Engineering and Technology Journal e-ISSN: 2456-3358

Volume 11 Issue 05 May-2026, Page No.-10128-10137

DOI: 10.47191/etj/v11i05.49, I.F. – 8.595

Assessment of Land Use and Land Cover Changes in Pantabangan, Nueva Ecija from 2015 – 2025 Using GIS Mapping

Zeus G. Narciso[1], Mike Janry B. Rios[2], Lance Andrei L. Rombaoa[3], Clarizz Jelo A. Sanchez[4], Kevin B. Tomas[5], Rosel V. Babalcon[6]

[1,2,3,4,5,6] Nueva Ecija University of Science and Technology, Sumacab Este, Cabanatuan City, Nueva Ecija

ABSTRACT: This study assesses the Land Use and Land Cover (LULC) changes in the municipality of Pantabangan, Nueva Ecija, from 2015 to 2025 using Geographic Information System (GIS) mapping. As a critical watershed area and the site of the Pantabangan Dam, understanding spatial transformations in the municipality is vital for evaluating ground stability, supporting infrastructure planning, and mitigating geological hazards. Employing a descriptive and spatial-analytical research design, the study utilized QGIS software to analyse secondary LULC datasets obtained from the Philippine Geoportal for the years 2015, 2020, and 2025. Spatial overlay analysis and area computations revealed significant transformations across multiple land cover categories over the ten-year period. Results indicate that while brush and shrubs remained the dominant land cover, this category experienced a notable decrease of 36.21%, translating to a loss of 4,889.91 hectares. Conversely, closed forests exhibited the most substantial growth, expanding by 1607.11% (2,769.38 hectares), suggesting potential vegetation recovery and natural ecological succession. Additionally, builtup areas increased by 175.30% and grasslands expanded by 89.97%, reflecting ongoing settlement growth, infrastructure development, and land conversion activities. Despite these developmental shifts, Pantabangan remains largely dominated by natural vegetation. Ultimately, the findings emphasize the necessity of integrating GIS-based environmental monitoring into civil engineering and municipal planning to ensure sustainable infrastructure development and the continuous preservation of watershed ecosystems.

KEYWORDS: Land Use and Land Cover (LULC), Geographic Information System (GIS), Spatial Analysis, Pantabangan Watershed, Land Conversion

I. INTRODUCTION

1.1 Background of the Study

Pantabangan is one of the largest municipalities in Nueva Ecija. Over the past decade, from 2015 to 2025, the town has seen widespread changes in how its land is used. While it is famous for its dam and watershed, the entire municipality has experienced growth in tourism, new residential developments, and expanded agricultural areas, which may be associated with observed land use changes based on spatial patterns and supporting literature. These shifts represent key Land Use and Land Cover (LULC) changes, including forest cover reduction, watershed alterations, agricultural expansion, built-up growth, and evolving needs for environmental planning.

When forests or natural terrains are cleared to make way for resorts, roads, or commercial spaces, the natural state of the ground is altered. Geology is highly important in understanding these changes. Removing vegetation exposes the topsoil, making the ground more vulnerable to erosion and shifting during heavy rains or earthquakes.

A related study titled Landslide Vulnerability Map of Barangay Fatima, Pantabangan, Nueva Ecija by Parcasio, Cabanesas, et al. (2023) utilized Geographic Information System (GIS) and the Analytic Hierarchy Process (AHP) to evaluate risks influenced by factors like rainfall, slope, soil type, land cover, and elevation. According to Cabanesas et al. (2023), rainfall, slope, land cover, and soil texture play significant roles in geological stability.

When rapid LULC changes occur, such as cutting trees for new roads or farms, the soil may lose its natural root reinforcement. Given Pantabangan's steep slopes and heavy rainfall, these alterations may increase vulnerability to erosion and soil instability.

By applying GIS mapping on a wider scale, we can visually track and calculate changes across the entire Pantabangan municipality over the last 10 years, quantifying trends in forest cover loss, watershed impacts, agricultural expansion, and built-up areas. For civil engineers, this municipality-wide LULC analysis provides a scientific baseline to evaluate ground stability in newly developed zones for supporting infrastructure like buildings, highways, and drainage systems. Geology is vital for interpreting LULC changes and their effects on environmental planning and infrastructure. Converting natural forests into commercial or residential areas on steep slopes removes root systems that stabilize soil. Without this support, the ground may become more prone to erosion from heavy rainfall, weakening slopes, and potentially affecting overlying structures.

Therefore, this case study highlights the geological implications of LULC changes, including forest cover shifts, watershed protection challenges, agricultural expansion, builtup growth, and long-term land conversion trends, and their influence on infrastructure design and safety. The environmental and engineering implications discussed are interpretative and were not directly measured in this study. Overlooking geological risks identified through GIS mapping in planning may increase the risk of early infrastructure damage. This also relates to issues like increased surface runoff from land conversion, which may lead to flooding and erosion even with standard construction.

1.2 Statement of the Problem

This study clearly defines the following engineering and geological issues to be investigated:

1. What were the dominant LULC classes in 2015, 2020, and 2025?
2. What major changes occurred between the selected years?
3. Which land cover types significantly increased or decreased the most?
4. What possible environmental implications may be inferred from the observed LULC changes based on spatial patterns and literature?

1.3 Objectives of the Study

This study aims to assess the Land Use and Land Cover (LULC) changes in Pantabangan, Nueva Ecija from 2015 to 2025 using GIS mapping. Specifically, it intends to:

1. To identify the different LULC categories in Pantabangan.
2. To quantify the area distribution in 2015, 2020, and 2025.
3. To determine changes between time periods.
4. To discuss the possible environmental implications of the observed LULC changes based on GISderived results and related literature.

1.4 Significance of the Study

For Civil Engineers – This study emphasizes the importance of assessing the geological history of a site prior to construction. By understanding previous land use, engineers can design more appropriate foundations and retain structures that match existing soil conditions.

For Municipal Planners / LGU Planners – This study provides guidance for municipal zoning and land-use planning. Through the use of GIS-based hazard maps, planners can identify which areas of Pantabangan are suitable for development and which areas should be preserved to reduce the risk of landslides.

For the Local Government Unit (LGU) – This study offers a scientific basis for decision-making in town expansion. Instead of approving construction in high-risk zones, officials can direct development toward geologically stable areas, helping reduce potential disaster-related costs and improve public safety.

