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Urban Expansion and Agricultural Land Change Patterns in Gapan City, Nueva Ecija (2015–2025): A GIS-Based Analysis of Geoportal Data

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ABSTRACT: Land use and land cover (LULC) changes have become an important concern in rapidly developing areas because of their implications for environmental sustainability, agricultural resource management, and urban planning. In Gapan City, Nueva Ecija, increasing urban expansion and infrastructure development may influence the transformation of agricultural lands into built-up areas, making it necessary to assess recent land cover patterns. This study aimed to analyze the land use and land cover of Gapan City in 2015 and 2025, determine dominant land cover categories, quantify changes in area and percentage distribution, and identify spatial patterns using Geographic Information System (GIS) techniques. Secondary spatial datasets from the National Mapping and Resource Information Authority Geoportal were processed in QGIS through clipping, reprojection, area calculation, percentage computation, and comparative map analysis. Findings show that built-up areas increased by 21.77%. However, despite a 4.27% decrease, annual crops remained the dominant land cover in Gapan City, while grassland showed the highest growth (160.18%). Fishponds and inland water also increased, although fishpond growth reflects a small baseline value. Brush/shrub and perennial crops declined. Based on visual comparison of generated GIS maps, spatial changes were concentrated near the city proper and along transportation corridors. Results indicate spatial trends rather than exact measurements.

KEYWORDS: LULC, Environmental Sustainability, Gapan City, Nueva Ecija, Urban Expansion, GIS, Geoportal, Spatial Changes.

I. INTRODUCTION

A. Background of the Study

Land use and land cover (LULC) changes refer to alterations of the Earth's surface due to human activities or natural processes that modify the distribution and arrangement of land cover types (Tadese et al., 2020). Analyzing LULC is essential in understanding how human activities influence environmental conditions and shape land patterns over time. With continuous population growth and urban expansion, many regions experience significant changes in land use that affect environmental sustainability, resource availability, and urban planning. Among these changes, urban expansion and agricultural land conversion are particularly significant in rapidly developing areas. As infrastructure development progresses, agricultural lands are increasingly transformed into built-up areas, affecting long-term land sustainability. Understanding these transformation patterns is important for effective environmental management and sustainable land-use planning (Khalil et al., 2025). Today, Geographic Information System (GIS) and remote sensing (RS) technologies enable efficient analysis and visualization of spatial data, allowing the identification and characterization of LULC dynamics over time (Mohamed et al., 2020).

Gapan City is recognized as part of the "Rice Granary of the Philippines," where agriculture, particularly rice farming, remains a primary source of livelihood. A large portion of its land area is devoted to agriculture, while other areas include inland fisheries, built-up zones, grasslands, and pasture lands (City Government of Gapan, n.d.). In recent years, the city has experienced urban expansion driven by infrastructure development and improved transportation networks. Its strategic location along the Maharlika Highway (Pan-Philippine Highway), the country's main transport corridor, enhances accessibility and supports regional economic activity (Department of Public Works and Highways, 2025). However, this development also places pressure on agricultural lands, leading to gradual land conversion into built-up areas.

Urban land use changes have important implications for civil engineering and infrastructure planning. The expansion of built-up areas increases impervious surfaces, which affects surface runoff and highlights the importance of effective drainage design. Rapid urbanization may also place stress on drainage systems and increase the risk of urban flooding if infrastructure is not properly planned or upgraded (Rinaldi & Vogelmann, 2026). In addition, urban growth increases the demand for transportation networks and the expansion of utility systems such as water supply, electricity, and sewage services to keep pace with development.

In rapidly developing areas, existing LULC data may no longer accurately reflect current conditions due to continuous urbanization and land transformation processes (Tan et al., 2024). Without regular monitoring, these changes may not be fully captured, limiting effective planning and resource management. In this context, GIS and remote sensing provide reliable approaches for assessing and mapping LULC changes over time (Pande et al., 2021). Therefore, this study analyzes land use and land cover changes in Gapan City from 2015 to 2025, with emphasis on urban expansion and agricultural land conversion, using GIS techniques to provide updated information for planning and decision-making.

