Engineering and Technology Journal e-ISSN: 2456-3358

Volume 11 Issue 05 May-2026, Page No.-10084-10089

DOI: 10.47191/etj/v11i05.43, I.F. – 8.595

Land Use Land Cover Update of Cabanatuan City in 2026

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ABSTRACT: This study focuses on the update of land use and land cover (LULC) of Cabanatuan City in 2026 using satellite imagery and Geographic Information System (GIS) mapping. The research aims to generate an updated LULC map based on satellite imagery and GIS processing, classify major land cover categories, and determine the area and percentage distribution of each class. Sentinel-2 satellite images, supported by Landsat-8 data, were processed using QGIS through supervised classification techniques to identify categories such as agricultural land, built-up areas, and other minor land cover types.

The results show that agricultural land dominates the area, covering approximately 79.30% of the total mapped area, while built-up areas account for 18.69% and are mainly located near the city center and major road networks. The remaining land cover types occupy only a small percentage of the total area. These findings indicate that Cabanatuan City maintains a strong agricultural land base while also supporting urban functions in accessible locations.

The study provides essential baseline data that can support urban planning, land management, and decision-making. The study also demonstrates the applicability of GIS and remote sensing in analyzing spatial land use patterns and supporting planning-related applications.

KEYWORDS: Land Use and Land Cover (LULC), Geographic Information System (GIS), Remote Sensing, Cabanatuan City, Satellite Imagery (Sentinel-2 and Landsat-8), Urban and Agricultural Land Distribution

I. INTRODUCTION

1.1 Background of the Study

People all over the world agree that land use and land cover (LULC) analysis is an important way to understand how cities and human activities change the landscape. Remote sensing and Geographic Information System (GIS) have become useful tools for mapping and keeping track of changes in land use as satellite images and geospatial technologies have become more widely available. These technologies allow for precise categorization of land cover types and yield significant insights into environmental and urban dynamics (Khan et al., 2024).

Recent studies emphasize that the integration of advanced remote sensing data, such as high-resolution satellite imagery, significantly improves the accuracy of LULC mapping. The use of multi-temporal data allows researchers to detect changes over time, particularly in srapidly developing areas. This approach supports better analysis of urban expansion and land conversion, making it highly relevant for planning and environmental management (Nasiri et al., 2022).

Moreover, Sentinel-2 imagery has been proven effective in identifying major land cover categories, including built-up areas, vegetation, and water bodies. Research shows that supervised classification techniques combined with GIS mapping can produce useful spatial representations depending on classification accuracy in detecting spatial distribution and changes in land use. These methods are widely used in analyzing urban growth and its impact on natural resources (Basheer et al., 2022).

In addition, studies highlight that rapid urban expansion often leads to the conversion of agricultural and natural lands into built-up areas, which may result in environmental challenges such as reduced vegetation cover and increased vulnerability to flooding. Continuous monitoring of LULC is therefore necessary to guide sustainable land use planning and mitigate potential environmental impacts (Ahmed et al., 2023).

Therefore, this study aims to update the land use and land cover of Cabanatuan City in 2026 using satellite imagery and GIS mapping. By applying these modern geospatial techniques, the research seeks to analyze current land use patterns, identify trends in urban expansion, and provide reliable data to support effective and sustainable planning decisions.

1.2 Rationale of the Study

Land use and Land cover constantly change due to population growth, urbanization, and frequent land development projects. Cabanatuan is a developing city, thus, a need for updated information on land usage increases. With the use of satellite imaging and GIS mapping, it supplies the demand of efficient spatial mapping to identify the changes on the land of Cabanatuan, and with the provided information of the images, it will help engineers understand the land conditions, which will then improve urban planning and sustainable development. This study addresses the need for updated spatial information to support planning and land management in a rapidly developing city.

1.3 Statement of the Problem

This study aims to update the land use and land cover of Cabanatuan City using satellite images and GIS mapping.

Specifically, it seeks to answer the following questions:

1. What are the major LULC classes in Cabanatuan City in 2026?
2. How are these LULC classes spatially distributed?
3. What are the area and percentage distributions of each LULC class?

1.4 Objective of the Study

The main objectives of the study "LAND USE/LAND COVER UPDATE OF CABANATUAN CITY IN 2026" are the following

- Generate a 2026 LULC map using Sentinel-2 imagery and GIS.
- Classify the major LULC categories.
- Determine the area and percentage distribution of each LULC class.