1.5 Scope and Limitations

The study's scope includes an assessment of how the land use and land cover (LULC) of the municipality of Pantabangan changed in 2015, 2020, and 2025, with 2020 serving as the midpoint year used for comparison of trends between 2015 and 2025. Additionally, the study will utilize Geographic Information System (GIS) mapping tools, such as the Philippines Geoportal and Quantum GIS (QGIS), to detect and analyze changes in land cover, including residential areas, forest lands, agricultural lands, grasslands, and water bodies. The spatial patterns of these changes within the municipality over the specified time periods will also be examined.

This study has several limitations. First, the results rely on secondary GIS data; therefore, their accuracy depends on the quality and reliability of the available datasets. Second, the study focuses only on the physical and spatial changes in land use and land cover and does not investigate the underlying causes of these changes, such as government policies, economic factors, or population growth. In addition, the study is limited to the municipality of Pantabangan, meaning the findings may not be directly applicable to other areas. Lastly, the study only covers the years 2015, 2020, and 2025. As a result, it may not fully capture gradual changes occurring before, between, or after these selected years. This study relies on Geoportal-derived datasets, and no independent ground validation or formal accuracy assessment was conducted. Results should therefore be interpreted as indicative spatial trends rather than exact field-validated measurements.

1.6 Conceptual Framework

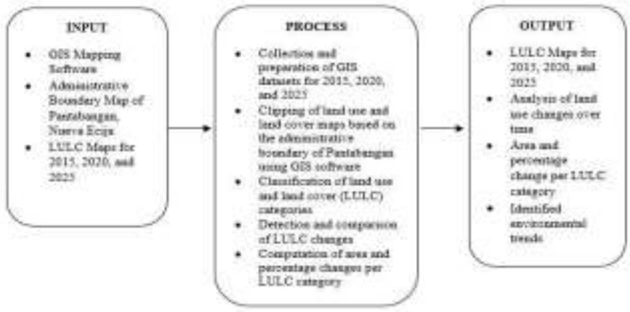

Figure 1. Conceptual Framework

The study uses an Input-Process-Output model to examine the changes in land use and land cover in the municipality of Pantabangan, Nueva Ecija for the years 2015, 2020, and 2025 using GIS mapping. The inputs include the needed tools and data such as GIS mapping software, the administrative boundary map of Pantabangan, and land use and land cover maps for the selected years. These serve as the main basis for the analysis.

The process includes several steps using GIS. First, the LULC maps for 2015, 2020, and 2025 are collected and prepared. These maps are then clipped based on the boundary of Pantabangan and loaded into the GIS software. The Geoportal LULC classifications were retained and standardized for comparison across the years. Changes are then identified between 2015 and 2020 and between 2020 and 2025 through spatial analysis. Next, the area for each category is measured, and the percentage changes are calculated to show how much change happened over time.

The outputs of the study include the land use and land cover maps of Pantabangan, Nueva Ecija for 2015, 2020, and 2025, along with the results of the changes over time. It also provides data on the area and percentage change for each category. These results help show important environmental trends such as urban growth, deforestation, or changes in agricultural land, which can be useful for planning and managing land use.

II. REVIEW OF RELATED LITERATURE

This chapter establishes the scientific foundation for investigating the Land Use and Land Cover (LULC) changes and their possible environmental implications. The theories, definitions, and principles discussed herein align with the core concepts of the CE 222 Geology for Civil Engineers module, explaining how natural ground conditions, earth processes, and external human developments interact with the stability of the environment and civil infrastructure.

Remote Sensing and GIS-Based Land Use and Land Cover (LULC) Mapping

According to Israel et al. (2024), Google Earth Engine (GEE) was used to generate land cover maps and analyze land use and land cover (LULC) change and deforestation patterns in the Sierra Madre Mountain Range, showing a declining forest cover from 2016 to 2022 in General Nakar and Rodriguez.

Landsat satellite imagery analyzed using Quantum Geographic Information System (QGIS) and classification

algorithms such as the minimum distance method was used to assess land cover change in and around Minalungao National Park, revealing dynamic land cover gains and losses over time influenced by human activities such as deforestation, grazing, ecotourism, and forest restoration said by Tumbaga (2023).
According to Zulueta (2024), a GIS-based approach using Sentinel-2 satellite data and GIS software such as QGIS and AutoCAD Civil 3D was used to generate a land use and land cover (LULC) map, assess LULC percentages, and support informed decision-making for sustainable development in Barangay San Miguel, Alaminos, Laguna.
Geographic Information System (GIS) in civil and environmental engineering is used to integrate, analyze, and visualize spatial data such as land use, environmental features, water resources, and infrastructure, supporting planning, design, and decision-making processes for sustainable development and environmental impact assessment.
Using satellite and remotely sensed data, the U.S. Geological Survey monitors land cover change over space and time at regional to global scales and analyzes its causes and consequences, including impacts on water quality, biodiversity, carbon fluctuations, and climate variability, where land cover refers to vegetation and artificial structures while land use refers to human activities on the land, (Slonecker et al., 2013).
The remote sensing technology and GIS tools cooperatively have made it easier to monitor the changes in land use land cover (LULC) from past to present, and the data from remote sensing satellites serve as the primary source for acquiring information about LULC change in recent decades, (Chughtai et al., 2021).
Remote sensing and GIS are widely used in studying land use and land cover changes by effectively mapping and analyzing environmental transformations over time. Satellitebased tools such as Google Earth Engine, QGIS, and Sentinel-2 imagery have been shown to accurately detect land cover changes like forest decline and land conversion caused by human activities such as deforestation, agriculture, and settlement expansion. These technologies are not only useful for mapping but also for supporting sustainable land use planning and decisionmaking through integration with engineering and spatial analysis applications. On a broader scale, remote sensing and GIS improve the accuracy, efficiency, and accessibility of monitoring land cover dynamics and understanding their environmental impacts. These studies show the growing importance of GIS-based approaches in analyzing land use changes, which strongly supports the assessment of land use and land cover dynamics in Pantabangan, Nueva Ecija from 2015 to 2025. Unlike studies that generate new classifications, this study uses preclassified Geoportal datasets and focuses on spatial comparison.