B. Statement of the Problem

This study addresses the issue of land use and land cover (LULC) changes in Gapan City over time. With increasing urban expansion and its potential impact on agricultural land, there is a need to assess how land cover has changed and what these changes indicate for future development. Using Geographic Information System (GIS) techniques, this study evaluates LULC changes between 2015 and 2025.

Specifically, the study seeks to answer:

1. What is the land use and land cover of Gapan City in 2015 and 2025?
2. Which land cover category occupied the largest portion of Gapan City in both years?
3. What are the changes in the percentage of area occupied by each land use and land cover category in Gapan City between 2015 and 2025?
4. Which general areas appear to have experienced notable land cover changes based on map comparison?
5. What do these changes indicate about the development and land use patterns of Gapan City?

C. Objective of the Study

This study aims to determine the changes in the land use and land cover (LULC) of Gapan City between 2015 and 2025 using Geographic Information System (GIS) software.

Specifically, the study aims to:

1. Identify the land use and land cover (LULC) classification of Gapan City in 2015 and 2025.
2. Determine the area and percentage distribution of each land cover category.
3. Analyze the changes in the percentage of area occupied by each land use and land cover category between 2015 and 2025.
4. Identify areas showing notable land cover changes based on map comparison.
5. Interpret the observed changes in relation to development and land use patterns of Gapan City.

D. Significance of the Study

This study on the land use and land cover (LULC) changes in Gapan City from 2015 to 2025 provides valuable information that can support effective planning and decision-making. The findings are expected to benefit local government units (LGUs), planners, engineers, researchers, and students.

LGU / Planners

The findings can assist the City Government of Gapan in improving land use planning, zoning regulations, and policy formulation, particularly in managing urban expansion and land conversion. It also contributes to better urban and environmental management by identifying changes in land cover that may affect agricultural areas, vegetation, and other natural resources.

Engineers

For engineers, particularly those involved in urban development and infrastructure planning, the study offers relevant spatial insights that can guide site selection, project feasibility, and sustainable design considerations. Understanding land cover changes helps in assessing potential environmental impacts and supports the integration of appropriate engineering solutions in rapidly developing areas.

Researchers

This study serves as a useful reference for researchers by demonstrating the application of Geographic Information System (GIS) tools, such as QGIS, in analyzing spatial data. It can be used as a basis for further studies related to land use change, urban growth analysis, and environmental assessment.

Students

For students, especially those in engineering, geography, and environmental science fields, the study provides a practical example of how GIS techniques can be applied in real-world analysis. It enhances their understanding of spatial data interpretation and supports the development of technical and analytical skills.

E. Scope and Limitations

This study focuses on assessing land use and land cover (LULC) changes in Gapan City from 2015 to 2025 using Geographic Information System (GIS) techniques. The spatial coverage is limited to the administrative boundary of Gapan City. The analysis is confined to seven land cover categories, including built-up areas, annual crops, grasslands, inland water, fishponds, brush or shrubs, and perennial crops.

The study relied solely on secondary land cover datasets, specifically the 2015 Land Cover of Luzon and the 2025 Land Cover of Region III obtained from the National Mapping and Resource Information Authority (NAMRIA) Geoportal. These datasets were processed using QGIS 3.44.8 Solothurn for clipping, spatial analysis, and area computation. Although both datasets were sourced from the same agency and use comparable land cover categories, variations in update procedures, mapping scale, classification methods, and data processing protocols may influence the observed changes.

No independent field validation or accuracy assessment was conducted since the study utilized pre classified datasets from NAMRIA. Classification accuracy is assumed based on the standards of the source agency. This introduces inherent uncertainty, and the findings should therefore be interpreted as GIS based approximations and indicative trends rather than exact representations of land conversion. Future studies are recommended to incorporate ground validation and accuracy assessment techniques such as confusion matrix analysis to improve reliability.

