IMS Engineering College, Ghaziabad

Project Report

LAND COVER ANALYSIS AND CHANGE DETECTION

KIT-753

COURSE: B.Tech.

SEMESTER: 7th

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Professor
Information Technology
IMSEC, Ghaziabad

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Department of Information Technology
IMS ENGINEERING COLLEGE
NH-09, Adhyatmik Nagar, Ghaziabad-201015
(2022-23)

Institute Vision Mission

Vision:

To make IMSEC an Institution of Excellence for empowering students through technical education coupled with incorporating values and developing engineering acumen for innovations and leadership skills for the betterment of society.

Mission:

- To promote academic excellence by continuous learning in core and emerging Engineering areas using innovative teaching and learning methodologies.
- To inculcate values and ethics among the learners.
- To promote industry interactions and produce young entrepreneurs.
- To create a conducive learning and research environment for life-long learning to develop the students as technology leaders and entrepreneurs for addressing societal needs.

Department of Information Technology

Department Vision Mission

Vision:

To be a department of excellence by imparting state-of-the-art technical education and preparing globally competent professionals to contribute innovatively to the real-time requirements of industry and society.

Mission:

M1. To provide strong fundamental and technical skills through effective teaching- learning practices and hands-on experience with the latest tools and technologies.

M2. To encourage students to become industry-ready professionals by possessing multidisciplinary skills, leadership abilities, and research-oriented understanding.

M3. To impart entrepreneurship skills, and develop a sense of respect for social values and professionals ethics among the upcoming IT professionals.

Program Outcomes (POs)

S. No.	Program Outcomes / Program Specific Outcomes
PO1.	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2.	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5.	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6.	**The engineer and society:** apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7.	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8.	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9.	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10.	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11.	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12.	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Educational Objectives

The Graduates will be able to

PEO 1: develop strong competency to formulate, analyse, and solve problems of the IT industry using the necessary mathematical, scientific, and engineering fundamentals.

PEO 2: apply the technical knowledge and competency for a successful career in the software industry and progressively hold more responsible positions.

PEO 3: demonstrate ethical behavior as technical professionals and a sense of responsibility towards the impact of technology on society.

PEO 4: demonstrate critical thinking, professional communication, teamwork, and entrepreneurial skills necessary for high productivity towards nation-building with a commitment of pursuing lifelong learning.

Program Specific Outcome (PSO)

Upon completion of this program, the student will be able to:

PSO1: apply knowledge and skills required for software development, database administration, and entrepreneurship in emerging fields like artificial intelligence, data analytics, networking, and cloud computing.

PSO2: apply programming languages, tools and techniques to demonstrate the acquired technical skills for seeking solutions to the problems of various interdisciplinary challenges.

Course Outcomes

CO. No.	DESCRIPTION	COGNITIVE LEVEL (BLOOMS TAXONOMY)
CO1(C406.1)	Developing a technical artifact requiring new technical skills and effectively utilizing a new software tool to complete a task	**K4,K5**
CO2(C406.2)	Writing requirements documentation, Selecting appropriate technologies, identifying and creating appropriate test cases for systems.	**K5,K6**
CO3(C406.3)	Demonstrating understanding of professional customs & practices and working with professional standards.	**K4,K5**
CO4(C406.4)	Improving problem-solving, critical thinking skills and report writing.	**K4,K5**
CO5(C406.5)	Learning professional skills like exercising leadership, behaving professionally, behaving ethically, listening effectively, participating as a member of a team, developing appropriate workplace attitudes	**K2,K4**

CO-PO-PSO Mapping

	PO 1	**PO 2**	**PO 3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
C406.1	3	3	3	3	3	2	1	2	2	2	2	3	3	3
C406.2	3	3	2	2	2	1	1	2	2	3	1	1	2	3
C406.3	1	1	1	1	1	3	2	3	2	2	2	2	2	1
C406.4	3	3	3	3	3	2	1	1	2	3	1	3	1	1
C406.5	1	1	1	1	1	2	2	3	3	3	3	1	1	1
C406(AVG)	**2.2**	**2.2**	**2**	**2**	**2**	**2**	**1.4**	**2.2**	**2.2**	**2.6**	**1.8**	**2**	**1.8**	**1.8**

Table Of Content

CANDIDATES DECLARATION

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

Signature*:*
Name: Anushka Tiwari
Roll No*:* 2001430130014
Date *:* /12/2023

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Name: Ayushi Goel
Roll No*:* 2001430130020
Date *:* /12/2023

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Roll No*:* 2001430130021
Date *:* /12/2023

Signature*:*
Name: Harshit Chauhan
Roll No*:* 2001430130032
Date *:* /12/2023

CERTIFICATE

We hereby certify that the work which is being presented in the mini-project report entitled **LAND COVER ANALYSIS AND CHANGE DETECTION** by **Anushka Tiwari, Ayushi Goel, Barun Kumar Mishra, Harshit Chauhan** in partial fulfillment of requirements for the award of degree of B.Tech. (IT), 4th year, 7th semester submitted in the **Department of Information Technology** at **"IMS Engineering College"** under A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW is an authentic record of my own work carried out under the supervision of **Dr. Siddhi Nath Rajan.**

Signature

Dr. S.N Rajan
Project Supervisor,
Professor,
Information Technology,
IMSEC, Ghaziabad.

ACKNOWLEDGEMENT

I would like to express my gratitude to **Dr. S.N Rajan**, my supervisor for this project. I would like to thank him for his constant support, enthusiastic encouragement, and useful critiques. I would like to thank our Director **Dr. Vikram Bali** and HOD of Information Technology **Dr. S.N Rajan** for providing me with this opportunity.

