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Land Use and Land Cover Change Assessment in Aurora Province (2020–2025) Using GIS-Based Spatial Analysis

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ABSTRACT: This study examines land use and land cover (LULC) changes in Aurora Province, Philippines, from 2020 to 2025 using Geographic Information System (GIS) mapping techniques. The objective is to identify spatial and quantitative changes in major land cover types, including forest, agricultural areas, built-up zones, and other land classifications. Secondary spatial datasets from the Philippine Geoportal were processed and analysed using QGIS to generate LULC maps and perform change detection. Results show that Aurora Province remains predominantly forested, with closed forest as the largest land cover category in both years. However, changes were observed, including increases in built-up areas and annual crops, and decreases in open forest, grassland, and fishpond areas. These trends may suggest gradual land conversion influenced by development pressures and land-use activities. Despite these changes, forest cover continues to dominate the landscape, indicating that forested areas remain the primary land cover within the province.

KEYWORDS: Land Use and Land Cover (LULC), Geographic Information System (GIS), Change Detection Analysis, Spatial Analysis, Aurora Province

I. INTRODUCTION

A. Background of the Study

The Earth's surface is continuously shaped by both natural processes and human activities. As the population increases, natural landscapes such as forests and open lands are converted into residential areas and infrastructure to meet growing demands. While this transformation supports development, it may also contribute to environmental problems, including vegetation loss, soil degradation, and increased flood susceptibility. The World Wildlife Fund notes that the removal of vegetation reduces the land's capacity to absorb rainfall, which may increase the likelihood of flooding.

In the Philippines, urban expansion has significantly influenced land-use patterns. The increasing demand for housing has driven the conversion of agricultural and natural lands into built-up areas. According to the Philippine Statistics Authority (2022), more than half of the country's population now resides in urban areas, intensifying pressure on limited land resources and natural ecosystems.

The Province of Aurora reflects these changes within a highly sensitive environmental context. Located along the eastern coast of Luzon and bordered by the Sierra Madre Mountain Range, the province serves as a natural barrier against Pacific typhoons while remaining vulnerable to their impacts. Its landscape, characterized by forests, agricultural areas, and coastal communities, is increasingly affected by development pressures. Changes in land cover are particularly critical in Aurora, as the loss of vegetation may increase the risk of landslides and flooding. The Pacific Disaster Center (2021) reports that the entire population of Aurora is exposed to typhoon winds, with a significant portion highly vulnerable to landslides. As emphasized in the Aurora Provincial Development and Physical Framework Plan, balancing development with environmental protection remains a key challenge.

This study presents a spatial assessment of land use and land cover (LULC) changes in Aurora from 2020 to 2025. A review of publicly available sources indicates limited recent localized GIS-based comparative studies for this period, with existing information often too generalized to reflect detailed spatial patterns.

To address this gap, the study applies Geographic Information System (GIS) mapping techniques using QGIS and spatial datasets obtained from the Philippine Geoportal. It aims to produce a clear, map-based analysis of land-use changes, offering a more precise understanding of how the province's landscape has evolved. The findings are intended to support local planning efforts and contribute to more sustainable land-use management.

B. Statement of the Problem

This study aims to assess the land use and land cover (LULC) changes in the Province of Aurora from 2020 to 2025 using Geographic Information System (GIS) mapping. Specifically, this study seeks to answer the following questions:

1. What are the LULC classifications of Aurora Province in 2020 and 2025?
2. What are the area and percentage distribution of each class in both years?
3. What are the changes in land use and land cover LULC types of the province between 2020 and 2025?
4. What planning and environmental implications may be inferred from the observed LULC changes?

C. Objectives of the Study

The main objective of this study is to determine the changes in land use and land cover (LULC) of Aurora Province between the two time periods, 2020 and 2025, using GIS mapping.

1. Identify the LULC classes of Aurora Province for 2020 and 2025.
2. Determine the area and percentage distribution of each class.
3. Quantify increases and decreases between 2020 and 2025.
4. Describe possible planning and environmental implications of the observed changes.