F. Conceptual Framework

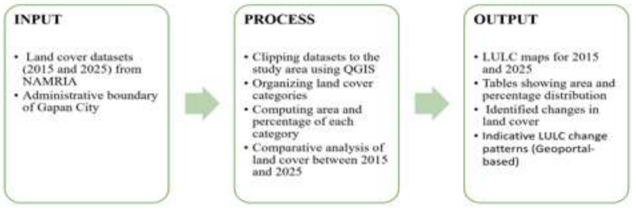

Figure 1. Conceptual Framework

Figure 1 shows the flow of the study from input, process, to output. The inputs include the 2015 and 2025 land cover datasets from NAMRIA and the administrative boundary of Gapan City. These data were processed in QGIS through clipping, organizing land cover categories, computing area and percentage, and comparing changes over time. The outputs include LULC maps, tables of area and percentage distribution, identified land cover changes in Gapan, and the Indicative LULC change patterns.

II. REVIEW OF RELATED LITERATURE

A. Land Use and Land Cover Change

Land use and land cover are two distinct concepts which are often used interchangeably, according to Rawat & Kuwar (2015), land cover refers to the physical characteristics of earth's surface, captured in the distribution of vegetation, water, soil and other physical features of the land, including those created solely by human activities. While land-use refers to the way in which land has been used by humans and their habitat, usually with emphasis on the functional role of land for economic activities. These two concepts are closely linked as changes in land use affects land cover and changes in land cover affect land use.

According to a study by Chen et al. (2025), LULC changes are driven by both natural and human activities and have wide-ranging impacts on the Earth's eco-environment, including modifications in temperature, precipitation patterns, runoff, evapotranspiration, and ecological conditions. Human activities on the Earth's surface continuously alter land cover, resulting in significant modifications to natural landscapes. These changes can disrupt the balance of essential Earth system components, including energy flow, soil stability, and the water cycle (Saket et al., 2024).

B. Urbanization and Agricultural Land Conversion

The province of Nueva Ecija is a vital part of the agricultural industry of the country. However, previous studies on urban growth explain that increasing population leads to the expansion of settlements, where land demand continuously rises. This situation becomes more critical in the Philippine context, where according to Araza et al. (2026), rapid urban expansion has intensified pressure on agricultural lands, raising concerns about food security and environmental sustainability. To accommodate this growth, land is continuously consumed through both urban densification and outward spatial expansion, which gradually reduces available agricultural spaces (Angel, 2023). As this process continues, inevitable urbanization driven by population growth and economic development places agricultural regions such as Nueva Ecija at increasing risk (Tinio, 2013).

In support of this, according to the study Paz-Alberto et al. (2019) shows that urban areas, although covering a much smaller proportion of the landscape/land cover in both 1989 and 2018 periods, increased at a much higher rate than any other land cover classes. While there is also an increase in agricultural and urban areas this mostly results in deforestation, which means some forest areas were removed and converted to agriculture and settlement in the municipalities/cities. These developments may contribute to significant changes in the land use and land cover of the area. Rapid and uncontrolled population growth, along with economic and industrial development, especially in developing countries during the late twentieth and early twenty-first centuries, have greatly increased the rate of land use transformation patterns.

C. GIS and Remote Sensing Applications

Previous studies have shown that Geographic Information Systems (GIS) is an effective tool for monitoring urban growth, agricultural conversion, and land cover dynamics in rapidly developing areas. According to Baguio (2025) GIS technology allows for the integration and analysis of various spatial data sources, including maps and satellite information, which are essential for modelling complex natural systems.

Remote sensing enhances GIS-based land monitoring by providing continuous and up-to-date satellite information on the Earth's surface. This allows changes in land use and land cover (LULC) to be observed more accurately over time, making it easier to analyze spatial patterns and environmental transformations in rapidly changing areas. This is supported by Janiola et al. (2018), who noted that remote sensing plays a key role in mapping the spatial distribution and temporal dynamics of land cover change, particularly in the Philippines where land transformation is occurring at a fast rate. Similarly, the integration of GIS with remote sensing improves the accuracy and efficiency of spatial data analysis by allowing better visualization and interpretation of land use patterns. This makes it more effective for environmental monitoring and land use planning. Hassan et al. (2016) emphasize that these technologies provide reliable and updated spatial information that significantly improves the identification and classification of land areas for agricultural, industrial, and urban use.