ABSTRACT

This project focuses on employing remote sensing techniques to conduct an in-depth analysis of land cover dynamics and change detection within a specific geographical area. Utilizing multi-temporal satellite imagery spanning over [duration], the study aims to assess and quantify alterations in land cover types, identifying transitions between various classes such as forests, urban areas, agricultural lands, water bodies, and barren land.

The methodology involves preprocessing and analyzing satellite imagery using advanced image processing algorithms and classification techniques. Initial steps include image registration, normalization, and feature extraction. Subsequently, supervised and unsupervised classification algorithms, such as [specific algorithms used], are applied to categorize land cover types.

Change detection methodologies, including post-classification comparison and vegetation indices, are employed to identify and delineate areas undergoing significant alterations over time. Quantitative assessments of land cover change rates and spatial patterns will be conducted to understand the dynamics and drivers of these changes.

The project aims to provide valuable insights into land cover transformations, aiding in environmental monitoring, natural resource management, and urban planning. The findings will contribute to a better understanding of the evolving landscape and facilitate informed decision-making for sustainable land use practices and conservation efforts.

CHAPTER 1

INTRODUCTION

The assessment and monitoring of land cover dynamics play a pivotal role in understanding the evolving landscape patterns, human-induced changes, and environmental impacts over time. With the advent of remote sensing technologies, the ability to analyze vast expanses of land has greatly advanced, offering a comprehensive view of terrestrial changes.

This project delves into the intricate realm of land cover analysis and change detection by harnessing the capabilities of remote sensing data. The primary objective is to scrutinize and quantify alterations in land cover types within a specified geographical area, spanning over [duration]. This analysis is crucial for comprehending the transitions between diverse land cover classes, such as forests, urban settlements, agricultural lands, water bodies, and barren areas, among others.

The utilization of multi-temporal satellite imagery, coupled with sophisticated image processing techniques, forms the backbone of this study. By leveraging state-of-the-art algorithms for image preprocessing, feature extraction, and classification, the project aims to accurately delineate and classify different land cover types across the study area.

Furthermore, this project integrates change detection methodologies to pinpoint areas undergoing significant transformations over the temporal scope of the study. By employing both supervised and unsupervised classification algorithms, in conjunction with change detection indices, the endeavor is to identify and analyze the spatial and temporal dynamics of land cover changes.

The insights garnered from this research endeavor are expected to offer substantial contributions to various fields including environmental monitoring, resource management, urban planning, and conservation efforts. Understanding the drivers and patterns of land cover changes is imperative for fostering sustainable land use practices and facilitating informed decision-making in the realm of land management and conservation.

1.1 - BACKGROUND OF THE PROJECT

Land cover, the physical and biological cover on the Earth's surface, is a critical component of the global environment, influencing ecological processes, climate patterns, and human activities. Understanding land cover dynamics and changes over time is essential for effective land management, environmental conservation, and sustainable development.

Traditionally, land cover analysis relied on ground-based surveys and manual interpretation, limiting the scope and accuracy of assessments. However, advancements in remote sensing technology have revolutionized the way we observe and analyze land cover on a larger scale. Satellite imagery and remote sensing data provide a wealth of information, enabling comprehensive assessments of land cover types and changes across diverse landscapes.

Over the past decades, rapid urbanization, agricultural expansion, deforestation, and climate change have significantly altered land cover patterns worldwide. These changes have far-reaching implications, affecting ecosystems, biodiversity, natural resources, and human livelihoods. Monitoring and analyzing these transformations are critical for mitigating environmental degradation, identifying areas of conservation priority, and guiding land use policies.

This project builds upon the foundation laid by remote sensing and image processing techniques to delve into the complexities of land cover dynamics. By leveraging the availability of multi-temporal satellite imagery, advanced classification algorithms, and change detection methodologies, this study aims to track, quantify, and analyze land cover changes within a specific geographical area.

The integration of supervised and unsupervised classification methods, alongside change detection indices and spatial analysis, forms the crux of this project. Through these techniques, the project endeavors to not only identify land cover transitions but also assess the rates, spatial patterns, and drivers of these changes over the defined temporal scale.

The findings from this research endeavor are anticipated to provide valuable insights for policymakers, land managers, conservationists, and urban planners. Understanding the nuances of land cover changes is instrumental in devising strategies for sustainable land management, conservation practices, and resilient urban development in the face of ongoing environmental transformations.

Why remote sensing?

Earlier, when there was no remotely sensed data and the assistance of computers, land use/land cover change was detected with the help of tracing paper and topographic sheet. But then this method was tedious and studying large areas required lot of effort and time. Conventional ground methods of land use mapping are labor intensive, time consuming and are done less frequently. Thus, with the advent of satellite remote sensing techniques, preparing accurate land use land cover maps and monitoring changes at regular intervals of time is relatively simpler. In case of inaccessible region, the only method of obtaining required data is by applying this technique.

Today remote sensing and GIS technology has enabled ecologists and natural resources managers to acquire timely data and observe periodical changes. With multi-temporal analyses, remote sensing gives a unique perspective of how rural area evolves. The most important element for mapping land use change due to mining is the ability to discriminate between rural uses (farming, forests and waste lands) and quarries.

What is change detection study?

"Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times". "Timely and accurate change detection of Earth's surface features provides the foundation for better understanding 3 relationships and interactions between human and natural phenomena to better manage and use resources".

Changes in land cover by land use do not necessarily imply degradation of the land. However, due to a shift in land use patterns, land cover changes that affects biodiversity, water and other processes that come together to affect climate and biosphere.