D. Significance of the Study

This research provides a data-driven spatial analysis of land use and land cover changes in Aurora from 2020 to 2025. By utilizing GIS mapping, the study offers visual and measurable outputs that are essential for the following:

Provincial Government. The findings serve as a technical basis for large-scale decision-making and provincial land management. The generated maps act as a guide for refining zoning ordinances, housing projects, and infrastructure development.

Environmental Planners. This study identifies critical environmental shifts, such as urban expansion and vegetation loss. These insights allow planners to support localized planning and disaster risk reduction initiatives.

Students and Researchers. By demonstrating the practical application of QGIS and the Philippine Geoportal, this research provides a technical reference for future spatial studies. It serves as a foundational methodology for those exploring provincial-level environmental analysis.

Communities. The study raises awareness regarding how local land transformations affect safety and resources. Visualizing these changes helps foster community support for sustainable land use and more responsible environmental practices.

E. Scope and Limitations

The scope of the study will cover an evaluation of the changes in land use and land cover (LULC) within the Province of Aurora from 2020 to 2025. Moreover, the study will employ Geographic Information System (GIS) mapping tools such as Quantum GIS (QGIS) and spatial datasets obtained from the Philippine Geoportal to identify and evaluate changes in land cover classifications, such as forest lands, agricultural lands, residential areas, grasslands, and water bodies. The study will focus on the spatial patterns of changes within the province over the given period. Furthermore, the study focuses only on observed spatial changes in land cover classifications and does not establish direct causation for the identified land transformations.

This study has several limitations. Firstly, the accuracy of the results depends on secondary data from GIS datasets, which may contain a slight discrepancy between the official provincial land area and the GIS-derived computed area. This inconsistency may be due to differences between the map boundaries, coastline data, clipping method, map projection, and the fact that the secondary maps have limited information. Additionally, no field validation was conducted. Therefore, the identified results may not represent real land transformations. Furthermore, the study did not consider any socio-economic aspect, such as the people, the economy, or the role played by the government. Lastly, the study is limited to a 5-year period from 2020 to 2025, which might not show the land change before and after this period. Also, findings are limited only to the province of Aurora and do not apply to other provinces or regions.

F. Conceptual Framework

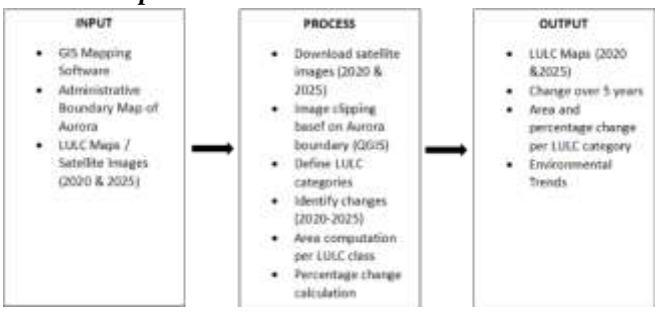

Figure 1. Conceptual Framework

The study uses an Input–Process–Output (IPO) model to assess land use and land cover (LULC) changes in Aurora Province from 2020 to 2025 using GIS mapping. The input includes GIS software, administrative boundary maps, and pre-classified LULC datasets or satellite imagery from 2020 and 2025 obtained from Geoportal Philippines.

The process involves processing the datasets in QGIS, classifying land use and land cover categories, and conducting spatial comparison and change detection analysis. Area computation and percentage change calculations are also performed to measure the extent of changes over the five-year period.

The output includes LULC maps for 2020 and 2025, a change detection map, and statistical results showing the area and percentage changes for each category. These outputs help identify environmental trends, such as changes in forest cover and urban expansion patterns, which can support land use planning and environmental management.

II. REVIEW OF RELATED LITERATURE

Literature Overview

The reviewed literature discusses the major causes, impacts, and significance of land use and land cover (LULC) change. It highlights how urbanization, population growth, economic activities, and human development continuously transform natural landscapes. The studies also emphasize the importance of GIS, remote sensing, and LULC modelling in monitoring land changes and supporting sustainable land-use planning. Furthermore, the literature explains the environmental, climatic, disaster-related, and socio-economic effects of LULC change, particularly in developing countries such as the Philippines.