In addition, these approaches are preferred over traditional methods because conventional field surveys and mapping techniques are time-consuming, costly, and often become outdated in rapidly changing environments (Dash et al., 2015). Furthermore, in changing environments, the traditionally produced maps quickly become obsolete. Satellite imagery also supports a wide range of applications such as environmental monitoring, disaster response, and land change detection, where large geographic coverage and limited manpower make automation necessary (Pritt, 2017).

D. Studies in the Philippines / Nueva Ecija

Nueva Ecija is recognized as the "Rice Granary" of the Philippines because it led the production of the nation's food staple during the twentieth century (Santiago Jr., 2015). The city of Gapan is one of the component cities of Nueva Ecija today that is at the forefront of the national effort to ensure social and economic advancement. Also, it is an inseparable part of the Rice Granary of the Philippines. The city of Gapan is located in Southeastern part of Nueva Ecija.

E. Research Gap

Despite the increasing use of Geographic Information Systems (GIS) and remote sensing in environmental studies, there is still a limited municipal-scale GIS-based analysis using recent Geoportal datasets in rapidly developing areas. Many existing studies focus on broader regional or provincial scales, which often overlook localized patterns of land transformation that are critical for city-level planning and decision-making. In addition, there is a lack of recent analysis that captures how land cover has evolved in the past decade and how these changes relate to urban growth, agricultural shifts, and infrastructure development in smaller cities such as Gapan City. This gap limits the ability of local planners and engineers to make data-driven decisions for sustainable development. Although several studies have examined land cover change at national and provincial scales, limited studies focus specifically on municipal scale LULC change in Gapan City using recent GIS datasets.

III. METHODOLOGY

A. Study Area

Gapan City is located in the southeastern part of Nueva Ecija, Philippines. It is bounded on the north by the municipality of San Leonardo, on the east by the municipalities of Peñaranda and General Tinio, on the west by the municipality of San Isidro, and on the south by the municipality of San Miguel, Bulacan (City of Gapan, n.d.).

Gapan City covers a total land area of approximately 164.44 square kilometers, as reported in the Philippine Statistics Authority Philippine Statistical Yearbook, and serves as a developing economic center in the southern part of the province. Situated strategically within the Central Plains of Central Luzon, the city has generally flat terrain that supports agricultural activities in one of the country's major rice-producing regions (Philippine Statistics Authority, 2024). Its accessibility is reinforced by sections of the Pan-Philippine Highway that pass through the city, facilitating transportation and connectivity. Due to its location, Gapan City plays a significant role in regional connectivity and contributes to the economic integration and development of the Nueva Ecija–Central Luzon corridor.

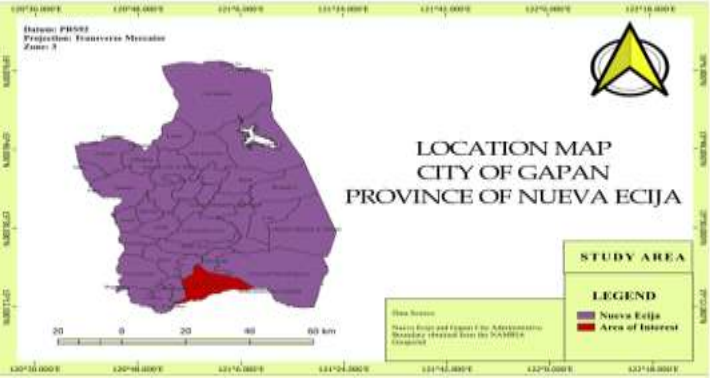

Figure 2. Area of Interest

Figure 2 shows the province of Nueva Ecija along with its geographic coordinates, where the area of interest is located. The area of interest of this study is the City of Gapan, where the land use and land cover changes will be assessed.