A detailed understanding of the impact of urbanization, industrialization, increase in barren lands, deforestation on changes in land use/land cover pattern has become necessary for the Ghaziabad, Uttar Pradesh, INDIA. Therefore, present study was undertaken to analyze the extent of human-induced landscape transformation in the mining affected areas of Ghaziabad District by interpreting temporal remote sensing data using geographic information system (GIS). Land cover types (Forests, Farming/Agriculture, Waste Lands and Urban/Residents Area) were delineated in order to achieve the above objective. The areas under settlement/non-forest were also taken into consideration to know the trend due to the impact of mining activities in different time periods.

In essence, this project aims to contribute to the collective knowledge of land cover dynamics, leveraging remote sensing technologies to address the challenges posed by land use changes and facilitating informed decision-making for a more sustainable future.

Remote Sensing (RS) and Geographic Information System (GIS) are now providing new tools for advanced ecosystem management. The collection of remotely sensed data facilitates the synoptic analyses of Earth - system function, patterning, and change at local, regional and global scales over time; such data also provide an important link between intensive, localized ecological research and regional, national and international conservation.

Therefore, attempt will be made in this study to map out the status of land use land cover of GHAZIABAD, INDIA between 2009 to 2023 with a view to detecting the land consumption rate and the changes that has taken place in this status particularly in the built-up land so as to predict possible changes that might take place in this status in the next years using both Geographic Information System and Remote Sensing data.

1.2 - PROBLEM STATEMENT

In Ghaziabad, INDIA the rapid urbanization, agricultural expansion, and industrial development have led to significant transformations in land cover patterns over recent years. The challenge lies in comprehensively understanding and quantifying these changes to support informed decision-making for sustainable land management and urban planning.

The existing methodologies for monitoring land cover changes often rely on traditional ground-based surveys and limited-scale assessments, which hinder a thorough understanding of the evolving landscape. The lack of a systematic, large-scale analysis utilizing modern technologies like remote sensing has created a gap in effectively capturing and analyzing the dynamics of land cover alterations in Ghaziabad.

Therefore, the primary problem addressed by this project is the absence of a comprehensive, data-driven approach to analyze and monitor land cover changes in Ghaziabad. The rapid urban expansion, agricultural intensification, and environmental changes call for a robust methodology that integrates remote sensing data, advanced image processing techniques, and change detection methodologies to accurately quantify and assess the spatiotemporal dynamics of land cover changes.

This project aims to bridge this gap by utilizing multi-temporal satellite imagery, classification algorithms, and change detection techniques to systematically analyze the shifts in land cover types within Ghaziabad. By doing so, it aims to provide actionable insights for urban planners, policymakers, and land managers to facilitate sustainable land use practices, mitigate environmental impacts, and support informed decision-making for the region's future development.

In essence, the project addresses the pressing need for a comprehensive and data-driven approach to monitor and analyze land cover changes in Ghaziabad, India, in order to support sustainable urban development and environmental conservation efforts.

1.3 – AIM AND OBJECTIVE

1.3.1 - AIM

The aim of this study is to produce a land use land cover map of Ghaziabad at different epochs in order to detect the changes that have taken place particularly in the built-up land and subsequently predict likely changes that might take place in the same over a given period.

1.3.2 – OBJECTIVE

The following specific objectives will be pursued in order to achieve the above Aim.

- **Comprehensive Land Cover Classification:** Utilize multi-temporal satellite imagery to conduct a detailed land cover classification for Ghaziabad, categorizing areas into distinct land cover types such as urban, agricultural, forested, water bodies, and barren land.

- **Temporal Analysis of Land Cover Changes:** Identify and quantify temporal changes in land cover over a specified period, delineating transitions and alterations occurring within Ghaziabad.

- **Change Detection Methodologies:** Employ change detection techniques to compare multi-temporal datasets, enabling the identification and mapping of significant changes in land cover types within Ghaziabad.

- **Documentation and Reporting:** Compile a comprehensive report detailing the methodologies, results, and implications of the land cover analysis and change detection study in Ghaziabad, India, for dissemination among relevant stakeholders and academic communities.

1.4 – SCOPE

The scope of a land cover analysis and change detection project in Ghaziabad, India, involves a comprehensive study encompassing various aspects of land cover dynamics and transformations. Here's an outline detailing the scope:

- **Geographical Boundaries**

  Define the study area within Ghaziabad, outlining specific administrative boundaries, geographical coordinates, and extent covered by the project.

- **Temporal Scale**

  Determine the temporal scope of the analysis, including the duration covered by multi-temporal satellite imagery and the time intervals for assessing land cover changes (e.g., yearly, seasonally).

- **Land Cover Classification:**

  Conduct a detailed classification of land cover types using satellite imagery, categorizing areas into distinct classes (urban, agricultural, forested, water bodies, etc.) using appropriate classification algorithms.

- **Change Detection Analysis**

  Employ change detection techniques to compare multiple time periods, identifying and quantifying significant changes in land cover types over time.

- **Methodologies and Algorithms**

  Detail the methodologies and algorithms utilized for image processing, classification, and change detection, ensuring their suitability for the study area and objectives.

- **Recommendations and Future Framework**

  Provide actionable recommendations for sustainable land management, conservation strategies, and urban planning based on the project's findings. Propose a framework for ongoing monitoring and future assessments.