1.5 Significance of the Study

This study is important because it helps understand the current land use and land cover in Cabanatuan City. By using satellite images and Geographic Information System (GIS) tools like QGIS. The result of this study will benefit local government officials by giving them accurate data for better planning and decision-making. such as agricultural land and natural environments. Urban planners and developers also use this information to design sustainably. Also, help researchers and students understand how GIS and satellite mapping can be used in real-life situations. This project supports smarter city development and guides Cabanatuan City in 2026 to support planning and land management in Cabanatuan City.

1.6 Scope and Limitation

This study focuses on the analysis of land use and land cover changes within the geographical boundaries of Cabanatuan City using selected satellite images and GIS-based mapping techniques. It covers a specific time frame of the year 2026. The study is limited to the interpretation of remotely sensed data and no classification accuracy assessment was conducted; therefore, the reliability of the classification depends on the source imagery and processing method. Additionally, it primarily examines major land cover categories such as urban areas, agricultural land, and natural environments, and does not provide a detailed classification of minor land use types.

Furthermore, the map was constructed using QGIS version 3.44, which may impose certain technical limitations related to the software's tools and processing capabilities. The quality of the Sentinel-2 images may also be affected by the specific dates of acquisition, as factors such as cloud cover and atmospheric conditions can influence image clarity and accuracy. The study provides a single-year LULC mapping assessment only and does not evaluate temporal land use change.

1.7 Conceptual Framework

INPUT	PROCESS	OUTPUT
Sentinel-2 imagery City boundary Shapefile Reference imagery GIS software Base maps and existing LULC data	• Image acquisition Pre-processing Classification • Area computation Mapping	2026 LULC map Table of area % Planning insights Land cover category

Figure 1: Conceptual Framework

This study is about the use of GIS technologies to generate updated land use and land cover maps. Satellite images serve as the primary data source, while GIS tools facilitate spatial analysis and classification. Through image processing and categorization, land cover types such as built up areas, vegetation, and water bodies are identified. The output is an updated map of Cabanatuan for 2026, which provides insights into land use changes and supports urban planning and environmental decision making.

II. REVIEW OF RELATED LITERATURE

2.1 Land Use and Land Cover for Sustainability

Land use/land cover is essential for sustainable development. According to a study (Kalfas et al. 2023), there is a significant relationship between integrated land use strategies and sustainable development goals. It proves that proper land use can lead to a more sustainable development of land, which indicates that sustainable urbanization does not simply mean converting agricultural land and forest without proper sustainable development goals. In this study, land use planning is a local effort to achieve a sustainable outcome when it comes to urbanization.

2.2 GIS and Satellite Mapping in Urban Planning

To overcome the difficulties of urban planning, it is necessary to implement a geographic information system (GIS) as the main tool in planning operations and satellite data. GIS and satellite imagery can support the urban planning process by enabling the storage, manipulation, and analysis of data valid for planning, and decision making. A study by Ouchra et al., (2022) shows that the implementation of GIS in urban planning can improve the result based on the quality of the urban planning process, save time, and the data can be obtained faster.

2.3 Significance of Mapping in Territorial Management

According to a study conducted by Branch in 2017, there is a significant yet often underexplored role of rapidly evolving mapping technologies in territorial conflict and negotiation processes. It explains that the shift from traditional paper maps to digital cartographic tools not only improves map accuracy but also fundamentally changes how territorial disputes are understood and resolved. Digital mapping influences negotiations by reshaping how possible solutions are evaluated, altering the perceived value of contested territories, and introducing new actors into the negotiation process. These effects are highly context-dependent,

asdigital mapping may support conflict resolution in some situations while creating additional challenges in others. The study further integrates concepts from mapping, negotiation, bargaining, and emotional dynamics in international relations and illustrates these ideas through case studies such as the 1995 Dayton Accords, the Eritrea–Ethiopia Boundary Commission, and the 2010 Costa Rica–Nicaragua border dispute, where digital mapping produced varied and sometimes unexpected impacts on territorial negotiation and dispute resolution.

2.4 Applications of LULC Mapping in Local Planning and Environmental Management

According to Aydinoglu et al. (2010), Land Use and Land Cover (LULC) data are essential tools in various applications, particularly in land administration and environmental management. They explained that land cover refers to the physical surface of the earth such as vegetation, water, and soil, while land use refers to how humans utilize these areas for activities like agriculture, residential, or commercial purposes.