Land Use Change and Forest Degradation in Watershed Systems in Pantabangan

The stability of a municipality's natural environment is heavily influenced by Land Use and Land Cover (LULC) changes. According to Dida et al. (2021), human activities such as agricultural expansion and the continuous development of human settlements drastically alter the landscape of the Pantabangan-Carranglan Watershed. Their study indicates that these environmental disturbances decrease the natural forest cover, which directly exposes the underlying geological materials to rapid degradation. To properly analyze these widespread geological changes, civil engineers and researchers rely on Geographic Information Systems (GIS) and remote sensing. Dida et al. (2021) utilized these spatial technologies to map the extent of forest disturbances in Pantabangan over several years. Through GIS mapping, professionals can visually track exactly which specific areas have lost their protective land cover and are now exposed to geological hazards.
The consequences of these geological failures extend beyond the immediate slopes and directly affect major town infrastructure. Alejo et al. (2024) emphasize that the eroded soils from the deforested and newly developed areas of Pantabangan eventually wash down into the watershed's main reservoir. This process, called sedimentation, decreases the water-holding capacity of the Pantabangan Dam, which poses a serious threat to both local irrigation supplies and regional hydroelectric power generation.
Land use and land cover changes significantly affect watershed stability, especially in Pantabangan where human activities such as agriculture expansion and settlement growth continuously reduce forest cover. This loss of vegetation weakens the land's natural protection, making it more vulnerable to soil and geological degradation. GIS and remote sensing are commonly used to map these changes and identify areas that have been exposed due to deforestation and land conversion. These environmental changes also extend beyond upland areas, as eroded soils are carried into the watershed and accumulate in reservoirs. This leads to sedimentation, which reduces water storage capacity and affects irrigation supply and hydroelectric power generation. Overall, land use change in Pantabangan shows a direct link between environmental degradation and its impact on essential water resources and infrastructure.

Soil Erosion, Slope Instability, and Land Conversion Effects

In measuring the actual volume of soil displaced by these land changes, the Revised Universal Soil Loss Equation (RUSLE) is often integrated into the GIS framework. As demonstrated by Alejo et al. (2024), the RUSLE model effectively calculates soil loss in Pantabangan by analyzing five specific geological and environmental factors: rainfall erosivity, soil erodibility, slope length and steepness, cover management, and conservation practices.
Beyond surface erosion, LULC changes directly increase a region's susceptibility to severe landslides. Parcasio et al. (2023) conducted a hazard assessment in Barangay Fatima, Pantabangan, identifying that land cover is one of the primary biophysical factors that dictate landslide occurrences. Their findings prove that when the natural land cover is altered on steep slopes, the ground beneath becomes highly vulnerable to collapse.
The interaction between altered land cover and local weather patterns creates a highly dangerous geological environment. According to the study by Parcasio et al. (2023), rainfall and slope are the most critical triggers for landslides in the Pantabangan area. When heavy rains hit newly cleared lands that no longer have trees to absorb the water, the rapid surface runoff easily washes away the topsoil, leading to catastrophic slope failures.
When natural forests are converted into open or barren lands, the soil loses the vital structural support previously provided by deep tree roots. Alejo, et al. (2024) state that areas converted into annual crop farms and open lands in Pantabangan exhibit the highest rates of soil erosion. Their research highlights that the removal of surface vegetation fundamentally weakens the soil's natural ability to resist environmental forces, making the ground highly unstable.

The mechanical behavior of the soil drastically changed when vegetation is removed. Das (2010), in his fundamental principles of geotechnical engineering, explains that the stability of any slope is governed by the shear strength of the soil. When land is cleared for development and heavy rains saturate on the ground, the water trapped inside the soil increases the pore water pressure. This proportionately reduces the effective stress and shear strength of the soil mass, making the newly developed area prone to sinking or sliding. Land use and land cover change (LULCC) analyzed using the RUSLE model in ArcGIS showed that increasing cultivated and bare land and decreasing vegetation cover in the Ethiopia Central Rift Valley, particularly in the Alaba Sub-Watershed, led to increased soil erosion rates and a worsening erosion risk condition over time, (Jemal & Gadisa, 2023).

Soil erosion, slope instability, and land conversion are strongly affected by land use and land cover changes, especially in watershed areas like Pantabangan. GIS-based models such as RUSLE are commonly used to estimate soil loss by analyzing rainfall, soil properties, slope, and land cover conditions. Land conversion from forests to agriculture or open areas increases soil exposure, making slopes more vulnerable to erosion and landslides. This risk becomes higher in steep areas were heavy rainfall and lack of vegetation trigger surface runoff and slope failure. Without tree roots, soil loses support and becomes unstable as water increases pore pressure and reduces soil strength. These findings show that land use changes greatly contribute to soil erosion and slope instability in watershed environments.

GIS Applications for Environmental and Engineering Decision-Making

To prevent these infrastructure disasters, the creation of geological hazard maps is necessary for local government planning. Parcasio et al. (2023) utilized the Analytic Hierarchy Process (AHP) alongside GIS software to map out the exact landslide vulnerability zones in Pantabangan. These vulnerability maps serve as a direct guide for civil engineers and city planners to avoid building critical structures, like roads and housing projects, in high-risk, geologically unstable areas.

Ultimately, tracking LULC changes over a ten-year period provides a clear scientific baseline for sustainable engineering. By continuously monitoring how the land in Pantabangan shifts from 2016 to 2026, researchers like Alejo et al. (2024) and Dida et al. (2021) prove that environmental monitoring is nonnegotiable. Civil engineering practices must incorporate these GIS-based geological assessments to ensure that future infrastructure can withstand the evolving conditions of the earth.

Using soil classification, field sampling, and mapping techniques, soil type maps were generated for agricultural lands in Science City of Muñoz and used as land mapping units to assess crop suitability, supporting land use planning and agricultural decision-making by identifying which soil types are highly suitable for crops such as rice, corn, onion, mango, and sugarcane, (Alejo & Fiegalan, 2025).

GIS plays an important role in environmental and engineering decision-making by supporting hazard mapping, land evaluation, and sustainable planning. In Pantabangan, GIS combined with analytical methods such as AHP is used to identify landslide-prone areas, helping planners avoid construction in high-risk zones and reduce infrastructure damage. Continuous monitoring of land use and land cover changes also provides a scientific basis for long-term planning, allowing engineers to understand how landscape conditions shift over time. These spatial analyses support safer infrastructure development by integrating environmental data into planning and design. GIS is also applied in soil and land suitability mapping, where field data and classification techniques help determine appropriate areas for agriculture and land use. These applications show how GIS strengthens evidence-based decision-making in both environmental management and civil engineering planning.

