Land Use And Land Cover Area Estimation of the MANIT Campus Using High Resolution Google Earth Images: An Advance Surveying Technique

PROJECT REPORT

for

PROJECT BASED LAB

SUBMITTED

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CERTIFICATE

This is to certify that Arpita Sharma, Pallavi Kumari, Tejas Anand, Bhavesh Gupta, Raghav Vishwakarma and Abhinav Ashok have successfully completed the project titled "**Land Use And Land Cover Area Estimation of the MANIT Campus Using High Resolution Google Earth Images: An Advance Surveying Technique**" under my supervision and guidance in the fulfillment of requirements of Fourth semester, Civil Engineering.

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ABSTRACT

This project focuses on creating a basic Geographic Information System (GIS) layer using Google Earth Pro, with the study area being the campus of Maulana Azad National Institute of Technology (MANIT), Bhopal. The main goal was to map and classify different parts of the campus using tools that are free and easy to use.

Using the satellite imagery provided by Google Earth Pro, important features of the campus were manually marked (digitized) using polygon and path tools. These features included hostels, academic buildings, sports complexes, roads, green areas, and open spaces like parks and grounds. After marking these areas, the data was saved in KML format (Keyhole Markup Language), which can be easily used in other GIS software.

To enhance the map, the data was further opened in QGIS software, which allowed for better visualization, styling, adding information (attributes), and calculating the area of different features. This helped in creating a clearer and more organized map of the campus.

The final GIS layer gives a good visual understanding of how different land uses are spread across the MANIT campus. This type of mapping can be useful for planning, managing land and infrastructure, environmental monitoring, and future development of the campus.

Overall, the project shows that with simple tools like Google Earth and QGIS, it is possible to create useful maps even without advanced technical knowledge, making this method suitable for students, researchers, and planners.

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1. Introduction

Geographic Information System (GIS) is an essential tool in modern spatial analysis and urban planning. It allows users to visualize, analyze, and interpret geographic data to understand spatial relationships and trends. Google Earth, with its high-resolution satellite imagery and user-friendly interface, offers a practical platform for GIS-based mapping and digitization.

This project aims to create the GIS layers for the MANIT (Maulana Azad National Institute of Technology), Bhopal campus using Google Earth. The area is digitized and categorized into various land-use types such as buildings, greenery, open areas, and roads.

Remote Sensing and Geographic Information Systems (GIS) are powerful modern tools that have transformed the way surveying is done. Traditional surveying methods often involve people measuring distances and angles on the ground using tools like theodolites and measuring tapes. While these methods are still useful, they can be time-consuming, expensive, and sometimes even risky—especially in hard-to-reach or dangerous areas.

Remote sensing solves this problem by collecting information about the Earth's surface from a distance, using satellites, drones, or aircraft. These tools capture images and data about land features, water bodies, vegetation, and man-made structures without needing to be on the ground.

Once this data is collected, GIS steps in. GIS is a computer-based system used to store, analyze, and visualize geographic data. It helps in creating detailed maps, spotting patterns, and making informed decisions. By combining the data from remote sensing with the mapping and analysis power of GIS, we can get a clear and accurate understanding of large areas—quickly and efficiently.

Together, Remote Sensing and GIS make surveying faster, safer, more accurate, and much more powerful. These technologies are now widely used in many fields such as urban planning, agriculture, environmental protection, disaster management, and infrastructure development. They help people monitor changes, manage resources, and plan for the future with better information.

In Geographic Information Systems (GIS), data is primarily stored and processed in two main formats: Raster and Vector. These formats are essential for representing various types of geographic features and each offers unique advantages depending on the nature of the data being analyzed.

1. Raster Data

Raster data is composed of a grid of cells or pixels, with each cell containing a value that represents specific information, such as elevation, temperature, or land cover. This format is particularly useful for continuous data, where changes occur gradually across space.

- Example Use Cases:
    - Satellite imagery
    - Aerial photographs
    - Digital Elevation Models (DEM)
    - Temperature, rainfall, and pollution mapping
- Common File Formats:
    - .tif / .tiff (GeoTIFF)
    - .img (Erdas Imagine)
    - .jpg (with georeferencing)
    - .grd, .asc (for terrain and elevation)
- Advantages:
    - Ideal for analyzing gradual spatial changes like vegetation or weather patterns
    - Efficient for mathematical and overlay analysis
- Limitations:
    - Larger file sizes
    - Less accurate in depicting clear boundaries of features such as roads or property lines

2. Vector Data

Vector data represents geographic features using points, lines, and polygons. This format is best suited for discrete data, where the exact location and shape of a feature are clearly defined.

- Example Use Cases:
    - Roads and rivers (lines)

    - Cities and schools (points)
    - Land parcels, buildings, or lakes (polygons)
- Common File Formats:
    - .shp (Shapefile – widely used)
    - .geojson (commonly used for web mapping)
    - .kml / .kmz (Google Earth)
    - .gdb (Geodatabase)
    - .dxf (CAD applications)
- Advantages:
    - High precision for representing exact shapes and boundaries
    - Easy to label, categorize, and analyze individual features
- Limitations:
    - Not suitable for continuous data like temperature or elevation changes

Land Use and Land Cover (LULC) in Remote Sensing and GIS:

Land Cover (LC) refers to the physical and biological cover of the Earth's surface, including natural features like forests, water bodies, bare soil, and artificial features like buildings and roads.

Land Use (LU) describes how humans utilize the land for various purposes such as agriculture, urban development, forestry, and industrial activities.