Furthermore, the study emphasized that accurate information regarding the spatial distribution and patterns of LULC is necessary for effective planning. This data serves as a basis for decision-makers to create sound land use policies, manage resources sustainably, and balance development with environmental protection.

2.5 Satellite Imagery in LULC Mapping & Urban Development

Satellite imagery is necessary, as it serves as a model that aids in LULC mapping, especially in places like Cabanatuan City. These models allow planners to make decisions based on the data gathered for better decision-making. According to Xu & Somers in 2022, Sentinel-2 imagery has become an effective tool for urban land use and land cover (LULC) mapping because of its high spatial and spectral resolution. They also explained that Sentinel-2 data improves the accuracy of identifying urban land cover types such as built-up areas, vegetation, and open spaces. The study emphasized that combining spectral, spatial, and temporal information leads to identifying the current land cover types. Furthermore, the researchers highlighted that Sentinel-2 imagery supports urban planning and sustainable development by providing information for the current state of land cover.

2.6 Application of Remote Sensing and GIS in Land Use and Land Cover (LULC) Mapping for Spatial Analysis and Land Management

Land use and land cover (LULC) mapping is an important application of remote sensing and Geographic Information Systems (GIS) for analyzing spatial changes and supporting land management. Supervised classification techniques are commonly used in LULC studies because they provide reliable results when classifying satellite imagery into different land cover categories. Abbas and Jaber (2020) explained that supervised classification combined with GIS techniques can effectively generate accurate land use maps through proper classification and validation procedures. Likewise, Alshari and Gawali (2021) emphasized that satellite imagery and GIS-based classification systems are useful for identifying and categorizing land cover types. In addition, Macarringue et al. (2022) noted that supervised classification remains one of the most widely applied approaches in remote sensing studies because of its practicality and compatibility with commonly used GIS software such as QGIS. These studies support the use of supervised classification and GIS techniques in producing reliable LULC maps for urban analysis and land use planning.

III. METHODOLOGY

This chapter presents the methods used to analyze Land Use and Land Cover (LULC) changes in the study area. It includes the research design, data collection, and the tools used for processing and analyzing the data. The procedures followed in this study are described to ensure useful spatial results.

3.1 Research Design

The study incorporates a descriptive GIS-based mapping study to examine and update the Land Use and Land Cover of Cabanatuan City in 2026, utilizing satellite imagery and GIS techniques. The said design is fitting for it focuses on describing and mapping existing areas without manipulating variables.

Satellite images were acquired from a reliable source, Sentinel 2, which was visually cross-checked with reference imagery; however, no formal accuracy assessment was performed. Then are processed and arranged into the following land use categories: built-up areas, agricultural land, and water bodies. A GIS software is later used to analyze distribution and create an updated mapping for the said city.

3.2 Study area

Cabanatuan City is located in the central part of Nueva Ecija in the Central Luzon region, making it easy to reach and connected to nearby towns and provinces. As the main city of Nueva Ecija, Cabanatuan is an important center for business, schools, hospitals, transportation, and government services to help both local people and nearby communities. It is also surrounded by large farming areas with rice fields, vegetable farms, and other crops that help support the food supply and economy of the province.

Data Collection

This study utilized remote sensing and Geographic Information System (GIS) techniques to analyze land use and land cover (LULC) within the study area. The procedure followed a systematic sequence to ensure consistency in data processing and interpretation.

First, image acquisition was carried out using Sentinel-2 satellite imagery, which served as the primary data source for classification. Three image dates were selected: January 25, 2025; December 25, 2025; and

February 25, 2026, with cloud cover percentages of 13.99%, 6.71%, and 19.79%, respectively. These multiple dates were

used to reduce cloud interference and to support consistent identification of land cover features. Landsat-8 imagery and available Geoportal data were used only as supplementary references during interpretation and validation.

Next, cloud-free image selection was performed by choosing images with relatively low cloud cover and acceptable visibility. The selected imagery provided moderate-resolution spatial data suitable for city-scale mapping.

The images were then imported into QGIS version 3.44, where preprocessing was conducted. This was followed by clipping the images to the boundary of the study area to focus the analysis within the defined geographic extent.

After preprocessing, a supervised classification approach was applied. Training samples were manually selected to represent the major land cover classes, including annual crops, brush/scrubs, fish ponds, grassland, inland water, open land, perennial crops, and residential/commercial/industrial areas. These samples were used to guide the classification process, allowing the software to categorize pixels based on their spectral characteristics.

