan Jauh Indonesia, 1*(1). http://jurnal.mapin.or.id/index.php/jpji/issue/view/124

Firmansyah, F., Yusuf, M., & Argaini, T. O. (2021). Strategi pengendalian alih fungsi lahan sawah di Provinsi Jawa Timur. *Jurnal Penataan Ruang, 16*(1), 47–53.

Hasanah, F., Setiawan, I., Noor, T. I., & Yudha, E. P. (2021). Pemetaan sebaran tingkat alih fungsi lahan sawah di Kabupaten Serang. *Jurnal Agrica, 14*(2), 171–182. https://doi.org/10.31289/agrica.v14i2.5039

Hidayat, M. A., & Noor, A. (2020). Pengaruh pertumbuhan ekonomi terhadap alih fungsi lahan di Kota Samarinda. *Inovasi, 16*(2), 299–308. http://journal.feb.unmul.ac.id/index.php/INOVASI

Hidayat, S. I., & Rofiqoh, L. L. (2020). Analisis alih fungsi lahan pertanian di Kabupaten Kediri. *Jurnal Social Economic, 9*(1), 59–68. https://doi.org/10.26418/j.sea.v9i1.40646

Arifin, M., Haji, C., Purwaningsih, E., & Prarikeslan, W. (2018). Pengukuran erosi aktual pada penggunaan lahan tegalan dan kebun campuran: Studi kasus DAS Bompon, Kecamatan Kajoran, Jawa Tengah. *Jurnal Geografi, 7*(2). http://geografi.ppj.unp.ac.id/index.php/geo/article/view/365?articlesBySameAuthorPage=2

Kaswanto, R. L., Aurora, R. M., Yusri, D., & Sjaf, S. (2021). Analisis faktor pendorong perubahan tutupan lahan selama satu dekade di Kabupaten Labuhanbatu Utara. *Jurnal Ilmu Lingkungan, 19*(1), 107-116. https://doi.org/10.14710/jil.19.1.107-116

Kelly-Fair, M., Gopal, S., Koch, M., Pancasakti Kusumaningrum, H., Helmi, M., Khairunnisa, D., & Kaufman, L. (2022). Analysis of Land Use and Land Cover Changes through the Lens of SDGs in Semarang, Indonesia. *Sustainability*, *14*(13), 7592. https://doi.org/10.3390/su14137592

Latue, P. C. (2023). Analisis spasial temporal perubahan tutupan lahan di Pulau Ternate, Provinsi Maluku Utara, citra satelit resolusi tinggi. *Jurnal Geografi, Ekologi, dan Kebencanaan, 1*(1), 31-38. https://doi.org/10.56211/buana.v1i1.339

Latue, P. C., & Rakuasa, H. (2023). Analisis spasial perubahan tutupan lahan di DAS Wae Batugantong, Kota Ambon. *Jurnal Tanah dan Sumberdaya Lahan, 10*(1), 149-155. https://doi.org/10.21776/ub.jtsl.2023.010.1.17x

Leal, D. C. P. V., Adam, K. D. N., Hüffner, A. N., Fernandes, L. L., & Sena, M. J. D. S. (2022). Impacts of changes in land use and coverage on the Ibicuí River Basin. *Research Square*. https://doi.org/10.21203/rs.3.rs-2203756/v1

Marlina, D. (2022). Klasifikasi tutupan lahan pada citra Sentinel-2 Kabupaten Kuningan dengan NDVI dan algoritme random forest. *Satuan Tulisan Riset dan Inovasi Teknologi, 7*(2), 41-49. http://dx.doi.org/10.30998/string.v7i1.12948

Mubarokah, A., & Hendrakusumah, E. (2022). Pengaruh alih fungsi lahan perkebunan terhadap ekosistem lingkungan. *Jurnal Riset Perencanaan Wilayah dan Kota, 2*(1), 1-14. https://doi.org/10.29313/jrpwk.v2i1.754

Parris, K.M. (2016). *Ecology of Urban Environments.* Melbourne: Wiley Blackwell.

Priyatmoko, H., Sampurno, S. A., & Adji, F. T. (2022). Sejarah Kekuasaan di Magelang: Era Klasik hingga Kolonial. *Prosiding Seminar Nasional Ilmu Sosial Dan Teknologi (SNISTEK)*, *4*, 55–62. Retrieved from https://ejournal.upbatam.ac.id/index.php/prosiding/article/view/5214

Rachmadiyanto, A. N., Wanda, I. F., Rinandio, D. S., & Magandhi, M. (2020). Evaluasi kesuburan tanah pada berbagai tutupan lahan di Kebun Raya Bogor. *Buletin Kebun Raya, 23*(2), 114-125. https://doi.org/10.14203/bkr.v23i2.263

Safitri, R., Vonnisa, M., Marzuki. (2022). Analisis Dampak Perubahan Tutupan Lahan di Kalimantan Terhadap Temperatur Permukaan. *Jurnal Fisika Unand, 11*(2), 173-179. https://doi.org/10.25077/jfu.11.2.173-179.2022

Sari, R. W., & Yuliani, E. (2021). Identifikasi dampak alih fungsi lahan pertanian ke non pertanian untuk perumahan. *Jurnal Kajian Ruang, 1*(2). https://doi.org/10.30659/jkr.v1i2.20032

Septory, J. S., Latue, P. C., & Rakuasa, H. (2023). Model dinamika spasial perubahan tutupan lahan dan daya dukung lahan permukiman Kota Ambon tahun 2031. *Jurnal Pendidikan dan Penelitian Geografi, 4*(1), 51-62. https://doi.org/10.53682/gjppg.v4i1.5801

Sihombing, B.H. (2020). Analisis Perubahan Tutupan Lahan Areal Konsessi Tambang PT Kaltim Prima Coal. *Agrifor: Jurnal Ilmu Pertanian dan Kehutanan, 16*(2), 83-89. https://ejurnal.untag-smd.ac.id/index.php/AG/article/view/106

Sugandhi, N., Supriatna, E., Kusratmoko, E., & Rakuasa, H. (2022). Prediksi Perubahan Tutupan Lahan di Kecamatan Sirimau, Kota Ambon Menggunakan Cellular Automata-Markov Chain. *Jurnal Pendidikan Geografi*, 9(2). Retrieved from https://ppjp.ulm.ac.id/journal/index.php/jpg

Suni, M.A., Muis, H., Arianingsih, I., & Baharuddin, R.F. (2023). Analisis Dan Pemodelan Spasial Perubahan Tutupan Lahan Di Hutan Produksi Terbatas Kecamatan Kulawi Kabupaten Sigi. *Jurnal Tanah dan Sumberdaya Lahan*, 10(2), 273-284. https://doi.org/10.21776/ub.jtsl.2023.010.2.1

Sutikno, et al. (2020). *Geomorfologi Dasar*. Gadjah Mada University Press. Yogyakarta.

Wijayakusuma, B. (2023). Faktor yang Mempengaruhi Alih Fungsi Lahan Daerah Resapan Air Kecamatan Cimenyan. *Jurnal Riset Perencanaan Wilayah dan Kota (JRPWK)*, 3(1). https://doi.org/10.29313/jrpwk.v3i1.1929

Biographies of Author

Muhammad Nurhalik Nasir, School of Environmental Science, University Indonesia, Jl. Salemba Raya No. 4, Central Jakarta, DKI Jakarta, 10430, Indonesia.

- Email: muhammadnurhalik@gmail.com
- ORCID: N/A
- Web of Science ResearcherID: N/A
- Scopus Author ID: N/A
- Homepage: N/A