CHAPTER 2

LITERATURE SURVEY

A literature review for a land cover analysis and change detection project in Ghaziabad, India, would encompass a range of studies, methodologies, and findings related to remote sensing, land cover classification, change detection, and similar projects in similar geographic and thematic contexts. Here's an outline for such a literature review:

- **Remote Sensing Applications in Land Cover Analysis:**
  Overview of remote sensing technologies and their applications in land cover mapping and monitoring. Review of studies utilizing satellite imagery and remote sensing techniques for land cover analysis in urban, peri-urban, and agricultural landscapes.

- **Land Cover Classification Methods:**
  Evaluation and comparison of different classification algorithms (e.g., supervised, unsupervised, object-based) used in land cover classification studies. Case studies highlighting successful methodologies for classifying diverse land cover types within similar geographic regions.

- **Change Detection Techniques and Methodologies:**
  Overview of change detection methodologies (e.g., post-classification comparison, vegetation indices) and their applicability in detecting land cover changes over time. Comparative analysis of change detection techniques in similar urbanizing environments or regions experiencing rapid land cover changes.

- **Studies Specific to Ghaziabad or Similar Urbanizing Regions:**
  Research and projects focusing on land cover analysis and change detection within Ghaziabad or neighboring regions, emphasizing methodologies, findings, and implications. Studies highlighting urban expansion, agricultural intensification, or environmental changes impacting land cover dynamics in Ghaziabad.

- **Environmental and Socioeconomic Implications of Land Cover Changes:**
  Reviewing literature that discusses the environmental, ecological, and socioeconomic impacts of observed land cover changes, specifically in rapidly urbanizing areas like Ghaziabad. Studies addressing the consequences of land cover changes on ecosystem services, biodiversity, water resources, and community livelihoods.

- **Challenges and Opportunities in Land Cover Analysis and Change Detection:**
  Identification of challenges, limitations, and uncertainties in land cover analysis using remote sensing data, especially in dynamic urbanizing landscapes. Opportunities for improving methodologies, data sources, and accuracy in detecting and analyzing land cover changes.

- **Integration of Remote Sensing with Policy and Decision-Making:**
  Review of studies showcasing successful integration of remote sensing-derived information into land use planning, policy formulation, and decision-making processes in similar regions.

- **Gap Analysis and Research Needs:**
  Identification of gaps in existing literature concerning land cover analysis and change detection specific to Ghaziabad, highlighting areas needing further research and exploration.

LITERATURE REVIEW

These studies were conducted in various areas including urban areas, agricultural area, Forest and Wasteland or Barrens area. For example, Our Team has done detail study on the impact of change detection in all given areas on land use pattern in and around Ghaziabad District using Remote Sensing data and GIS. Database for land use was prepared for multispectral, multi-temporal data of years 2009, 2014 and 2019 and 2023 of Ghaziabad area using Google Earth and GIS software. The study revealed that Urban and Wastelands increased from 2009 to current 2023. There was substantial loss in forests land which was due to rapid industrialization and urbanization of the area.

Barun Kumar Mishra have worked on Urbanization impact on land use/land cover and change in Ghaziabad district of UTTAR PRADESH, INDIA using remote sensing and GIS technique used Google

Earth and Global Mapper data of 2009 to conclude that there was increase in Urban and Residents area from

2009 to 2014 accompanied by decrease in forest area. Visual interpretation technique was used for land use/land cover mapping for the different data of 5 years.

Another study was carried out by **Ayushi Goel** on the impact analysis of Forests area of Ghaziabad district on land use land cover using remote sensing and GIS technique. The study was carried out in between year of 2014, 2015, 2016, 2017 and 2018 using multi-temporal satellite data with help of Google Earth and ARC GIS to create a land use/ land cover mapping of the area; and reported a __% decrease in forest area.

Anushka Tiwari have worked on land-use/cover mapping and change detection in the Wasteland or Barren land using GIS Techniques was carried out using remote sensed data; Google Earth Pro in 2019 map of Major marked areas of Ghaziabad, used as reference base maps of the region and resulted in increased of wasteland or Barren lands.