☐ LULC mapping and monitoring are crucial for:

- **Environmental Management** (deforestation, wetland conservation).
- **Urban Planning** (smart cities, infrastructure development).
- **Agriculture** (crop monitoring, soil health).
- **Disaster Management** (flood risk assessment, wildfire tracking).
- **Climate Change Studies** (carbon sequestration, land degradation).

☐ Role of Remote Sensing & GIS in LULC Mapping

Remote Sensing (RS)

- Provides **multispectral, hyperspectral, and radar imagery** for land classification.
- Enables **time-series analysis** (e.g., Landsat, Sentinel-2).
- Helps detect changes in vegetation (NDVI), water bodies (NDWI), and urban expansion.

Geographic Information System (GIS)

- Stores, analyzes, and visualizes spatial LULC data.
- Supports **change detection** through overlay analysis.
- Facilitates **decision-making** with thematic maps and spatial statistics.

☐ Future Trends

- **AI & Deep Learning** for automated LULC classification.
- **High-resolution satellite data** (e.g., Planet Labs, SkySat).
- **Integration with IoT** for real-time land monitoring.

2. Objective

- To create accurate polygon layers representing key features of the MANIT, Bhopal campus using Google Earth .
- To develop individual GIS layers for:
  - Buildings (Hostels, Academic Buildings, Sports Complex, etc.)
  - Greenery (Forests, Gardens, Tree Cover)
  - Open Areas (Grounds, Parks, Playfields)
  - Roads (Internal Road Network)
- To understand the methodology and challenges involved in creating GIS layers from satellite imagery.

3. Literature Review

Creating GIS layers from remote sensing data particularly satellite imagery available through platforms like Google Earth—has become a widely adopted method in spatial data analysis. A range of studies and academic resources have explored both the techniques and practical applications of this approach like.

(a) Digitization Techniques in GIS

Fundamental concepts of GIS digitization are thoroughly discussed in key texts such as *Principles of Geographic Information Systems* by Burrough and McDonnell (1998), and *GIS Fundamentals: A Gentle Introduction to the Basics* by Bolstad (2019). These works offer detailed guidance on the creation of point, line, and polygon features and stress the significance of accuracy, appropriate scale selection, and attribute data integration. Mastery of these principles is essential to ensure the quality and usability of the digitized spatial data.

(b) Utilizing Google Earth for GIS Data Capture

Numerous research papers and online tutorials (e.g., Haklay & Weber, 2008; Krisnawati et al., 2018) have explored the use of Google Earth as a readily accessible and user-friendly platform for GIS data capture. Its high-resolution imagery and georeferencing capabilities make it a valuable tool, especially for projects with limited resources or for preliminary spatial data collection.

Hence it affirms that Google Earth is a viable platform for base mapping and initial digitization, especially for small-scale and institutional studies.

4. Methodology

The methodology followed in the project includes the following steps:

1. Study Area Selection

The selected area is the campus of MANIT, Bhopal, which comprises academic buildings, hostels, sports facilities, roads, and greenery , open spaces.

2. Software Used

(a) **Google Earth Pro:** This software is used as the primary tool for visualizing the MANIT campus through high-resolution satellite imagery and for on-screen digitization. Its features for creating placemarks, paths, and polygons, along with its inherent georeferencing capabilities (latitude/longitude), were utilized.

(b) QGIS (Quantum GIS): QGIS is a free and open-source Geographic Information System (GIS) software widely used for spatial data analysis, map creation, and data visualization. In this project, QGIS was used after the initial digitization in Google Earth Pro to perform more advanced GIS operations, including:

- **Importing KML/KMZ Files:** Allowed seamless integration of digitized data from Google Earth.
- **Layer Management and Styling:** Enabled the categorization, coloring, and labeling of different features such as buildings, greenery, roads, and open areas for better visualization.
- **Attribute Editing:** Provided options to add descriptive information to each polygon, like names, types, and area details.
- **Area and Distance Measurements:** Used to calculate accurate spatial statistics such as the total area covered by greenery, buildings, etc.
- **Map Layout Creation:** QGIS facilitated the creation of professionally styled maps with legends, scale bars, and north arrows for reporting and presentation purposes

QGIS added analytical depth and cartographic quality to the project, complementing the intuitive digitization done in Google Earth Pro.

3. Feature Identification and Categorization

- Based on the project objectives, distinct categories of features were identified for digitization:
    - **<u>Buildings</u>:** All permanent structures including academic departments, hostels, administrative blocks, the library, the auditorium, the sports complex, and other ancillary buildings.
    - **<u>Greenery</u>:** Areas covered by significant vegetation, including forests within the campus, gardens, and dense tree cover. Individual scattered trees were generally not digitized.
    - **<u>Open Areas</u>:** Unbuilt and largely unpaved areas such as sports grounds (cricket, football, hockey fields), parks, lawns, and large open spaces not covered by buildings or dense greenery.
    - **<u>Roads</u>:** The internal road network within the MANIT campus, represented as linear features (which were later converted to narrow polygons for area representation if needed for visualization).