B. Data Collection

The data for this study were obtained from secondary sources to analyze land use and land cover (LULC) changes in Gapan City from 2015 to 2025, accessed on March 14, 2026. The datasets include vector files of the administrative boundaries of Gapan City and Nueva Ecija, as well as the 2015 Land Cover of Luzon and the 2025 Land Cover of Region III. These were acquired through the Philippine Geoportal platform and processed using QGIS.

The Philippine Geoportal, managed by the National Mapping and Resource Information Authority (NAMRIA), provides official spatial datasets and geospatial information in the Philippines. Based on dataset metadata, the 2015 Land Cover of Luzon was produced by the Resource Data Analysis Branch, while the 2025 Land Cover of Region III was produced by the Land Resource Data Analysis Division of NAMRIA.

The analysis relied entirely on pre-classified Geoportal datasets, and no reclassification or field validation was performed. Therefore, the results depend on the consistency and comparability of the source datasets.

Table I. Obtained Datasets

Data	Layer Type	Source	Year	CRS	Acquired
Administrative Boundary (Gapan & Nueva Ecija)	Vector	Philippine Geoportal	-	EPSG:3857 - WGS 84/Pseudo-Mercator	March 14, 2026
2015 Land Cover - Luzon	Vector	Philippine Geoportal	2015	EPSG:3857 - WGS 84/Pseudo-Mercator	March 14, 2026
2025 Land Cover Map of Region 3	Vector	Philippine Geoportal	2025	ESRI:102457 - PRS_1992_UTM_ZONE_51N	March 14, 2026

Table I shows the obtained datasets information such as the layer type, source, year, coordinates, and the time it was acquired.

C. Data Processing

QGIS version 3.44.8 "Solothurn" was used for data processing, spatial analysis, and map preparation. The 2015 Land Cover of Luzon and 2025 Land Cover of Region III datasets weimported into QGIS and clipped using the administrative boundary of Gapan City to define the area of interest (AOI). Both datasets, originally in different coordinate reference systems (EPSG:3857 and ESRI:102457), were reprojected into a common coordinate reference system (PRS92 / Philippines Zone 3) to ensure spatial consistency and comparability. Since the datasets were pre-classified, no reclassification was performed.

After preprocessing, land cover classes were analyzed using the QGIS field calculator to compute geometric areas for each category. The resulting area values per class were then exported and summed and organized in Microsoft Excel for final tabulation and analysis.

D. Classification Categories

The dataset already contained pre-classified land cover categories provided by the NAMRIA Geoportal, and therefore no image classification or reclassification was performed. Since both the 2015 and 2025 datasets use a consistent classification scheme, they are directly comparable for temporal analysis of land use and land cover changes in Gapan City.

The datasets were imported into QGIS version 3.44.8 "Solothurn" and clipped using the administrative boundary of Gapan City to define the study area. Land cover categories were extracted from the attribute table, which contains the pre-defined classification fields of the Geoportal dataset.

Each land cover class within the study area was identified and separated into vector layers, where each class was assigned a specific color. Consistent symbology was applied across both datasets to ensure uniform visualization and comparability of land cover maps.

E. Land Cover Area Calculation

The calculation of land cover area was performed using Geographic Information System (GIS) tools in QGIS. After clipping the dataset to the administrative boundary of Gapan City, the attribute table was used to extract land cover categories, including inland water, built-up areas, annual crop, brush/shrub, fishpond, grassland, and perennial crop.

Area values for each class were computed using the geometry function in QGIS Field Calculator. The resulting values were exported and processed in Microsoft Excel, where land cover areas were organized, summed, and used to determine the total land area and percentage distribution of each category. The results were tabulated to present the spatial distribution of land cover types and to support comparison between 2015 and 2025.

1.) ***Land Cover Percentage Calculation Formula:*** This formula was used to compute the percentage of each land cover category relative to the total land area of Gapan City:

where:

Percentage = proportion of each land cover category relative to total area (%)

$$\textit{Relative Percent Change}\ (\%) = \frac{A_{2025} - A_{2015}}{A_{2015}}\ x\ 100$$

Area of Land Cover Class = area occupied by a specific land cover type (km² or ha)

Total Land Cover Area = total land area of Gapan City (km² or ha)

2.) ***Percentage Change Calculation Formula:*** This formula was used to compute the relative percentage changes of each land cover category.