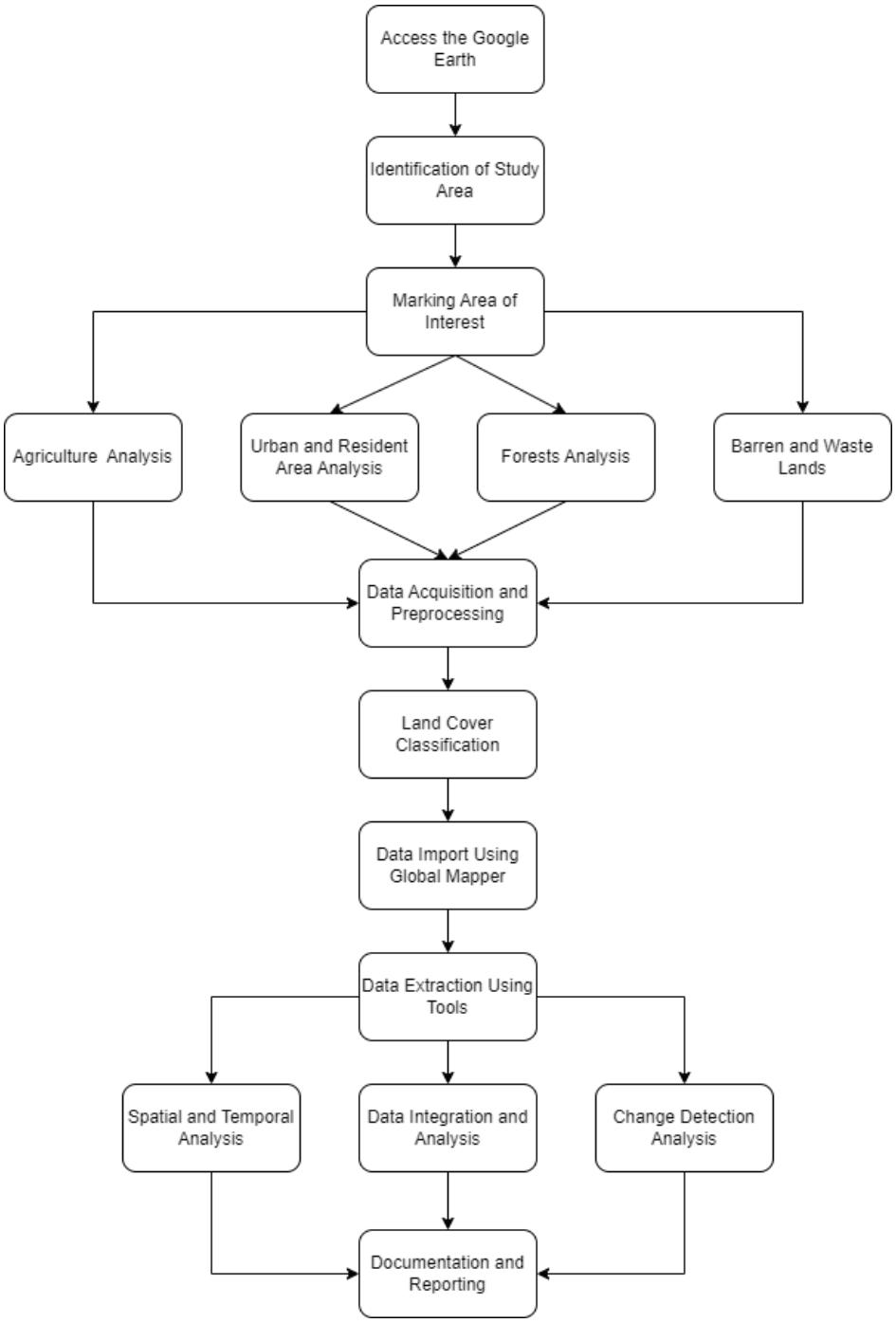
A detailed study has been done on the work of **Harshit Chauhan** in year 2023 on agriculture land and manage changes in marked Ghaziabad area of UTTAR PRADESH. Land use change due to deforestation and increase in industrialization over a past year period (2009 – 2023) was analyzed that decrease in agriculture area.

CHAPTER 3

METHODOLOGY

The detailed methodology adopted in this thesis to achieve the above objective is described in this chapter.

Flowchart of the broad steps followed in this work for deriving statistics of land use pattern of the area is shown in Figure below.



3.1 – ALGORITHM USED

1. **Data Collection and Preprocessing:**

   1.1 - Satellite Imagery Acquisition:

   Obtain multi-temporal satellite imagery (e.g., Landsat, Sentinel) covering Ghaziabad from relevant sources (USGS, ESA).

   1.2 - Data Preprocessing:

   Correct for atmospheric effects, perform geometric correction, and stack/mosaic images to create seamless datasets for each time period.

2. **Image Enhancement and Feature Extraction:**

   2.1 - Radiometric and Geometric Corrections:

   Apply radiometric and geometric corrections to improve image quality and accuracy.

   2.2 - Feature Extraction:

   Extract spectral, textural, and contextual features from preprocessed imagery to create feature layers for classification.

3. **Land Cover Classification:**

   3.1 - Training Data Collection:

   Collect training samples representing different land cover classes using ground truth data, field surveys, or high-resolution imagery.

   3.2 - Supervised Classification:

   Employ classification algorithms (e.g., Maximum Likelihood, Random Forest) using training samples to classify land cover types for each time period.

   3.3 - Unsupervised Classification:

   Perform unsupervised classification to identify spectral clusters and derive additional information on land cover classes.

4. **Change Detection Analysis:**

   4.1 - Post-Classification Comparison:

   Compare classified land cover maps of different time periods to detect changes pixel-wise.

4.2 - Change Detection Indices:

Utilize indices (e.g., NDVI differencing, Tasseled Cap transformation) to highlight temporal changes in specific land cover types.

5. Accuracy Assessment and Validation:

5.1 - Validation Dataset Creation:

Prepare a validation dataset for accuracy assessment, ideally consisting of ground truth data or high-resolution imagery.

5.2 - Accuracy Metrics Calculation:

Evaluate classification and change detection accuracy using metrics like overall accuracy, Kappa coefficient, and user/producer accuracies.

6. Spatial and Temporal Analysis:

6.1 - Spatial Patterns:

Analyze spatial distribution and patterns of land cover changes, identifying hotspots or areas undergoing significant transformations.

6.2 - Temporal Trends:

Investigate temporal trends and rates of change across different land cover types over the study period.

7. Marking Areas of Interest:

7.1 - Use the "Polygon" or "Line" drawing tools within Google Earth to mark and delineate specific areas for analysis.

7.2 - Select the appropriate tool based on the shape of the area you want to mark (e.g., polygon for irregular shapes, line for linear features).

8. Drawing and Annotation:

8.1 - Trace the boundaries of the desired area by clicking on the map to create vertices that form the shape.

8.2 - Double-click to close the polygon or finish drawing the line, creating a defined area or boundary.

8.3 - Add annotations or labels to the marked areas for identification and reference.

9. Data Extraction Tools:

Utilize the extraction tools available in Global Mapper:

9.1 - Feature Info Tool:

Use this tool to click on specific points or areas to retrieve attribute information from the underlying layers.