4. On-Screen Digitization Process

The process of digitizing spatial features using polygons in Google Earth Pro was carried out through the following steps:

a) Launch Google Earth Pro

Open the Google Earth Pro application and allow it to load the base imagery.

b) Navigate to the Area of Interest

Use the search bar or manually pan and zoom to locate the MANIT campus. Adjust the view to a suitable angle and zoom level to ensure the features are clearly visible.

c) Create a New Polygon Layer

- Click on the **"Add Polygon"** button from the toolbar (or go to *Add* > *Polygon*).
- A dialog box will appear for naming the layer and setting its properties.
- Assign a relevant name to the polygon (e.g., "Main Building" or "Hostel Block A").
- Optional: Use the **Style, Color** tab in the dialog box to set fill color, opacity, and boundary style for better visual distinction.

d) Trace the Feature Boundary

- While the dialog box is still open, move the cursor to the satellite imagery.
- Click along the visible edges of the feature to place vertices and outline the shape.
- Ensure that vertices are placed at corners or points of change in direction for better accuracy.
- Use the zoom and pan tools frequently to enhance precision during tracing.

e) Adjust and Edit Vertices (if necessary)

- Vertices can be adjusted by clicking and dragging them to better align with the feature boundary.
- Additional vertices can be inserted or deleted for more accurate shaping.

f) Save the Polygon

- After completing the digitization of the feature, click **OK** in the dialog box to save the polygon.
- The polygon will now appear in the **Places** panel under "Temporary Places."

g) Repeat for Other Features

- Repeat the process for each additional feature category (buildings, roads, open spaces, etc.) using new polygon entries.
- Use consistent styling or naming conventions to ensure uniformity across all layers.

h) Organize and Save the Data

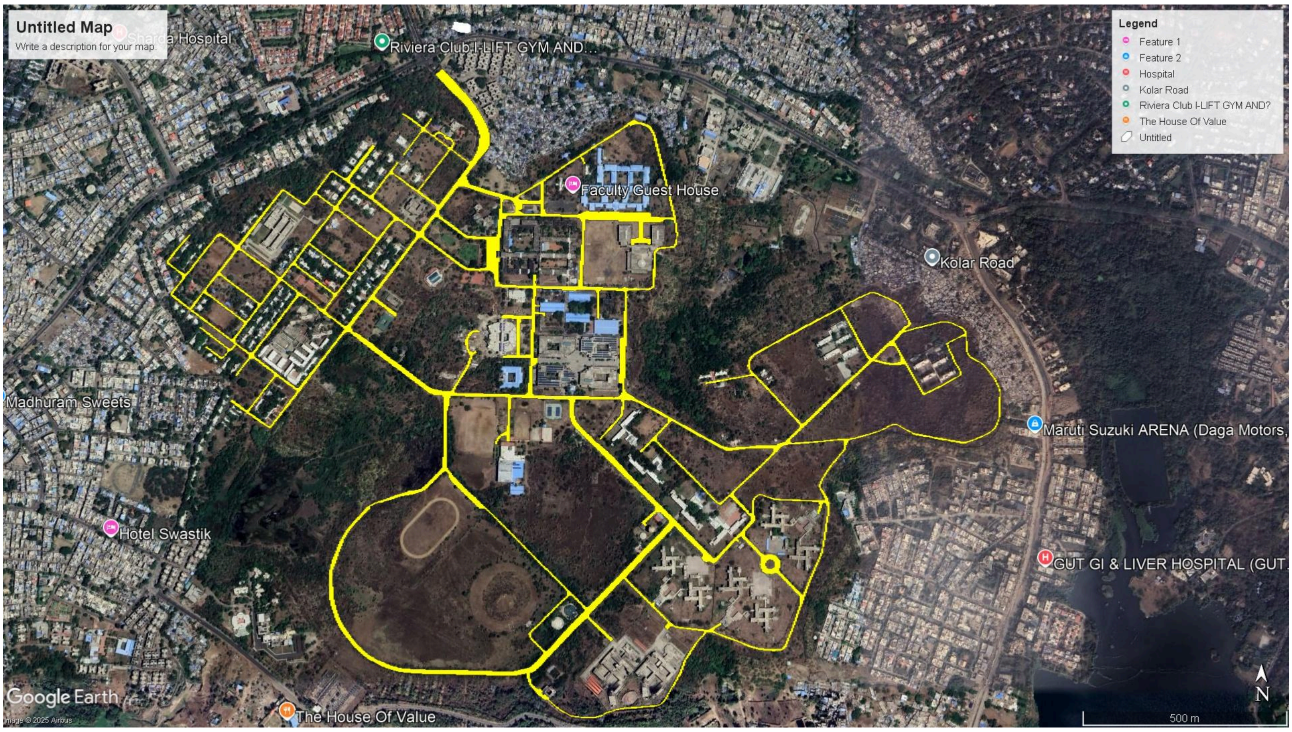
- Once all features are digitized, organize them into folders (e.g., "Buildings," "Roads") in the Places panel.
- Right-click on the folder or individual layers and choose **"Save Place As..."** to export the data as a **.KML** or **.KMZ** file for use in GIS software.