Where:

A_{2025} - Area of Land Cover Classification in 2025

A_{2015} - Area of Land Cover Classification in 2015

F. Land Use and Land Cover Analysis

$$\textit{Percentage}\ (\%) = \left(\frac{\textit{Area of Land Cover Class}}{\textit{Total Land Cover}}\right) x\ 100$$

The land use and land cover (LULC) analysis was conducted using Geographic Information System (GIS) software, specifically QGIS 3.44.8 "Solothurn." After clipping the land cover datasets to the administrative boundary of Gapan City, spatial data were organized and analyzed based on classified land cover attributes obtained from the NAMRIA Geoportal.

Each land cover category was identified according to its attribute classification, and its spatial distribution was examined within the study area. The 2015 and 2025 datasets were processed using a consistent classification scheme to ensure comparability across time periods.

A transition matrix was not generated because the datasets represent independently classified land cover products rather than pixel-level temporally linked data. As such, direct class-to-class change tracking is limited. Therefore, the analysis focuses on changes in area and spatial distribution between 2015 and 2025 rather than explicit land cover conversions.

IV. RESULT AND DISCUSSION

A. *Results*

Results are derived from GIS-based analysis of secondary datasets obtained from the National Mapping and Resource Information Authority (NAMRIA) Geoportal. The spatial datasets were processed and standardized prior to analysis to ensure consistency in projection, scale, and classification scheme. The total computed land area for both datasets is consistent at approximately 172.15 km², confirming dataset comparability after processing and clipping to the administrative boundary of Gapan City.

The land cover classification obtained from the Geoportal dataset includes several major categories that represent both natural and human-modified environments. The resulting classification provides a basis for quantifying the extent of each land cover type and examining their spatial distribution within the study area.

Table II. Classification Categories

Land Cover	Description
Inland Water	Inland water bodies such as rivers, lakes, streams, and reservoirs.
Built-up	Areas occupied by human-made structures.
Annual Crop	Agricultural land with seasonal crops such as rice and corn.
Brush/Shrub	Land covered by shrubs, bushes, and other small woody plants.
Fishpond	Man-made water bodies used for aquaculture or fish farming.
Grassland	Areas with grasses and low vegetation, with little or no tree cover.
Perennial Crop	Agricultural areas planted with crops such as fruit trees and plantations.

Table II presents the land use and land cover classification categories extracted from NAMRIA Geoportal datasets. These categories include Inland Water, Built-up, Annual Crop, Brush/Shrub, Grassland, Fishpond and Perennial Crop.

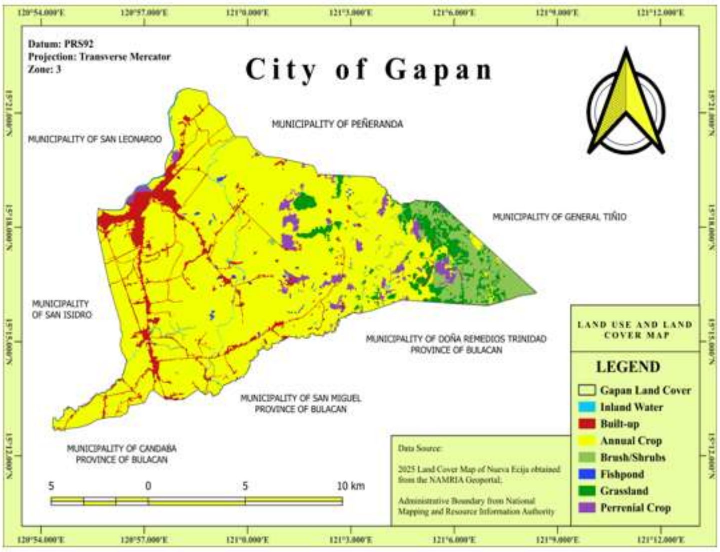

Figure 3. 2015 Land Use and Land Cover Map

Figure 3 shows the land use and land cover map of Gapan City 2015 generated from the data obtained at Geoportal. The map presents the spatial distribution of different land categories such as Inland Water, Built-up, Annual Crop, Grassland, Fishpond and Perennial Crop. The map also featured the boundary of Gapan City and the Municipalities around it.