9.2 - Digitizing Tools:

Employ digitizing tools (point, line, polygon) to create new features or draw boundaries around areas of interest.

10. Extraction of Data:

10.1 - Attribute Query:

Perform attribute queries to extract specific data based on attribute filters (e.g., land cover classes, administrative boundaries) from imported layers.

10.2 - Selection and Export:

Select specific features or areas using the digitizing tools and export them to new files or formats (e.g., shapefile, KML) for further analysis.

11. Documentation and Reporting:

11.1 - Report Preparation:

Compile a comprehensive report detailing the methodology, results, accuracy assessments, and analysis findings.

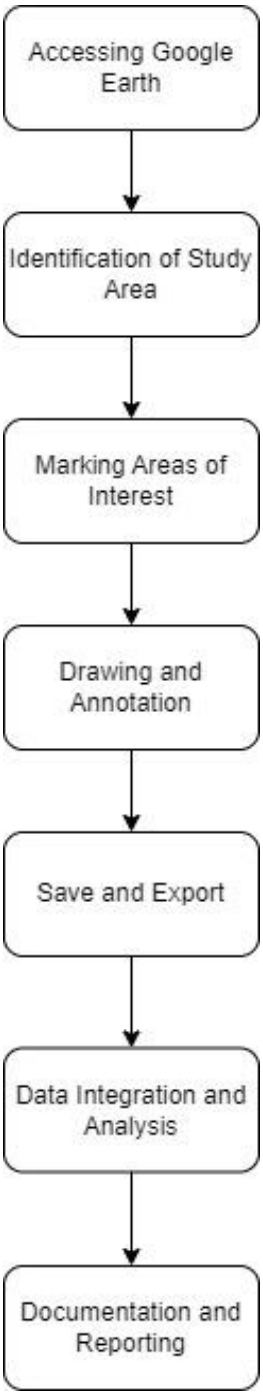
11.2 - Visualization:

Present results using maps, graphs, and visual aids to effectively communicate the outcomes of the analysis.

CHAPTER 4

IMPLEMENTATION

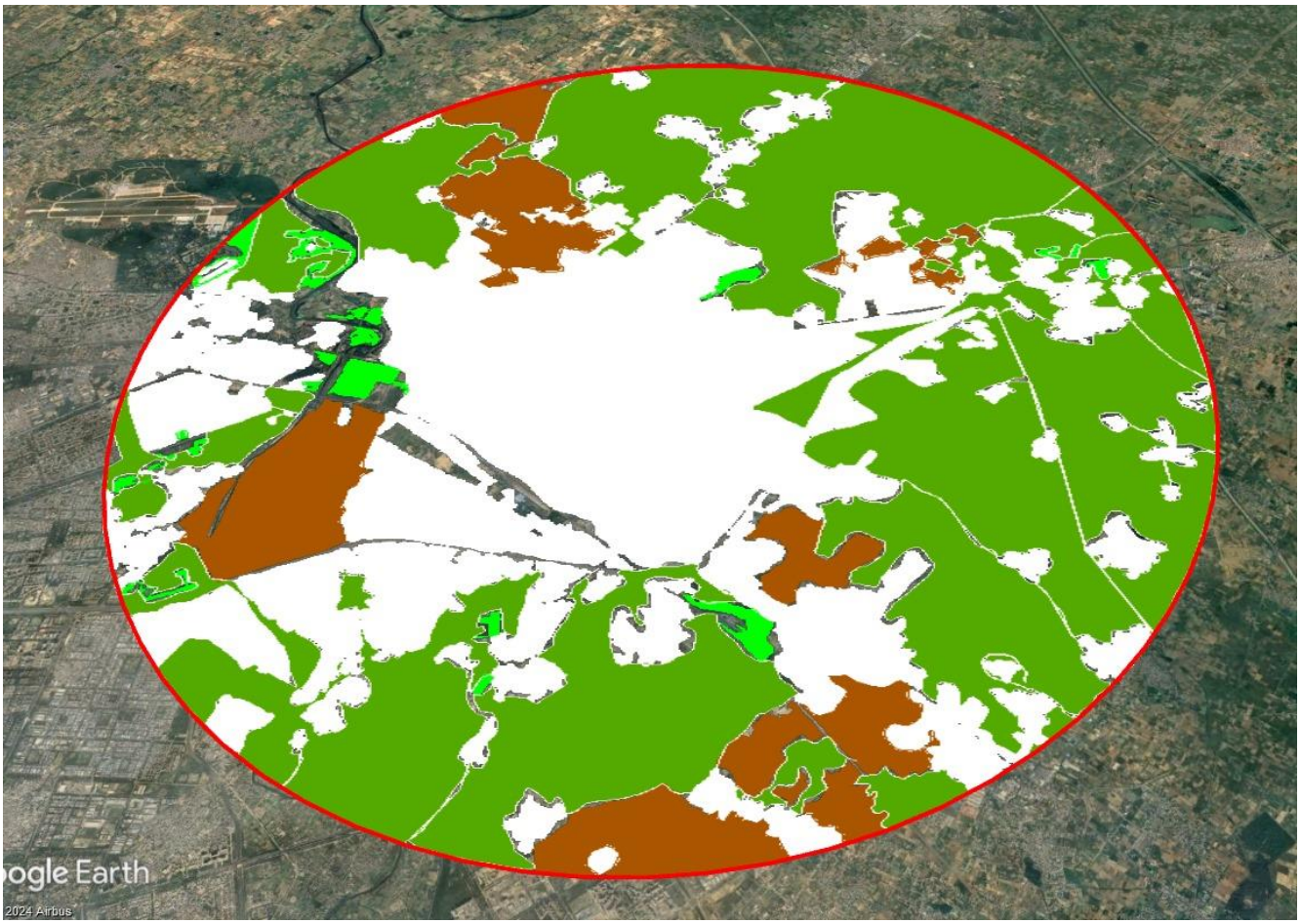
Implementing a land cover analysis and change detection project involves executing the methodologies and workflows designed for data collection, analysis, and interpretation. Here's an implementation plan for such a project:



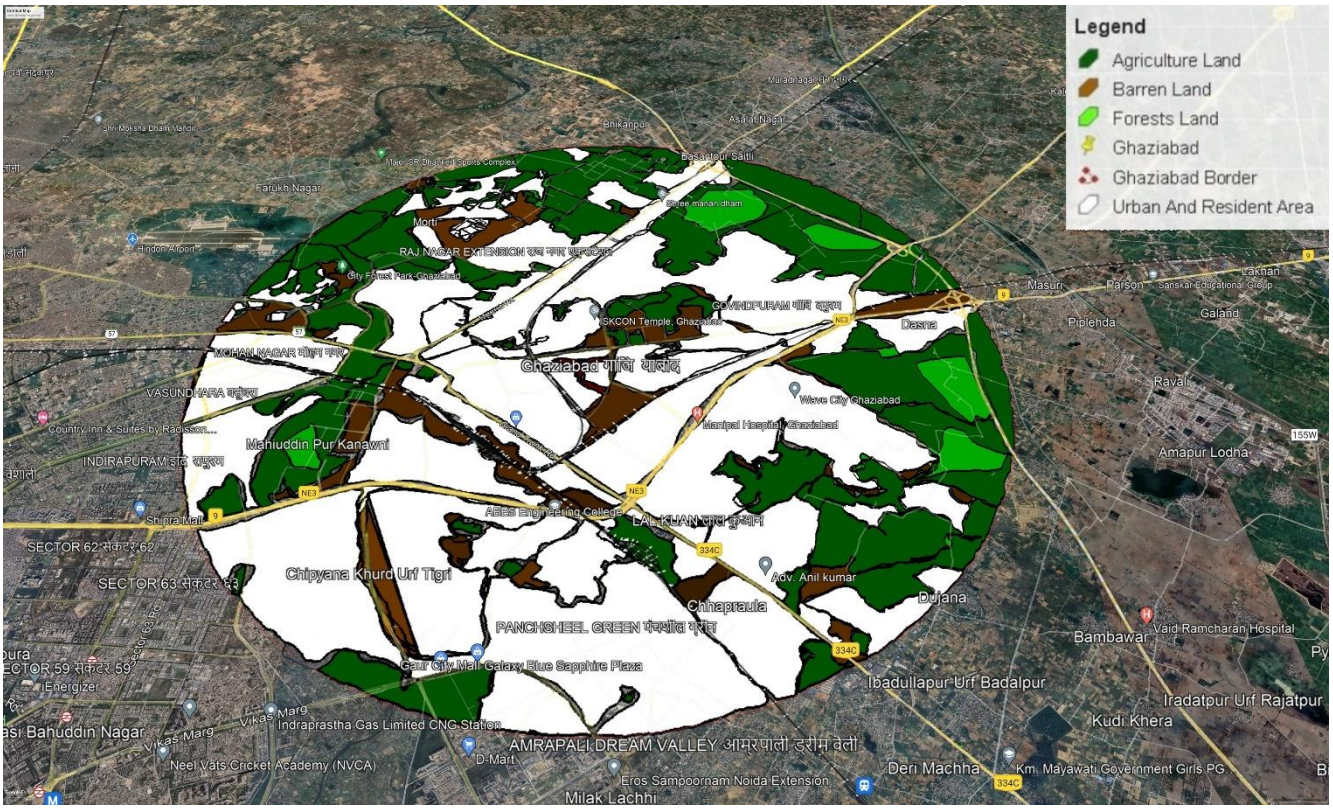
- **Accessing Google Earth:**
  - Open Google Earth via the web application or download the desktop version for more advanced features.
  - Navigate to the area of interest (Ghaziabad) using the search bar or by manually zooming in.

- **Identification of Study Area:**
  - Define the boundaries of the study area within Ghaziabad using visual cues and geographical landmarks available on Google Earth.