Following classification, the outputs were reclassified into final land cover categories to simplify interpretation. The area of each class was then calculated within the software to quantify spatial distribution.

Finally, validation was limited to visual checking. The classified map was visually compared with recent high-resolution imagery, Landsat-8 data, Geoportal references, and known landmarks to assess general consistency. However, no quantitative accuracy assessment was conducted, and the results should be interpreted accordingly. The final output was presented in map form, showing the spatial distribution of land cover within the study area.

3.3 Presentation Of Data

This chapter presents the results of the land use and land cover analysis of Cabanatuan City using Sentinel 2 satellite images for reference and geoportal data for identifying the shapes and classes of the areas. The data are presented through a map to clearly show the distribution of different land cover types.

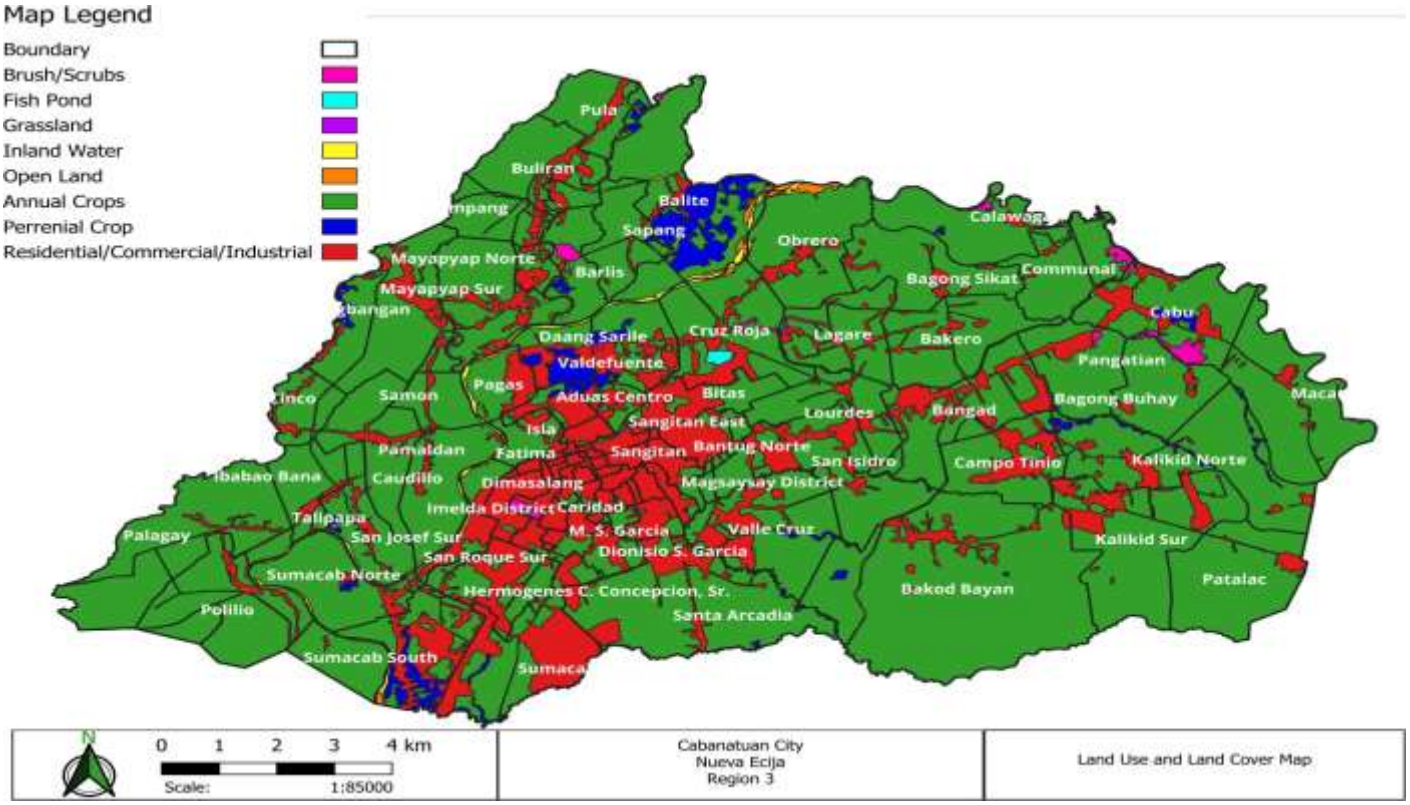

Figure 2. 2026 Land Use and Land Cover Map of Cabanatuan City

Figure 2 shows the land use and land cover map of Cabanatuan City. The map illustrates the spatial distribution of different land cover types such as boundary, building, brush/scrubs, fish ponds, grassland, inland water, open land, annual crops, perennial crop and residential/commercial/industrial areas.