A. Causes of LULC

Studies explain that LULC change is mainly driven by population growth, urbanization, economic expansion, and human activities such as agriculture and infrastructure development. These factors increase pressure on land resources and contribute to environmental degradation (Demissie, 2017; Geist, 2006; Kuma et al., 2022; Nxumalo, 2025; Adarkwah et al., 2024).

B. Importance of LULC Change Analysis

LULC analysis is important for monitoring environmental changes, predicting land-use trends, and supporting sustainable planning. It helps assess biodiversity loss, urban growth, and ecosystem degradation while guiding policymakers and planners in resource management (Turner et al., 2007; Lambin & Geist, 2006; Seyam et al., 2023; Souza et al., 2022).

C. GIS Mapping in LULC Analysis

GIS and remote sensing are widely used in LULC studies because they effectively monitor spatial and temporal land changes. These tools improve the accuracy of land assessment and support better environmental planning and management (Abino et al., 2015).

D. LULC Modelling

LULC modelling helps predict future land-use patterns and urban expansion. Modern models use statistical and machine learning techniques to improve prediction accuracy and support sustainable planning (Gaur et al., 2023).

E. LULC in the Philippines

In the Philippines, LULC changes are mainly caused by urban expansion, agriculture, and infrastructure development. Studies show increasing built-up areas and decreasing agricultural and natural lands due to rapid development (Estoque & Murayama, 2015; Lasco et al., 2013; IPCC, 2021).

F. Climate Change and LULC Interaction

LULC change and climate change are closely related because land conversion affects carbon storage and greenhouse gas emissions. At the same time, climate change influences land systems through droughts, floods, and other extreme events (IPCC, 2021; Foley et al., 2005; FAO, 2020).

G. Policy and Land Use Planning

Effective land-use planning and policy implementation are important for managing LULC changes and promoting sustainable development. In the Philippines, CLUPs help guide local development, although weak enforcement often leads to environmental problems (UNEP, 2019; HLURB, 2014; World Bank, 2017).

H. Research Gap

Existing studies on LULC mostly focus on large-scale analyses and lack updated localized assessments. There is limited recent GIS-based research on LULC changes in Aurora Province from 2020–2025, which this study aims to address.

III. METHODOLOGY

This section presents the methods used to investigate land use and land cover (LULC) changes in the Province of Aurora. It includes the research design, data sources, study locale, and procedures for data collection and analysis.

A. Research Design

This study employs a GIS-based descriptive spatial analysis to examine land use and land cover (LULC) changes from 2020 to 2025. The design enables a temporal and spatial comparison of land transitions within a defined administrative boundary. The study focuses on quantitative spatial data, using QGIS to analyses, compare, and measure the extent of changes among existing land cover classifications.

B. Data Sources

To ensure technical accuracy, the study utilized official datasets downloaded in 2026 from the Philippine Geoportal, a centralized web-based clearinghouse managed by the National Mapping and Resource Information Authority (NAMRIA). The following specifications were applied:

- **Data Format:**
  The primary datasets were obtained as vector shapefiles (.shp) for both the 2020 and 2025 LULC maps, along with administrative boundary data.
- **Classification System:**
  The study follows the NAMRIA Land Cover Classification System, which categorizes land into standardized classes such as Forest, Brush/Shrubs, Annual Crop, Perennial Crop, Open/Barren Land, and Built-up Areas.
- **Coordinate Reference System (CRS):**
  All datasets were projected to WGS 84 / UTM Zone 51N (EPSG:32651). This projected coordinate system was used to ensure accurate area measurements in hectares (ha), as geographic coordinates (decimal degrees) are not suitable for calculating land extent.

Classification accuracy depends on the quality and consistency of the secondary datasets used.

C. Research Locale

The study was conducted in the Province of Aurora, located along the eastern coast of Luzon. The study area covers approximately 308,175.22 hectares (PhilAtlas, n.d.). The province is suitable for spatial analysis due to its diverse landscape, which includes the Sierra Madre mountain range, agricultural zones, and expanding coastal communities.