III. METHODOLOGY

This chapter explains the application of Geographic Information System (GIS) mapping in assessing the Land Use and Land Cover (LULC) change in Pantabangan, Nueva Ecija, Philippines, between 2015 and 2025. The methods that the study employed to identify and determine the changes in the land use patterns in the municipality were spatial analysis, map interpretation, and land cover categorization. The research involved the analysis of the terrain variation of Pantabangan in the past decade as a result of land conversion, development as well as environmental aspects through GIS technology.

3.1 Research Design

The study employed a descriptive and spatial-analytical research design using Geographic Information System to assess Land Use and Land Cover changes in Pantabangan, Nueva Ecija from 2015 to 2025. The research utilized existing spatial datasets and geo-referenced land use and land cover maps to identify, compare, and analyze land use changes over time. This study is descriptive and relies on secondary GIS datasets without generating new classifications.

The study followed a three-period temporal framework covering the years 2015, 2020, and 2025. The year 2020 served as the midpoint reference year used to compare and evaluate trends between the baseline year 2015 and the most recent year 2025. This approach allowed a clearer interpretation of the direction and progression of land use changes.

3.2 Study Area Description

The study focuses on the municipality of Pantabangan, situated in the northern part of Nueva Ecija, Philippines. According to the latest census, Pantabangan has a population of 31,763. The municipality is widely recognized for the Pantabangan Dam, a major infrastructure that supplies irrigation water for agricultural lands and generates hydroelectric power for Central Luzon.

Geographically, Pantabangan is characterized by mountainous terrain, as it is surrounded by the Sierra Madre and Caraballo mountain ranges. The area features a diverse landscape composed of forested regions, rolling hills, and agricultural lands. Due to its role as a significant watershed, Pantabangan serves as an ideal study area for analysing changes in land use and forest cover across the years 2015, 2020, and 2025.

3.3 Data Collection

3.3.1 Datasets Used

- Land Use and Land Cover (LULC) maps for the years 2015, 2020, and 2025 is used as the primary data for analysing land use changes over time.
- Administrative boundary map of Pantabangan, Nueva Ecija is used to define the exact study area and ensure spatial accuracy.
- Supporting GIS reference maps from geoportal sources is used to provide additional spatial context and improve interpretation of land cover features.

3.3.2 Data Sources

- Philippine Geoportal – provides official spatial datasets and reference maps from government agencies. Specifically, Geoportal-derived LULC datasets were used for 2015, 2020, and 2025.
- Existing GIS-based land use datasets and spatial records – consist of pre-processed spatial data such as land use maps and georeferenced records used to support and validate the analysis.

3.3.3 Software Used

- **QGIS Version 4.0** – an open-source Geographic Information System software used for spatial data processing, map preparation, overlay analysis, and visualization of Land Use and Land Cover (LULC) maps. Specific tools used include Clip Tool, Raster to Vector Conversion, Field Calculator, and Intersection Tool for spatial analysis and change detection.

3.4 Data Preparation

All spatial datasets were processed to ensure consistency prior to analysis. This included standardizing coordinate reference systems, clipping all datasets to the administrative boundary of Pantabangan, and organizing land use and land cover maps into separate layers for 2015, 2020, and 2025. Dataset completeness and spatial alignment were also verified to ensure accuracy and compatibility across all layers.

3.5 Land Use and Land Cover Classification and Standardization

The land use and land cover (LULC) categories were based on detailed classifications obtained from Geoportal datasets. These include brush/shrubs, open forest, closed forest, grassland, inland water, annual crops, perennial crops, built-up areas, and open/barren land. For consistency in analysis, these categories were retained throughout all datasets for 2015, 2020, and 2025 without generalization to ensure accurate spatial comparison and change detection.

3.6 Spatial Analysis

Spatial analysis was conducted using Geographic Information System (GIS) tools in QGIS to determine and quantify land use changes in the study area. The process was carried out through the following steps:

Import Layers: The LULC maps for 2015, 2020, and 2025 were imported into the GIS environment for processing.

Clip to Boundary: The Clip Tool was used to extract only the land cover data that falls strictly within the administrative boundary of Pantabangan.

Standardize CRS: All layers were processed and converted into a uniform Coordinate Reference System (CRS) and format to ensure accurate spatial alignment and compatibility.

Compute Area: Attribute tables were analyzed using the Field Calculator to compute the exact area of each land use category.

Compare Changes: Map overlay analysis was performed using the Intersection Tool to overlay the LULC layers of different years (2015–2020 and 2020–2025). This generated new spatial layers showing areas of land conversion, quantifying changes over time to determine whether specific land cover types increased, decreased, or remained stable.

3.7 Data Analysis

The data analysis focused on identifying patterns and trends in land use changes across the three time periods. The results were interpreted based on increases and decreases in forest cover, agricultural land, built up areas, and water bodies.

The findings were presented using thematic maps tables of land area per category and percentage change analysis to clearly illustrate spatial and temporal trends.

No reclassification or accuracy validation was conducted; results depend on the source dataset.

Locale of the Study

The study is conducted in the Municipality of Pantabangan, located in the Central part of Luzon, Philippines. The area is characterized by a mix of forest lands, agricultural areas, Inland water, and developing residential communities.

Pantabangan is selected as the study locale due to its noticeable land use transformations over time, influenced by both natural processes and increasing human activities such as urban expansion and agricultural development. The municipality provides a suitable setting for analyzing land use and land cover changes using GIS Mapping.

Figure 2: Satellite View of Pantabangan, Region 3, Philippines

IV. RESULTS AND DISCUSSION

The Results and Discussion section presents the findings of the land use and land cover assessment of the Municipality of Pantabangan for the years 2015, 2020, and 2025 using GIS mapping techniques. This section also interprets and discusses the data analysed.

Thematic Map

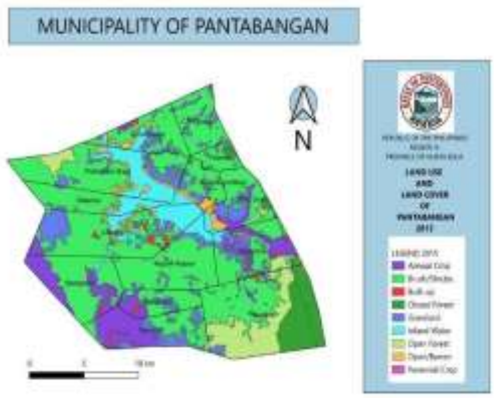

Figure 3: Pantabangan LULC 2015

[Source link : Click here →](https://drive.google.com/drive/folders)

https://drive.google.com/drive/folders

Figure 2 presents the Land Use and Land Cover (LULC) distribution of Pantabangan, Nueva Ecija for the year 2015, illustrating the spatial distribution of various land cover types across the area. Brush/Shrubs are the dominant land cover, covering approximately 13,511.99 hectares, indicating that a large portion of the municipality is classified as brush/Shrub land cover.