Classification	Area (sqm)	Percentage
Annual Crop	145437025.45	76.856%
Bush/Scrub	971411.87	0.513%
Fish Pond	112502.11	0.059%
Grassland	5872.15	0.003%
Inland Water	2335932.05	1.234%
Openland	373670.69	0.197%
Perennial Crop	4626505.37	2.445%
tial/Commercial/ Industrial	35370340.811	18.691%

Figure 3. LULC Area and Percentage

Figure 3 presents the distribution and percentage of different land use and land cover classes in the study area. Agricultural lands, consisting of Annual Crops and

Perennial Crops, dominate the landscape, accounting for 79.301% of the total area. This clearly indicates that agriculture remains the primary land use activity. Built-up areas, which include residential, commercial, and industrial areas, cover about 18.691% of the land. This significant proportion reflects the city's current urbanization and economic development. Other categories such as inland water, bush/scrub, open land, fish ponds, and grassland occupy the remaining small portion, collectively representing 2.024% of the total area.

IV. DISCUSSION AND ANALYSIS OF DATA

Agricultural land occupies about 79.30% of the total mapped area. This indicates that agriculture remains the primary land use in the study area. This may be associated with favorable agricultural conditions as commonly noted in land use studies. Moreover, these areas are currently utilized for agricultural activities. In addition, many communities rely on farming as a primary source of livelihood, which may help explain why a large portion of land is allocated to agricultural purposes.

Built-up areas account for 18.69% of the total area and are mainly located near the city center. The concentration of built-up areas appears associated with more developed and accessible urban areas and major road corridors. These areas include residential, commercial, and institutional functions. The presence of essential facilities such as markets, schools, and government offices also supports the concentration of development in these accessible zones.

The remaining land cover classes occupy only small portions, which may reflect the limited extent of natural or transitional land types. These areas may vary in characteristics such as accessibility and land features, or may not be currently utilized for agricultural or built-up use. As a result, they represent only a small share of the total mapped area compared to the dominant agricultural and built-up land uses.

From a Civil Engineering perspective, these results are important for land use and infrastructure planning, as development appears associated with existing road networks. The findings may also indicate increasing infrastructure demand and potential urban expansion pressures in concentrated areas. The data may provide baseline spatial information for planning and engineering applications by showing how land is spatially distributed.

Summary of Findings

The 2026 LULC map of Cabanatuan City shows that agricultural land still dominates, while built-up areas are concentrated in the city center and along major roads. Other land cover types, like water bodies, remain present but are influenced by nearby land uses, highlighting the need for effective land use planning.

V. CONCLUSIONS

The study indicates that agricultural land remains the dominant land cover in Cabanatuan City, highlighting its continued importance in supporting local food production and maintaining the city's rural landscape. In contrast, built-up areas occupy a smaller portion but are mainly concentrated in the city center and along major transportation routes, indicating that urban growth appears concentrated near accessible areas and existing infrastructure. This pattern shows that Cabanatuan is undergoing gradual urbanization, where development is expanding but remains spatially clustered rather than evenly distributed across the city.

The generated LULC map provides valuable baseline spatial information, as it may be useful for planning considerations, identifying indicative spatial patterns, and supporting planning-related applications and land management strategies. Overall, the study emphasizes the importance of GIS-based mapping in understanding land use dynamics and in supporting more informed and sustainable planning and development in Cabanatuan City.

RECOMMENDATIONS

1. Local planners may use the generated LULC map as baseline spatial information for planning and land management.
2. Future studies should include classification accuracy assessment and field validation.
3. Additional time periods may be analyzed to monitor future land use changes in Cabanatuan City.
4. Future studies may expand the analysis to other municipalities within Nueva Ecija.

ACKNOWLEDGMENT

The researchers express their sincere gratitude to Almighty God for His guidance and strength throughout the completion of this study. The researchers also extend their appreciation to Nueva Ecija University of Science and Technology, particularly the College of Engineering, for providing academic support and a conducive learning environment. Lastly, the researchers thank their families and friends for their encouragement and support during the conduct of the study.

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