D. Data Collection Workflow

1. Download the LULC datasets from publicly available sources.
2. Clip the datasets to the administrative boundary of Aurora Province.
3. Standardize and organize land cover categories to ensure consistency between the 2020 and 2025 maps.
4. Compute the total area (in hectares) for each land cover category.
5. Compare the datasets to identify changes in land use and land cover over time.

E. Data Analysis

The analysis focuses on change detection to identify differences in land cover between 2020 and 2025. By comparing the datasets, the study quantifies variations in built-up areas and natural land cover. This approach ensures that observed changes in Aurora's landscape are supported by measurable spatial data.

IV. RESULTS AND DISCUSSION

The Results and Discussion section presents the findings of the land use and land cover assessment of the Province of Aurora for the years 2020 and 2025 using GIS mapping techniques. This section also interprets and discusses the data analysed.

A. 2020 LULC Profile

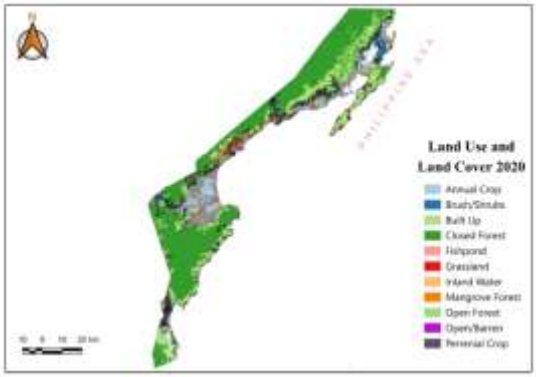

Figure 2: Aurora LULC 2020

Table I. Land use and Land cover Area Distribution of Aurora Province for 2020

LULC	2020 Area (ha)
Annual crop	17,858.83
Brush/shrubs	19,147.79
Built up	3,937.32
Closed forest	147,935.96
Fishpond	69.89
Inland water	3,845.79
Mangrove forest	578.58
Open forest	70,554.01
Open/barren	2,664.11
Perennial crop	35,430.28
Grassland	6,152.65
Total	**308,175.22**

Table 1 and the corresponding figure present the Land Use and Land Cover (LULC) distribution of the Province of Aurora for the year 2020, illustrating the spatial and quantitative distribution of various land cover categories across the region. Based on the documented data, Closed forest remains the most dominant land cover type, occupying 147,935.96 hectares. This signifies that the province maintains a high level of dense vegetation and ecological stability at the start of this five-year study period.

Following the closed forest, Open forest and Perennial crop also represent significant portions of the province, covering 70,554.01 hectares and 35,430.28 hectares, respectively. The presence of these categories, along with 19,147.79 hectares of Brush and shrubs and 17,858.83 hectares of Annual crops, highlights a diverse landscape characterized by both natural regrowth and active agricultural production. Additionally, Built-up areas occupy 3,937.32 hectares, reflecting the extent of human settlement and infrastructure development present in 2020.

Other land cover types constitute smaller segments of the provincial land area. Grassland covers 6,152.65 hectares, while Inland water bodies and Open or barren land account for 3,845.79 hectares and 2,664.11 hectares, respectively. The coastal and aquatic ecosystems are represented by 578.58 hectares of Mangrove Forest and 69.89 hectares of Fishponds, which remains the smallest classification in the province. These figures provide a baseline for understanding the environmental and spatial state of Aurora before the subsequent transformations analysed in the 2025 data.

Overall, the 2020 data confirms that the Province of Aurora is predominantly characterized by forest cover, with Closed Forest acting as the primary land cover type. This baseline indicates that a substantial majority of the province consists of natural vegetation and agricultural lands, while built-up environments and aquaculture activities occupy a relatively small percentage of the total land area of 308,175.22 hectares.