The following images shown below show the Overall Land Distribution of MANIT campus

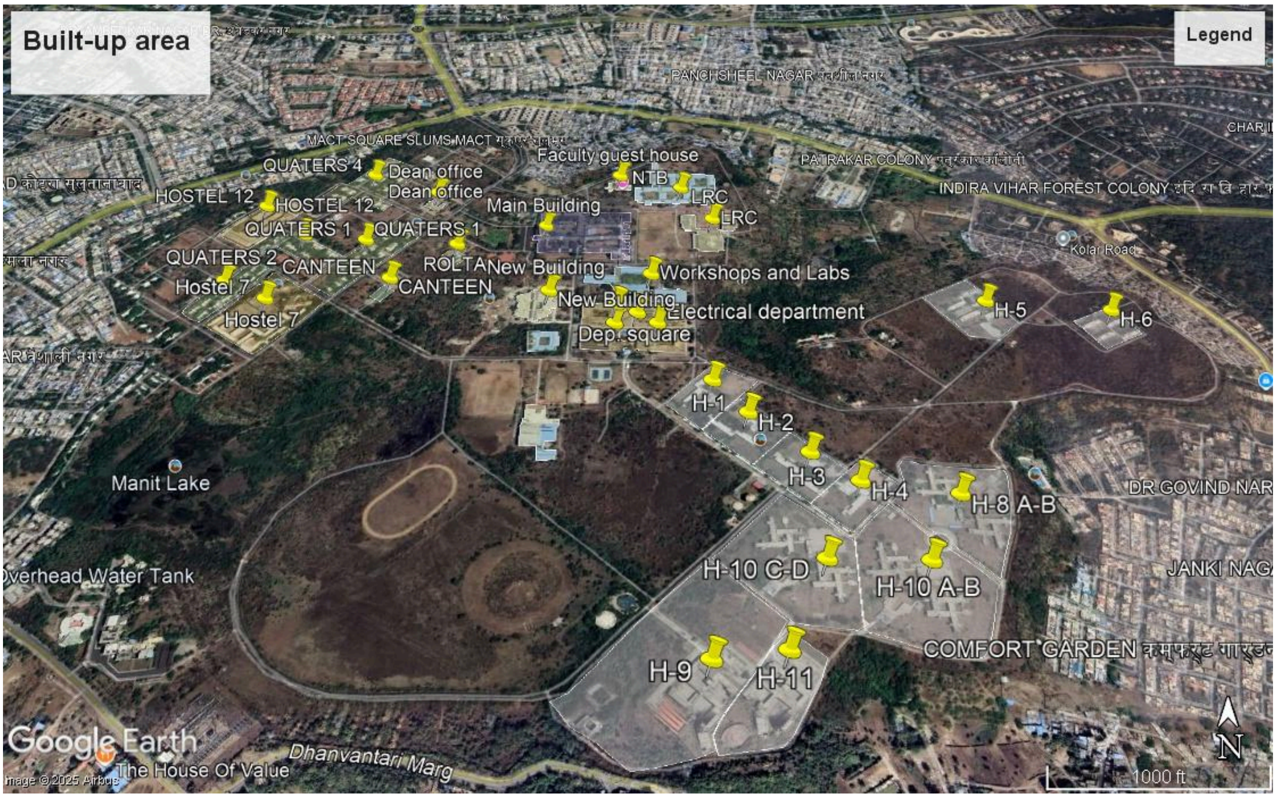
MANIT BOUNDARY

OVERALL VEGETATION

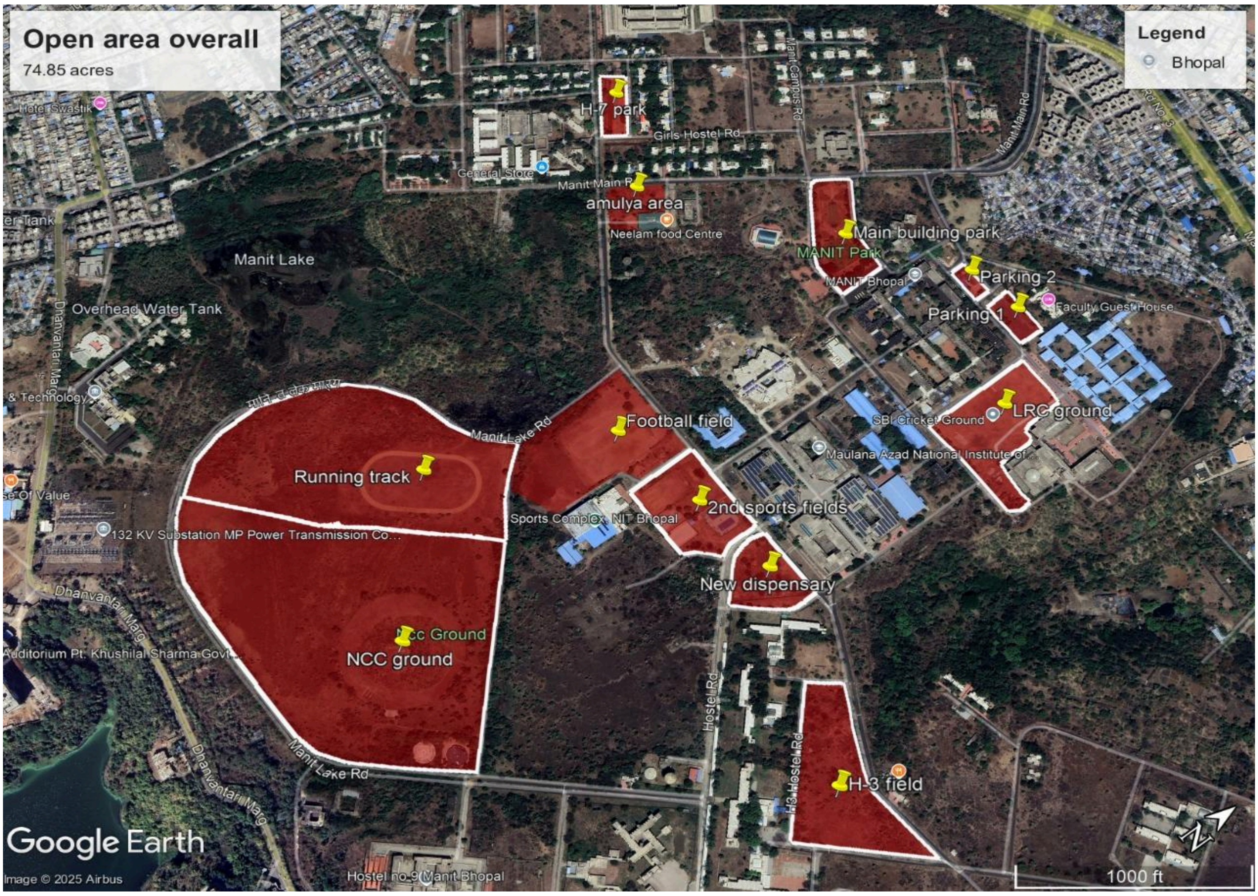
ROAD NETWORK



BUILT-UP AREA



OVERALL OPEN-SPACE AREA



DATA SOURCE

Data Type	Description	Source
High-Resolution Basemaps	Google Earth	ESA, Google

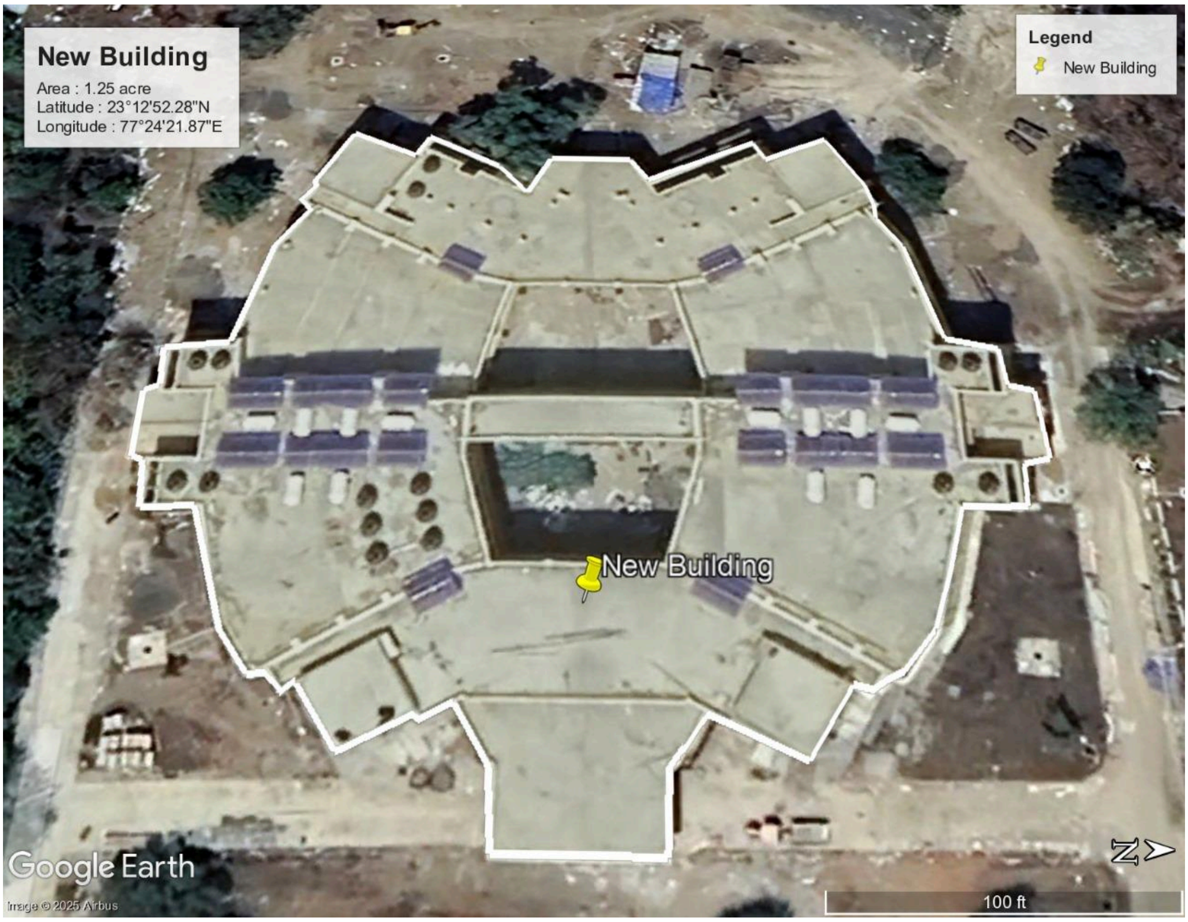
Sample Output of Academic Buildings


NTB
Area : 4.40 acre
Latitude : 23°13'3.29"N
Longitude : 77°24'31.52"E
Legend
NTB
Faculty Guest House
NCC Unit Rd
NTB
Google Earth
Image © 2025 Airbus
200 ft


LRC
Area : 1.88 acre
Latitude : 23°12'59.69"N
Longitude : 77°24'33.71"E
Legend
Feature 3
LRC
Google Earth
Image © 2025 Airbus
100 ft


Sports Complex
Area : 1.46 acre
Latitude : 23°12'41.60"N
Longitude : 77°24'22.59"E
Legend
Feature 3
Sports Complex, NIT Bhopal
MANIT Basketball Court
Google Earth
Image © 2025 Airbus
200 ft
N