Open Forest also occupies a significant area of about 6,597.93 hectares, followed by Inland Water with 3,645.15 hectares, showing the presence of forested areas and water bodies. Grassland covers 1,392.31 hectares, indicating areas classified as Grassland/Open Vegetation.
Meanwhile, Annual Crops and Perennial Crops account for 219.60 hectares and 40.01 hectares, respectively, indicating relatively smaller agricultural activities. Closed Forest occupies 172.32 hectares, showing limited dense forest cover. Open or barren land covers 146.95 hectares, while Builtup areas represent the smallest land cover type at only 90.08 hectares, suggesting minimal urban development in Pantabangan during 2015.

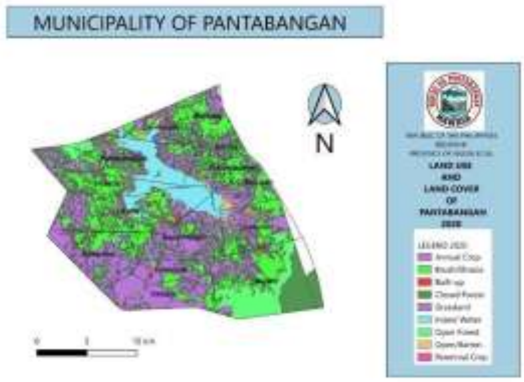

Figure 4: Pantabangan LULC 2020
Source link : Click here →
https://drive.google.com/drive/folders

This figure shows the Land Use and Land Cover (LULC) distribution of Pantabangan, Nueva Ecija for the year 2020, showing the spatial extent of different land cover classes across the municipality. The results show that Brush/Shrubs are the dominant land cover type, covering approximately 9,312.61 hectares, indicating that a large portion of the area is classified as Brush/Shrub land cover.
Grassland follows as the second most extensive class with about 6,284.10 hectares, indicating extensive Grassland areas. Open Forest also covers a significant portion at 4,613.87 hectares, showing the presence of Open Forest areas.
Inland Water occupies approximately 3,669.88 hectares, showing the presence of Inland Water bodies. Closed Forest covers about 2,467.46 hectares, showing areas classified as Closed Forest within the municipality.
Meanwhile, agricultural areas are less extensive, with Annual Crops covering 401.41 hectares and Perennial Crops only 36.43 hectares, indicating relatively small agricultural land areas. Built-up areas account for 182.61 hectares, while Open or Barren land covers 167.39 hectares. This shows that Built-up and Open/Barren areas remain relatively small compared to other land cover types in Pantabangan as of 2020.

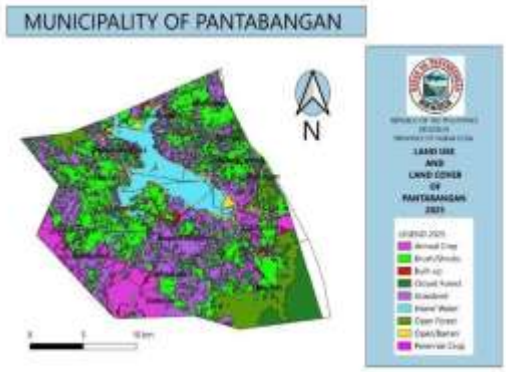

Figure 5: Pantabangan LULC 2025
Source link : Click here →
https://drive.google.com/drive/folders

In the year 2025, Brush/Shrubs remain the dominant land cover, covering approximately 8622.08 hectares, indicating that a large portion of the area is classified as Brush/Shrub land cover.
Grassland follows about 6,445.46 hectares, indicating an increase in Grassland areas. Open Forest occupies 4,625.88 hectares, while Inland Water covers 3,670.81 hectares, showing the presence of Open Forest and Inland Water areas. Closed Forest accounts for 2,941.70 hectares, showing an increase in the Closed Forest area. Meanwhile, Annual Crops and Perennial Crops cover 382.44 hectares and 23.37 hectares, respectively, indicating limited agricultural land use. Open or Barren land occupies 176.01 hectares, while Built-up areas cover 247.99 hectares, showing an increase in Built-up areas. Overall, the 2025 data show that Brush/Shrubs, Grassland, and forest-related land covers remain the major land cover types in the municipality.

Table 1. Land Use and Land Cover Area Distribution of Pantabangan, Nueva Ecija for 2015

LULC Category	Area in Hectares
Annual Crop	219.60
Brush/Shrubs	13,511.99
Built-up	90.08
Closed Forest	172.32
Grassland	3,392.42
Inland Water	3,645.15
Open Forest	6,597.93
Open/Barren	146.95
Perennial Crop	40.01
Total	**27,135.74**

Results indicate the area in hectares of each land use and land cover (LULC) category in the year 2015. Based on the data gathered, Brush/Shrubs in the municipality of Pantabangan, Nueva Ecija recorded the highest land cover area, covering an area of 13,511.99 hectares. On the other hand, the least land cover in 2015 was the Perennial Crop, covering only 40.01 hectares of land in Pantabangan, Nueva Ecija, making it the smallest land cover class among the given data. This table shows that Pantabangan, Nueva Ecija, was mostly composed of Brush/Shrubs in 2015.

Table 2. Land Use and Land Cover Area Distribution of Pantabangan, Nueva Ecija for 2020

LULC Category	Area in Hectares
Annual Crop	401.41
Brush/Shrubs	9312.61
Built-up	182.61
Closed Forest	2467.46
Grassland	6284.10
Inland Water	3669.88
Open Forest	4613.87
Open/Barren	167.39
Perennial Crop	36.43
Total	**27,135.74**

The table shows the area of Pantabangan, Nueva Ecija in hectares for each land use and land cover (LULC) category in the year 2020. Based on the data, Brush or Shrubs has the highest land cover in Pantabangan, covering an area of 9,312.61 hectares. This indicates that the municipality is still largely dominated by secondary vegetation and transitional landscapes. On the other hand, the least land cover in 2020 is Perennial Crops, which only covers 36.43 hectares, making it the smallest land cover class among the given categories in Pantabangan, Nueva Ecija. This table shows that Pantabangan, Nueva Ecija was still mostly covered with Brush or Shrubs in 2020.