Table III. 2015 Land Use and Land Cover Map

Land Cover Type	Area (km^2)	Percentage (%)
Inland Water	0.58	0.34
Built-up	10.06	5.84
Annual Crop	139.00	80.74
Brush/Shrub	13.22	7.68
Grassland	3.34	1.94
Fishpond	0.02	0.01
Perennial Crop	5.93	3.44

Table III shows Gapan City's 2015 land cover classification of the land use and land cover map and its corresponding area distribution. The result shows that the Annual Crop dominates the land cover with an area of 139.00 square kilometers that is 80.74 percent of the total land area of Gapan City indicating that agriculture remains the dominant land cover of Gapan City. Non-agricultural categories such as built-up areas occupied a much smaller share, while fishponds and inland water covered only limited portions of the city.

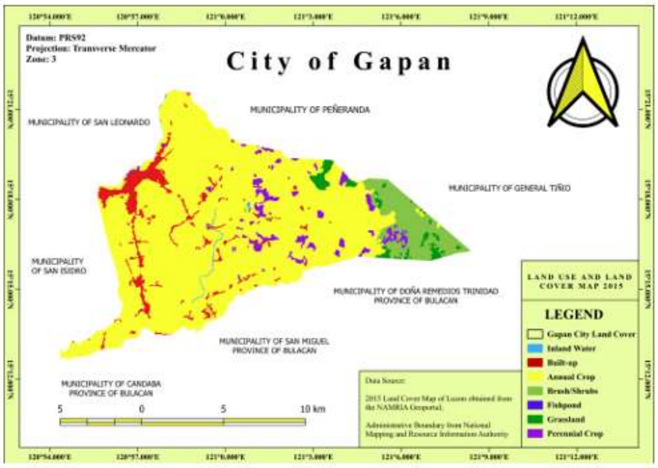

Figure 4. 2025 Land Use and Land Cover Map

Figure 4 presents the 2025 land use and land cover map of Gapan City based on the NAMRIA Geoportal datasets. It shows the spatial distribution of the same land cover categories as in 2015, allowing visual comparison of changes over time within the city boundary.

Table IV. 2025 Land Use and Land Cover Map

Land Cover Type	Area (km^2)	Percentage (%)
Inland Water	1.00	0.58
Built-up	12.25	7.12
Annual Crop	133.07	77.29
Brush/Shrub	10.83	6.29
Grassland	8.69	5.05
Fishpond	0.70	0.41
Perennial Crop	5.61	3.26

Table IV shows the land cover classification of the land use and land cover map and its corresponding area distribution. The result indicates that Annual Crop still dominates with an area of 133.07 square kilometers and 77.29 percent of the total area of Gapan City, this indicates that the area is still mainly used for agricultural purposes, although their share declined compared with 2015. Built-up and grassland areas increased during the study period, while fishponds and inland water recorded smaller gains. In contrast, brush/shrub and perennial crop areas decreased.

Table V. Land Use and Land Cover Changes

Land Cover	2015 Area (km^2)	2025 Area (km^2)	Change (km^2)	Relative Percent Changes (%)	Trend
Inland Water	0.58	1.00	0.42	72.41%	Increased
Built-up	10.06	12.25	2.19	21.77%	Increased
Annual Crop	139.00	133.07	-5.93	-4.27%	Decreased
Brush/Shrub	13.22	10.83	-2.39	-18.07%	Decreased
Grassland	3.34	8.69	5.35	160.18%	Increased
Fishpond	0.02	0.70	0.68	3400%	Increased
Perennial Crop	5.93	5.61	-0.32	-5.40%	Decreased

Table V presents the changes in land use and land cover in Gapan City between 2015 and 2025, including area differences, relative change, and overall trend for each land cover category. The results show that grassland recorded the highest increase, followed by built-up areas, while annual crops exhibited the largest decrease. Other categories, such as fishponds and inland water, showed smaller increases, whereas brush/shrub and perennial crops declined during the study period. The large percentage increase in fishpond area reflects the very small baseline area recorded in 2015.