Workshops and labs
Area : 2.35 acre
Latitude : 23°12'53.86"N
Longitude : 77°24'29.20"E
Legend
Feature 3
Maulana Azad National Institute of...
vil Department
Department
p. square
MANIT New Mechanical Engineering Department
Workshops and Labs
Department Of Biological S
Maulana Azad National Institute of Technology
Google Earth
Image © 2025 Airbus
200 ft
N


New Building
Area : 1.25 acre
Latitude : 23°12'52.28"N
Longitude : 77°24'21.87"E
Legend
New Building
New Building
Google Earth
Image © 2025 Airbus
100 ft


H-7
Area : 6.28 acre
Latitude : 23°12'52.04"N
Longitude :77°24'3.62"E
Legend
Feature 2
Hostel 7
General Store
Manit Main Rd
Google Earth
Image © 2025 Airbus
200 ft


H-12
Area : 3.77 acre
Latitude : 23°13'1.21"N
Longitude : 77°24'0.91"E
Legend
HOSTEL 12
HOSTEL 12
Google Earth
Image © 2025 Airbus
900 ft


Energy Centre
Area : 0.77 acre
Latitude : 23° 12' 48.96"N
Longitude : 77° 24' 23.4"E
Legend
ENERGY CENTRE, MANIT, BHOPAL
ENERGY CENTRE, MANIT, BHOPAL
ENERGY CENTRE, MANIT, BHOPAL
Google Earth
Image © 2025 Airbus
100 ft

5. RESULTS

a) Table 1 shows that ,among all, the **NCC Ground** stands out as the largest area, spanning 30.7 acres, followed by the **Running Track** with 19.2 acres. On the smaller side, spaces like the **Amulya Open Area** (1.25 acres), **H-7 Park** (1.00 acre), and the two parking lots, **Parking 1** (0.78 acre) and **Parking 2** (0.35 acre), represent utility zones catering to daily campus activities.

Table 1: Open Areas

PLACE	LATITUDE	LONGITUDE	AREA(ACRES)
Football field	23°12'44.83"N	77°24'19.75"E	2.33
H-7 park	23°12'55.90"N	77°24'4.27"E	1.00
Other sports field	23°12'45.53"N	77°24'25.19"E	3.77
New Dispensary	23°12'45.94"N	77°24'29.99"E	2.19
Field in front of H-3	23°12'41.80"N	77°24'40.45"E	5.65
Main Building park	23°12'59.53"N	77°24'18.13"E	2.98
LRC ground	23°12'59.39"N	77°24'30.38"E	4.65
Parking 1	23°13'3.23"N	77°24'26.74"E	0.78
Parking 2	23°13'2.90"N	77°24'23.69"E	0.35
Amulya open area	23°12'53.49"N	77°24'9.36"E	1.25
Running track	23°12'36.78"N	77°24'15.54"E	19.2
NCC ground	23°12'31.17"N	77°24'22.20"E	30.7

b) Table 2 Buildings lists various academic, residential, and administrative buildings. These include hostels (e.g., H-1 to H-11), academic departments, amenities like the **Energy Centre**, **LRC**, **NTB**, **New Building**, **Dean Office**, and **Main Building**, as well as staff accommodations like **Quarters 1–4**. Each entry provides precise geographic coordinates, indicating their exact placement within the campus. The **H-10 A-B building** and **Main Building** appear to be among the largest, occupying **9.64** and **5.48 acres** respectively. Smaller structures like the **Dean Office** and **Faculty Guest House** cover just **0.04** and **0.56 acres**, respectively.

Table 2: Buildings

H-1	23°12'44.30"N	77°24'32.93"E	3.17
H-2	23°12'41.79"N	77°24'34.97"E	2.85
H-3	23°12'38.82"N	77°24'38.35"E	3.00
H-4	23°12'36.79"N	77°24'40.98"E	2.72
H-10 C-D	23°12'31.86"N	77°24'38.44"E	8.64
H-10 A-B	23°12'31.78"N	77°24'44.04"E	9.84
H-8 A-B	23°12'36.07"N	77°24'46.56"E	7.1
H-5	23°12'51.16"N	77°24'51.52"E	4.1
H-6	23°12'50.43"N	77°24'59.72"E	1.97
H-9	23°12'26.32"N	77°24'31.97"E	14.6
H-11	23°12'26.86"N	77°24'35.93"E	4.13
Departments	23°12'50.28"N	77°24'29.70"E	6.18
Energy Centre	23° 12' 48.96"N	77°24'23.4"E	0.77
Hostel 7	23°12'52.04"N	77°24'3.62"E	6.28
Hostel 12	23°13'1.21"N	77°24'0.91"E	3.77
LRC	23°12'59.69"N	77°24'33.71"E	1.88
New Building	23°12'52.28"N	77°24'21.87"E	1.25
NTB	23°13'3.29"N	77°24'31.52"E	4.40
Sports Complex	23°12'41.60"N	77°24'22.59"E	1.46
Workshops And Labs	23°12'53.86"N	77°24'29.20"E	2.35
Faculty Guest House	23°13'4.96"N	77°24'26.96"E	0.30
Dean Office	23°13'2.84"N	77°24'13.32"E	0.20
Rolta	23°12'57.13"N	77°24'15.46"E	0.44
Canteen	23°12'53.51"N	77°24'11.30"E	0.26
Quarters 1	23°12'57.44"N	77°24'8.92"E	4.21
Quarters 2	23°12'53.25"N	77°24'0.05"E	2.44
Quarters 3	23°12'57.92"N	77°24'4.46"E	2.64

Quarters 4	23°13'4.99"N	77°24'8.22"E	4.92
Main Building	23°12'59.06"N	77°24'21.69"E	5.48

c) Table 3: Vegetation identifies green zones or vegetated areas labeled as Vegetation-1 and Vegetation-2. These spaces are quite expansive, with Vegetation-1 covering 6.3 acres and Vegetation-2 covering 5.4 acres.