Table 3. Land Use and Land Cover Area Distribution of Pantabangan, Nueva Ecija for 2025

LULC Category	Area in Hectares
Annual Crop	382.44
Brush/Shrubs	8622.08
Built-up	247.89
Closed Forest	2941.70
Grassland	6445.46
Inland Water	3670.81
Open Forest	4625.88
Open/Barren	176.01
Perennial Crop	23.37
Total	**27,135.74**

Data reveal the area of Pantabangan, Nueva Ecija, in hectares of each land use and land cover (LULC) category in the year 2025. Based on the 2025 Geoportal data, Brush/Shrubs remained the dominant land cover category in Pantabangan, Nueva Ecija, covering an area of 8622.08 hectares. On the other hand, the least land cover in 2025 became the Perennial Crops, which drops significantly to only 23.37 hectares of land in Pantabangan, Nueva Ecija, making it the smallest land cover class among the given data. This table shows that Pantabangan, Nueva Ecija, was still mostly covered with features, Brush/Shrubs, in the year 2025.

Table 4. Land Use and Land Cover Comparison of Pantabangan, Nueva Ecija for 2015 and 2020

LULC Category	2020 Area (ha)	2015 Area (ha)	Change (ha)	% Change	Remarks
Annual Crop	401.41	219.60	181.81	82.80%	Increased
Brush/Shrubs	9312.61	13,511.99	-4,199.38	-31.08%	Decreased
Built-up	182.61	90.08	92.53	102.72%	Increased
Closed Forest	2467.46	172.32	2295.114	1331.98%	Increased
Grassland	6284.10	3392.42	2,891.68	85.24%	Increased
Inland Water	3669.88	3645.15	24.73	0.68%	Slightly Increased
Open Forest	4613.87	6597.93	-1984.06	-30.07%	Decreased
Open/Barren	167.39	146.95	20.44	13.91%	Increased
Perennial Crop	36.43	40.01	-3.58	-8.95%	Slightly Decreased
Total	**27,135.74**	**27,135.74**	**2,388.39**	**12.75%**	**Increased**

The table presents the comparison of land use and land cover (LULC) of Pantabangan, Nueva Ecija for the years 2015 and 2020. The results show significant changes in the municipality's land cover over the five-year period. Based on the data, most land cover categories experienced an increase in area, including Annual Crops, Built-up areas, Closed Forest, Grassland, and Open/Barren land, while Brush/Shrubs, Open Forest, and Perennial Crops showed a decrease. Inland Water showed only a slight change, indicating minimal variation during the period. Among all categories, Closed Forest recorded the highest increase, expanding by 2,295.14 hectares or 1331.98%, and it is noted that large percentage changes are influenced by relatively small baseline values and inherent differences in land cover classification across time periods.

This large percentage increase is due to a small baseline area. While Brush/Shrubs experienced the greatest decrease, declining by 4,199.38 hectares or 31.08%. These changes indicate that land use and land cover in Pantabangan underwent major transformations between 2015 and 2020. According to Abad et al. (2026), increases in forest cover of about 89 km² were observed for the 2017–2020 period, along with gains in non-forest vegetation and bare soil classes. These results suggest significant land cover changes and ecological succession over time, indicating continuous landscape transformation in the area.

Despite these changes, Pantabangan remains largely dominated by forest and vegetation cover, particularly Open Forest, Closed Forest, Grassland, and Brush/Shrubs. Although some categories such as Built-up areas and Annual Crops increased, forest-related land covers still occupy a significant portion of the municipality. This suggests that while land conversion and development continue to occur, the natural landscape of Pantabangan remains strongly influenced by its forest ecosystems. Forest resources continue to play an important role in maintaining ecological balance, biodiversity, and watershed protection in the area.

Moreover, the remarkable increase in Closed Forest may indicate possible forest recovery and natural vegetation regrowth within the municipality. Mukul et al. (2016) found that secondary forests in the Philippines undergo progressive recovery of aboveground biomass carbon over time, indicating natural forest regeneration and the increasing ability of these forests to restore structure and ecological function as they mature. This change may be associated with forest protection policies and watershed management efforts implemented in Pantabangan, which aim to maintain forest cover due to its importance in water regulation and environmental sustainability. Since Pantabangan is part of the Pantabangan-Carranglan Watershed, forest conservation is crucial in maintaining hydrological balance and supporting the dam system.

On the other hand, the decline in Brush/Shrubs and Open Forest may be associated with land conversion into agricultural land, Grassland expansion, and natural vegetation succession where secondary vegetation develops into denser forest cover. The increase in Built-up areas may also reflect population growth and infrastructure development, which may contribute to urban expansion. Similarly, the increase in Grassland may indicate land clearing for grazing, farming, or transitional vegetation changes.

Furthermore, the slight increase in Inland Water may be influenced by the presence of the Pantabangan Dam and reservoir, which serve as major water sources in the municipality. The minimal change in Perennial Crops may indicate relatively stable agricultural practices for long-term crops. Overall, these findings highlight the dynamic interaction between natural processes and human activities in shaping the land use and land cover of Pantabangan, Nueva Ecija.

Table 5. Land Use and Land Cover Comparison of Pantabangan, Nueva Ecija for 2020 and 2025

LULC Category	2025 Area (ha)	2020 Area (ha)	Changes (ha)	% Changes	Remarks
Annual Crop	382.44	401.41	-18.97	-4.73%	Slightly Decreased
Brush/Shrubs	8622.08	9312.61	-690.53	-7.41%	Slightly Decreased
Built-up	247.99	182.61	65.38	35.80%	Increased
Closed Forest	2941.70	2467.46	474.24	19.22%	Increased
Grassland	6445.46	6284.10	161.36	2.57%	Slightly Increased
Inland Water	3670.81	3669.88	0.93	0.03%	Slightly Increased
Open Forest	4625.88	4613.87	12.01	0.26%	Slightly Increased
Open/Barren	176.01	167.39	8.62	5.15%	Slightly Increased
Perennial Crop	23.37	36.43	-13.06	-35.85%	Decreased
Total	**27,135.74**	**27,135.74**	**282.22**	**-0.84%**	**Decreased**

An analysis of the Land Use and Land Cover (LULC) data for Pantabangan, Nueva Ecija between 2020 and 2025 reveals a landscape experiencing noticeable land use and land cover changes over time. The most prominent environmental indicator is the inverse relationship between forested areas and brushlands. Specifically, Closed Forests experienced a substantial increase of 19.22% (474.24 hectares), which corresponds with a decrease of 7.41% (690.53 hectares) in Brush/Shrubs. This pattern may indicate a possible transition from Brush/Shrub areas toward more forested land cover.