B. ***2025 LULC Profile***

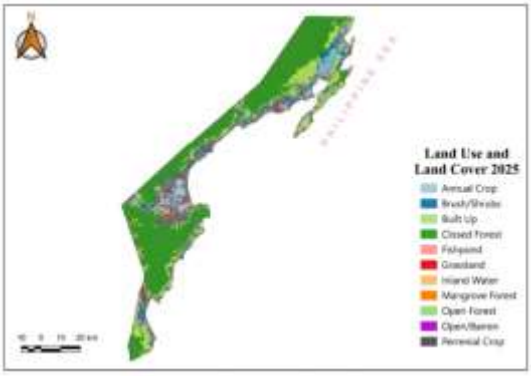

Figure 3: Aurora LULC 2025.

Table II. Land Use and Land Cover Area Distribution of Aurora Province for 2025.

LULC	2025 Area (ha)
Annual crop	20,171.51
Brush/shrubs	19,844.39
Built up	4,283.45
Closed forest	157,652.00
Fishpond	14.57
Inland water	3,076.50
Mangrove forest	575.30
Open forest	62,891.03
Open/barren	2,920.59
Perennial crop	32,709.72
Grassland	4,036.13
Total	**308,175.22**

Figure 3 and Table 2 present the LULC profile of Aurora Province for the year 2025, showing both the spatial distribution and the corresponding area in hectares of each land cover category. Based on the data, Closed forest is the most dominant land cover, occupying 157,652.00 hectares. This is also reflected in the figure, where large continuous areas are covered by dense forest, indicating that Aurora remains largely forested. Open forest is the second largest category, covering 62,891.03 hectares, appearing primarily as transitional zones between dense forests and other land uses.

Agricultural areas such as Perennial crops (32,709.72 hectares) and Annual crops (20,171.51 hectares) are also visible in the figure, showing their distribution across suitable land areas. Brush/shrubs (19,844.39 hectares) further indicate transitional vegetation zones, which can be observed in the map as scattered patches. Meanwhile, Built-up areas (4,283.45 hectares) and Grassland (4,036.13 hectares) occupy relatively smaller portions, which correspond to limited urban development and open land areas in the figure. Inland water bodies (3,076.50 hectares) and Open/barren land (2,920.59 hectares) are also present in smaller amounts. Coastal features such as Mangrove forests (575.30 hectares) appear in narrow strips along shoreline areas, while Fishponds, with only 14.57 hectares, represent the smallest land cover category. Overall, the 2025 data confirms that forest types, particularly closed forests, dominate the landscape of Aurora Province.

C. Change Detection.

Table III. Changes in Aurora Province Land Use and Land Cover Area from 2020 to 2025.

LULC Category	Change (ha)	% Change	Remarks
Annual crop	2,312.69	12.95%	Increased
Brush/ shrubs	696.60	3.64%	Increased
Built up	346.13	8.79%	Increased
Closed forest	9,716.04	6.57%	Increased
Fishpond	-55.32	-79.15%	Decreased
Inland water	-769.29	-20.00%	Decreased
Mangrove forest	-3.28	-0.57%	Slightly Decreased
Open forest	-7,662.98	-10.86%	Decreased
Open/ barren	256.48	9.63%	Increased
Perennial crop	-2,720.56	-7.68%	Decreased
Grassland	-2,116.52	-34.40%	Decreased
Total	0	0.00%	No Change

The table presents the percentage distribution of land use and land cover (LULC) for the years 2020 and 2025. The results show noticeable changes in LULC within the Province of Aurora over this period. Based on the data, several land cover types experienced an increase in area, including annual crops, brush/shrubs, built-up areas, closed forest, and open/barren land, while other categories showed decreases. Among the categories, annual crops recorded the greatest increase, expanding by 12.95% (2,312.69 ha), whereas fishponds experienced the largest decrease, declining by 79.15% (-55.32 ha). Overall, the province experienced observable land-cover transitions during the five-year period.

Despite these changes, Aurora Province remains largely forest-dominated, with closed forest as the most extensive land cover. However, the observed increase in closed forest and decrease in open forest may be associated with dataset classification differences, mapping updates, or transitions between forest classes rather than solely actual ecological recovery. Nevertheless, the results indicate that the province continues to maintain a strong forest base, which remains important for ecological stability and sustainability.