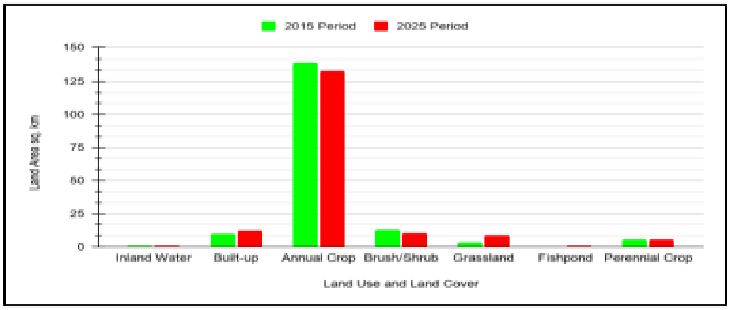

Figure 5. Comparison of Land Cover Areas in Gapan City, 2015 and 2025

Figure 5 presents a visual comparison of land cover areas in Gapan City for 2015 and 2025. The chart highlights differences in the extent of each land cover category between the two years, showing which categories increased or decreased during the study period.

B. Discussion

The results show that Geographic Information System (GIS) techniques are effective for analyzing land use and land cover (LULC) changes using secondary Geoportal datasets. Gapan City remains predominantly agricultural. However, changes in land cover distribution were observed between 2015 and 2025.

Annual crop areas decreased from 139.00 km² to 133.07 km² (−4.27%), averaging a reduction of 0.59 km² per year. This decline may reflect changes in agricultural practices, temporary land conditions, or possible land conversion associated with development pressure. Similar trends have been observed in other developing regions where agricultural land gradually decreases due to urban expansion and economic activity (Del Moro et al., 2024).

In contrast, built-up areas increased from 10.06 km² to 12.25 km² (21.77%), averaging 0.22 km² per year. This growth is likely associated with population increase, residential expansion, and infrastructure development. Comparable patterns have been reported in other rapidly urbanizing areas in Central Luzon where built-up expansion is linked to peri-urban growth and settlement development (Olfato-Parojinog et al., 2023).

Other land cover classes showed mixed trends. Grassland increased by 160.18%, inland water increased by 72.41%, and fishpond area showed a large percentage increase. The latter is attributed to its very small baseline area in 2015. In absolute terms, the increase is only 0.68 km², indicating limited spatial significance. These changes may reflect transitional land conditions, classification differences, or seasonal vegetation variability rather than major land use shifts.

Meanwhile, brush and shrub areas and perennial crop areas decreased, possibly indicating changes in vegetation cover or land management practices. However, these cannot be confirmed as direct land conversions due to dataset limitations. Further validation is required to determine whether this change reflects a sustained ecological trend or is influenced by data and classification uncertainty.

Overall, the results indicate a gradual shift from agricultural to built-up and transitional land cover types. However, these patterns should be interpreted as indicative spatial trends rather than definitive land conversion, given the use of secondary datasets and the absence of independent accuracy assessment.

V. CONCLUSIONS

The following conclusions are obtained based on the findings of this study. Gapan City remained predominantly agricultural from 2015 to 2025, with agricultural land still occupying the largest portion of the land area in both years.

1. Annual crop areas showed a decreasing trend during the study period, which appears consistent with the gradual reduction in farming areas over time.
2. Built-up areas increased, which may indicate ongoing urban growth and possible land use conversion within the city.
3. The study confirmed that Geographic Information System (GIS)-based analysis is effective for monitoring and assessing municipal land use and land cover changes.
4. The findings may support land use planning, infrastructure development, and sustainable management in Gapan City.

These conclusions are based on secondary Geoportal datasets and do not represent field-validated land conversion. Therefore, they should be interpreted as indicative patterns of land cover change.

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