This pattern may possibly reflect vegetation recovery consistent with trends reported in related watershed studies, including areas influenced by forest management and reforestation programs such as the National Greening Program (NGP).

Simultaneously, the data shows changes in land cover that may reflect possible human activities such as urban expansion and land use modification. Built-up areas saw the highest proportional growth at 35.80% (65.38 hectares), indicating possible expansion of Built-up areas over the five-year period. The increase in Built-up areas may influence surface runoff and hydrological conditions, as noted in related studies.

Conversely, farming sectors experienced a noticeable decline, with Annual Crops decreasing by 4.73% and Perennial Crops dropping by 35.85%. This reduction in agricultural land may reflect changes in land use practices within the watershed. It may also be associated with soil erosion processes observed in similar watershed studies, which can affect agricultural land use.

Meanwhile, the Inland Water category remained relatively stable, showing only a negligible 0.03% increase, indicating relatively stable water area during the study period.

(Note: Any discrepancies in total land area between years are due to dataset processing and not actual land change.

Table 6. Land Use and Land Cover Comparison of Pantabangan, Nueva Ecija for 2015 and 2025

LULC Category	2025 Area (ha)	2015 Area (ha)	Changes (ha)	% Changes	Remarks
Annual Crop	382.44	219.60	162.84	74.15%	Increased
Brush/Shrubs	8622.08	13,511.99	-4,889.91	-36.21%	Decreased
Built-up	247.99	90.08	157.91	175.30%	Increased
Closed Forest	2941.70	172.32	2,769.38	1607.11%	Increased
Grassland	6445.46	3392.42	3,053.04	89.97%	Increased
Inland Water	3670.81	3645.15	25.66	0.70%	Slightly Increased
Open Forest	4625.88	6597.93	-1,972.05	-29.89%	Decreased
Open/Barren	176.01	146.95	29.06	19.78%	Increased
Perennial Crop	23.37	40.01	-16.64	-41.59%	Decreased
Total	**27,135.74**	**27,135.74**	**2,160.20**	**11.80%**	**Increased**

An analysis of the Land Use and Land Cover (LULC) data for Pantabangan, Nueva Ecija between 2015 and 2025 reveals a landscape undergoing noticeable land use and land cover changes over time. One of the most notable changes is the increase in forest cover. Over this period, Closed Forest expanded by 2,769.38 hectares; large percentage changes are influenced by relatively small baseline values and differences in land cover classification between time periods. While Brush/Shrubs declined by 4,889.91 hectares and Open Forest decreased by 1,972.05 hectares. This pattern may indicate possible ecological succession from open vegetation toward Closed Forest. Such changes may be influenced by both natural regeneration and land management practices.

This pattern may possibly reflect vegetation recovery trends reported in related watershed studies, including areas influenced by reforestation programs such as the National Greening Program (NGP). At the same time, the data shows an increase in Built-up areas. Built-up land expanded by 158 hectares, indicating possible expansion of developed areas over the study period. Meanwhile, Annual Crops increased by 163 hectares, while Perennial Crops decreased by nearly 17 hectares. This variation may reflect changes in agricultural land use patterns within the municipality. Another notable trend is the increase in Grassland area, which grew by over 3,053.04 hectares. This may indicate areas where vegetation changes or land clearing occurred, or transitions between land cover types. It may also be associated with land use transitions in open areas.

Inland Water remained relatively stable, increasing only slightly by 26 hectares, showing relatively stable water conditions in the study area. As a methodological note, the minor discrepancy in total values is commonly observed in satellite-based GIS analysis and may be due to differences in image resolution, cloud cover, or boundary alignment between datasets. This reflects common limitations in remote sensing data analysis.

The drivers discussed in this section are interpretative in nature and are based on observed spatial patterns and supporting literature and were not quantitatively analyzed in this study. The slight difference (~0.84%) is due to raster resolution, classification, and boundary alignment differences in Geoportal datasets. Analysis focuses on relative category changes.

V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Summary

The study investigates the land use and land cover (LULC) changes in the Municipality of Pantabangan, Nueva Ecija, Philippines, from 2015 to 2025 using Geographic Information System (GIS) mapping techniques to provide a clear and measurable assessment of land transformation. As Pantabangan is a major watershed area and home to the Pantabangan Dam, the research aims to identify and quantify spatial changes that may reflect possible agricultural expansion, Built-up development, forest cover changes, and other land conversion activities that may affect environmental stability and infrastructure planning. The study focuses on determining the dominant LULC classes in 2015, 2020, and 2025, identifying the major changes that occurred between these years, determining which land cover types significantly increased or decreased, and assessing the possible environmental effects of these changes. Its significance lies in providing useful data for civil engineers, municipal planners, and the Local Government Unit (LGU) to support land-use planning, hazard prevention, and sustainable infrastructure development. However, the study is limited to the physical and spatial changes within Pantabangan and relies only on secondary GIS datasets, excluding the socioeconomic and political causes behind these land cover changes.

The methodology follows a descriptive and spatialanalytical case study design using an Input-Process-Output (IPO) model with GIS software such as QGIS and data from the Philippine Geoportal. Through map analysis, land cover classification, and area computation, the study identified significant LULC changes from 2015 to 2025. The findings reveal that Brush/Shrubs remained the dominant land cover throughout the study period, while Closed Forest showed the most remarkable increase, indicating possible forest recovery and reforestation efforts. Grassland, Built-up areas, and Annual Crops also increased, which may reflect possible natural ecological succession and human development such as settlement expansion and infrastructure growth. On the other hand, Brush/Shrubs, Open Forest, and Perennial Crops showed significant decreases, which may reflect possible land conversion and vegetation transition. Despite these changes, Pantabangan remains largely dominated by forest and vegetation cover, highlighting the continued importance of forest ecosystems, watershed protection, and environmental sustainability in shaping the municipality's land composition.

5.2 Conclusions

The assessment of land use and land cover (LULC) changes in Pantabangan, Nueva Ecija from 2015 to 2025 shows that all land cover categories experienced noticeable changes over the ten-year period. However, despite these changes, the municipality remains largely dominated by vegetation-related land cover. Brush/shrubs remained the dominant land cover throughout the study period, while Closed Forest recorded the most significant increase, showing possible forest recovery or vegetation succession. Grassland also showed a major increase, while Built-up areas gradually expanded, reflecting settlement growth, infrastructure development, and human activities within the municipality.