The spatial data also indicate a gradual expansion of more intensive human land-use activities. Built-up areas increased by 8.79%, which may indicate continuing urban and infrastructure development within the province. Similarly, annual crop areas showed the highest increase among agricultural categories, suggesting intensified agricultural activity during the study period. Agricultural initiatives and farmer training programs reported by institutions such as ASCOT and ATI may provide contextual support for this

observed trend. However, these programs were not directly analyzed in the study, and no direct causation was established.

The area covered by fishponds showed the highest percentage decrease (-79.15%). This reduction may reflect changing land-use utilization patterns or classification of changes within the datasets used in the study. In some cases, unproductive fishponds may also be converted into other land uses such as agriculture or settlements. However, these interpretations remain tentative because the study relied on secondary GIS datasets and did not include field validation.

Overall, the findings show that Aurora continues to maintain a strong forest base while experiencing gradual increases in agricultural and built-up areas. These land-cover changes highlight the importance of sustainable land-use planning and environmental management to balance development and ecological protection within the province.

V. SUMMARY, CONCLUSION, AND RECOMMENDATIONS

A. Summary of the Findings

The study investigates land use and land cover (LULC) changes in the Province of Aurora, Philippines, between 2020 and 2025 by using GIS-based mapping techniques to provide a clear and measurable assessment of spatial transformations. Recognizing the effects of human activities on the Earth's surface, the research aims to describe and quantify these changes to support urban planning and environmental management in the region. The significance of this study lies in its potential to provide data-driven insights for stakeholders, including the provincial government and local communities, to support informed decision-making. However, the study is limited to spatial changes within Aurora Province from 2020 to 2025 and relies on secondary GIS data from the Philippine Geoportal, excluding an in-depth analysis of the socio-economic drivers of land-use change.

The methodology adopts a GIS-based descriptive spatial analysis using QGIS software to analyze and compare pre-classified LULC datasets, identify changes, and compute area and percentage differences. The findings reveal shifts in land cover distribution, with Closed Forest remaining dominant and showing a significant increase of 9,716.04 hectares (6.57%). Notable increases were also observed in Annual Crops (12.95%), Open/Barren Land (9.63%), and Built-up areas (8.79%). In contrast, Open Forest, Grassland, and Perennial Crops experienced declines. Despite these changes, forest cover remains the dominant land use in the Province of Aurora.

B. Conclusions

The assessment of land use and land cover (LULC) changes in the Province of Aurora from 2020 to 2025 reveals a landscape that remains fundamentally forest-dominated, with forest cover remaining its dominant land-cover characteristic. While closed forests continue to occupy the largest portion of the province, the observed decrease in open forest cover suggests a gradual transition of natural landscapes toward more intensive human land-use activities.

Among the notable shifts, agriculture recorded the most significant expansion through the increase of annual crops, while built-up areas showed moderate growth, which may reflect localized development needs. In contrast, certain categories experienced declines, most significantly in the aquaculture sector. The reduction in fishpond areas may suggest land conversion or shifting economic conditions; however, this interpretation remains tentative due to the study's reliance on secondary classification data.

Ultimately, these findings demonstrate that while Aurora's general ecological character is preserved, specific land-use types are intensifying. The study underscores the effectiveness of GIS and remote sensing as critical tools for monitoring these temporal changes, providing a necessary spatial foundation for future sustainable land-use planning and environmental management in the province.

C. Recommendations

Future researchers are encouraged to improve this study by including other factors that may affect land use and land cover (LULC) changes in the Province of Aurora. These factors may include population growth, economic activities, government policies, and environmental conditions, which may help explain the causes behind the observed changes.

It is also recommended that future studies use higher-resolution satellite images and more advanced GIS techniques to produce more accurate and detailed results. This can help in identifying smaller and more specific land changes that may not be clearly seen in general datasets.

Lastly, it is suggested that future researchers conduct validation in the field or ground verification to support and confirm the results obtained from GIS analysis. This can improve the accuracy and reliability of the findings and provide a more realistic interpretation of land use and land cover changes

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