Table 3: Vegetation

Vegetation-1	23°12'52.21"N	77°24'38.27"E	63.3
Vegetation-2	23°12'40.32"N	77°24'4.43"E	54
Vegetation-3	23°12'51.28"N	77°24'14.97"E	10.7
Vegetation-4	23°13'4.71"N	77°24'3.22"E	17.1
Vegetation-5	23°12'27.29"N	77°24'27.95"E	38.8

d) Land use Distribution in MANIT : The bar chart shows the Land Use Distribution in MANIT, and it provides the area (in acres) for different categories

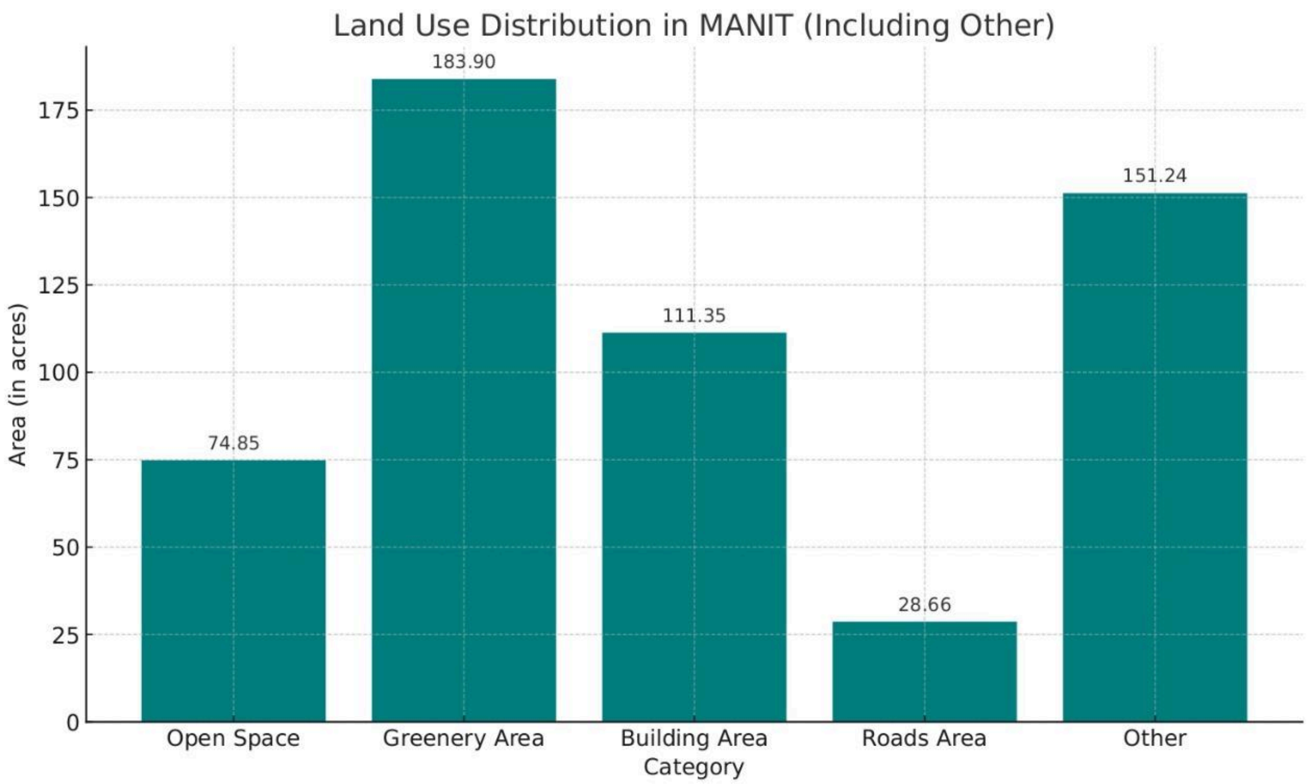


Fig. 1 Bar Chart Showcasing the Land use Distribution in MANIT

- MANIT area : 550 acres
- Total Open Space Area : 74.85 acres
- Total Vegetation area : 183.9 acres
- Building Area : 111.35 acres
- Roads Area : 28.6614 acres

Map Generated Using QGIS Software:

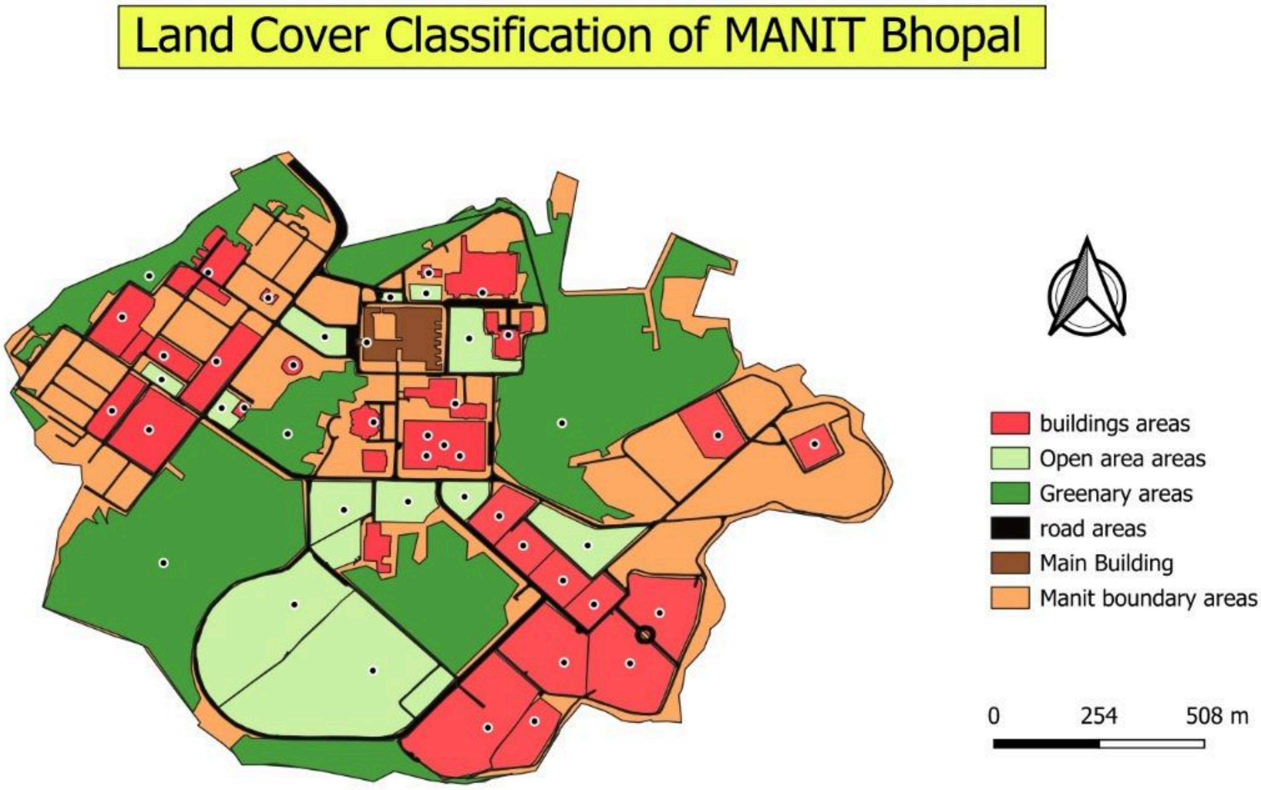


Fig. 2 Land Use and Land Cover Map of the MANIT Bhopal Campus

The land cover classification map of MANIT Bhopal provides a comprehensive spatial overview of the campus, highlighting various categories of land use. The map distinguishes between building areas, open areas, greenery, roads, and the main building, all enclosed within the defined campus boundary. A significant portion of the campus is covered in greenery, primarily concentrated in the northeastern, southern, and southwestern regions, which visually supports the data indicating that 33.44% of the total area is dedicated to green spaces.

Building areas, marked in red, are densely clustered in the central and southern parts of the campus, aligning with the reported 20.24% allocation. Open areas, shown in light orange and constituting 13.61% of the land, appear sporadically across the campus, likely representing sports fields or buffer zones.

The internal road network is well-distributed, reflected in the 5.21% road area, ensuring connectivity throughout the campus. The centrally marked main building is distinctly highlighted in dark brown. The remaining 27.5% categorized as 'others' could include unclassified areas such as water bodies, parking lots, utility zones, or undeclared land types. Overall, the map validates the quantitative land use data and reflects a well-balanced, sustainable campus layout with a strong emphasis on green cover and efficient spatial planning.

6. Conclusions

This project effectively demonstrates the utility of Google Earth as a practical and accessible tool for creating basic GIS layers, particularly for small-scale areas such as educational institutions and academic campuses. By leveraging high-resolution satellite imagery available on Google Earth, we were able to accurately digitize and classify various land use and land cover (LULC) features within the MANIT, Bhopal campus.

The digitization process included mapping of built-up areas like hostels, academic blocks, and sports complexes, along with the categorization of green spaces, open recreational zones, and the internal road network. These classifications provide a comprehensive spatial overview of the campus, which can be used for a variety of applications including infrastructure planning, green space management, mobility analysis, emergency preparedness, and sustainable campus development.

To enhance the utility of the created GIS data, the digitized features were exported in KML/KMZ format, which can be easily imported into QGIS, a powerful open-source GIS software. In QGIS, users can perform advanced operations such as area and perimeter calculations, map styling and symbology, layer overlay and analysis, and even temporal or 3D visualizations.

The integration of QGIS in this project not only adds analytical depth but also provides a scalable platform for future spatial studies or development planning.

Moreover, combining Google Earth digitization with QGIS analysis bridges the gap between user-friendly mapping and professional-level GIS capabilities, making it suitable for academic projects, campus monitoring systems, and institutional planning strategies.

In conclusion, this project presents a cost-effective, beginner-friendly, and scalable approach to GIS-based mapping using readily available tools. The GIS layer of MANIT, Bhopal created here stands as a foundational spatial dataset that can be periodically updated, expanded, or integrated with additional data layers paving the way for smart campus management, data-driven decision-making, and environmentally responsible development.

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