On the other hand, Brush/Shrubs and Open Forest showed significant decreases, which may be associated with land conversion, vegetation transition, and the development of denser forest cover. Perennial crops also declined, while Annual Crops showed moderate growth, indicating changing agricultural practices in the area. Inland Water remained relatively stable due to the continued presence of the Pantabangan Dam and reservoir. Despite these transformations, Pantabangan remained predominantly covered by forests, grasslands, and other natural vegetation, showing that environmental preservation still plays a major role in shaping the municipality. This suggests that while development and land conversion continue, forest ecosystems and watershed protection may support ecological balance, and environmental management in Pantabangan.

5.3 Recommendations

Based on the results of the study, the researchers propose the following recommendations. These are based on GISderived trends and require field validation:

The continuous dominance of forest and vegetation cover, particularly the significant increase in Closed Forest and the large area of Brush/Shrubs in Pantabangan, indicates the importance of maintaining forest ecosystems and watershed protection. With this, the researchers suggest that the government, environmental planners, and local communities should strengthen forest conservation programs such as reforestation, stricter monitoring of illegal logging, protection of watershed areas, and community-based forest management to preserve ecological balance and support the sustainability of the Pantabangan Dam and reservoir.

The gradual increase in Built-up areas and Annual Crops, along with the decrease in Brush/Shrubs and Open Forest, should be carefully managed to prevent excessive land conversion and environmental degradation. The researchers recommend that proper land-use planning, zoning regulations, and sustainable agricultural practices must be implemented to ensure that development activities remain controlled and do not increase the risks of soil erosion, landslides, and flooding, especially in steep and vulnerable areas.

The noticeable changes in different land use and land cover categories highlight the importance of continuous monitoring using GIS technology. The researchers suggest that government agencies, municipal planners, and civil engineers should regularly utilize GIS tools such as QGIS and the Philippine Geoportal to monitor land cover changes, update hazard maps, and support decision-making for safer infrastructure planning and environmental management.

Future researchers are encouraged to include additional factors that may influence land use and land cover changes in Pantabangan. Since this study is limited to spatial analysis, future studies should examine variables such as population growth, tourism development, economic activities, government policies, and climate-related factors to provide a more comprehensive understanding of land transformation and its long-term environmental impacts.

ACKNOWLEDGEMENT

The researchers would like to express their sincere gratitude NEUST College of Engineering, which made this study possible. Finally, we appreciate the encouragement from my colleagues and family, whose support kept me motivated throughout the case study process.

REFERENCES

1. Alejo, R. J. T., & Fiegalan, F. T. (2025). GISbased mapping of crop suitability rating for the re-delineated soil types in Barangay Bantug, Science City of Muñoz, Nueva Ecija, Philippines. *Southeast Asian Journal of Agriculture and Allied Sciences, 5*(1), 45–61. https://doi.org/10.63943/sajaas.vol5iss1art70_p_p45-58
2. Dida, J., Tiburan Jr., C., & Saizen, I. (2021). Assessment of forest disturbances and carbon stock in Pantabangan-Carranglan Watershed, Philippines using remote sensing. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences.
3. Gojo Cruz, P. H., Afuang, L., Gonzalez, J. C., & Gruezo, W. (2019). Distribution and diversity patterns of herpetofauna in the Pantabangan-Carranglan Watershed, Nueva Ecija, Caraballo Mountain Range, Philippines. Biodiversity Data Journal, 7. https://doi.org/10.3897/bdj.7.e31638
4. Israel, K. P. R., Gabriel, M. J. C., Hintural, W.P., & Baldonado, M. M. M. (2024).
5. Deforestation and forest degradation analysis of Southern Sierra Madre, Philippines using Google Earth Engine and community mapping. *The International Archives of the*
6. Photogrammetry, Remote Sensing and Spatial Information Sciences, XLVIII-4/W8-2023, 313–320. https://doi.org/10.5194/isprs-archiveshttps://doi.org/10.5194/isprs-archivesxlviii-4-w8-2023-313-2024xlviii-4-w8-2023-313-2024
7. Jemal, K., & Gadisa, M. (2023). Effect of land use and land cover change on soil erosion in Alaba Sub-Watersheds of Central Rift Valley Basin, Ethiopia. *American Journal of Environment and Climate, 2*(3), 140–152. https://doi.org/10.54536/ajec.v2i3.2125
8. Alejo, R. T., Bato, V. A., Medina, S. M., & Sobremisana, M. J. (2024). *Spatio-temporal estimation of soil erosion using the Revised Universal Soil Loss Equation model in Pantabangan-Carranglan Watershed, Philippines*. Journal of Ecological Engineering, 25(11), 1–14. https://doi.org/10.12911/22998993/191029
9. Mukul, S. A., Herbohn, J., & Firn, J. (2016). Tropical secondary forests regenerating after shifting cultivation in the Philippines uplands are important carbon sinks. *Scientific Reports, 6*(1), 22483. https://doi.org/10.1038/srep22483
10. Parcasio, M. M. S., Hizon, R. A. V., Madrid, C. M., Portillo, J. C. M., Cabanesas, A. J. A., & Abenoja, A. D. Jr. (2023). Landslide vulnerability map of Barangay Fatima, Pantabangan, Nueva Ecija. *Engineering and Technology Journal, 8*(5), 2287–2298.
11. Shrestha, B. B. (2019). Approach for analysis of land-cover changes and their impact on flooding regime. *Quaternary, 2*, 27.https://doi.org/10.3390/quat2030027
12. Slonecker, E. T., Barnes, C., Karstensen, K., Milheim, L. E., & Roig-Silva, C. M. (2013). Consequences of land use and land cover change. U.S. Geological Survey Fact Sheet. https://doi.org/10.3133/fs20133010
13. Tumbaga, J. (2023). Assessment of land cover change (2001–2021) using remote sensing within and around Minalungao National Park in Nueva Ecija, Philippines. *Applied Ecology and Environmental Research, 21*(4), 3591– 3613. https://doi.org/10.15666/aeer/2104_35913613
14. Zulueta, G. G. E. F. P. J. G. (2024). A GISbased land use and land cover mapping project for informed decision-making in Barangay San Miguel, Alaminos, Laguna. Retrieved from https://mseuf.edu.ph/research/read/2355