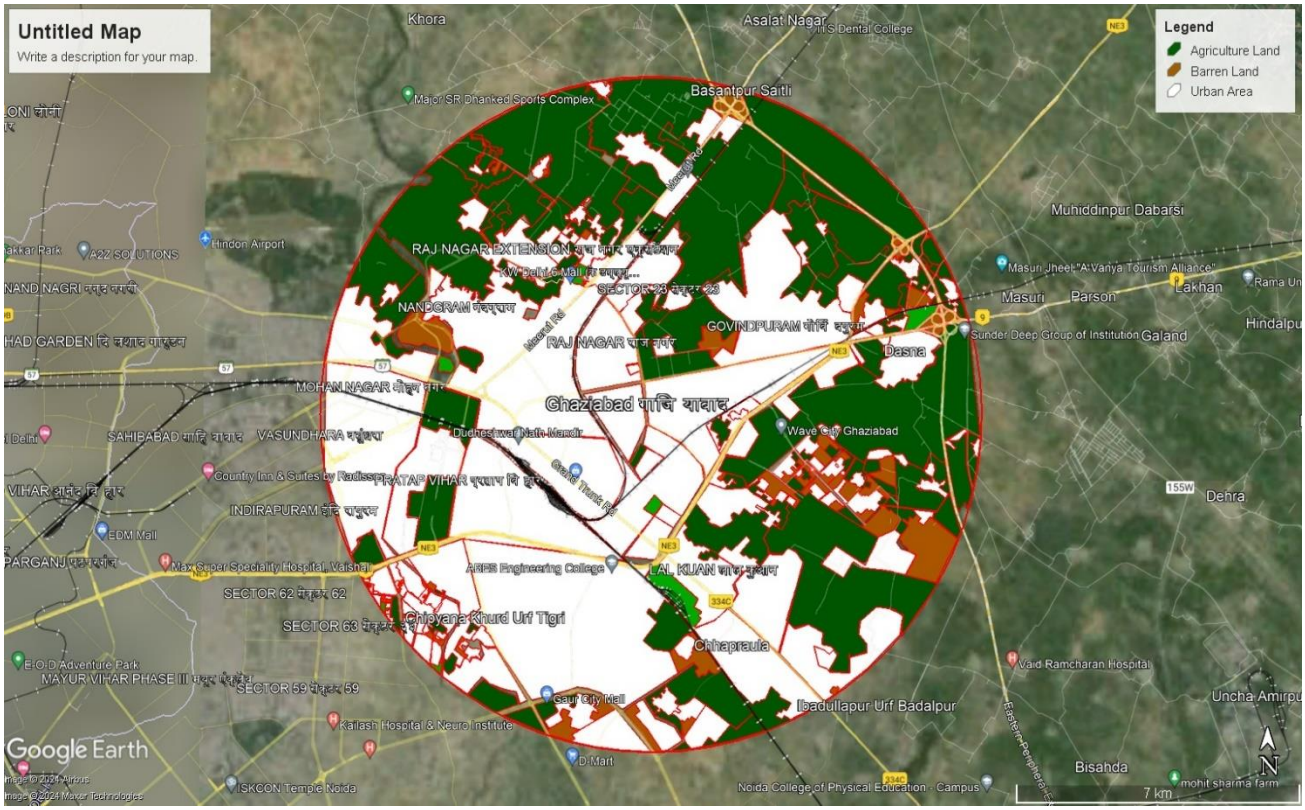
- **Marking Areas of Interest:**
  - Use the "Polygon" or "Line" drawing tools within Google Earth to mark and delineate specific areas for analysis.
  - Select the appropriate tool based on the shape of the area you want to mark (e.g., polygon for irregular shapes, line for linear features).



LACD MAP MARKING - 2009



LACD MAP MARKING – 2014



LACD MAP MARKING – 2019

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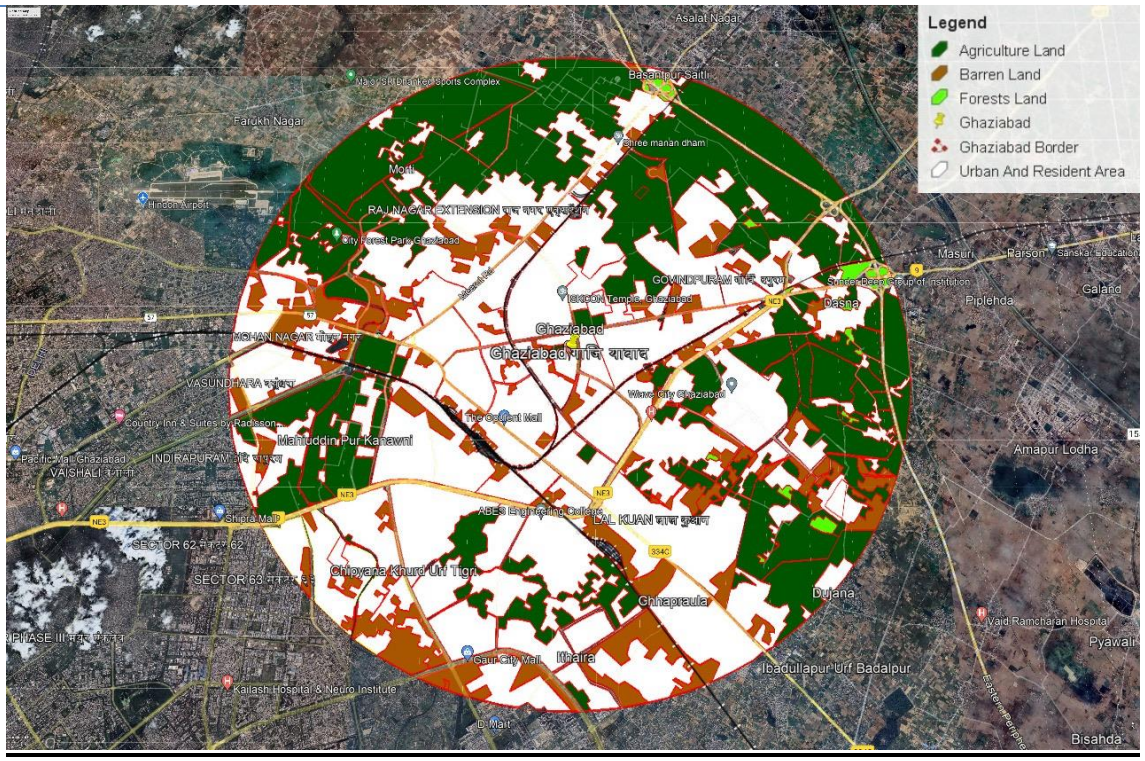


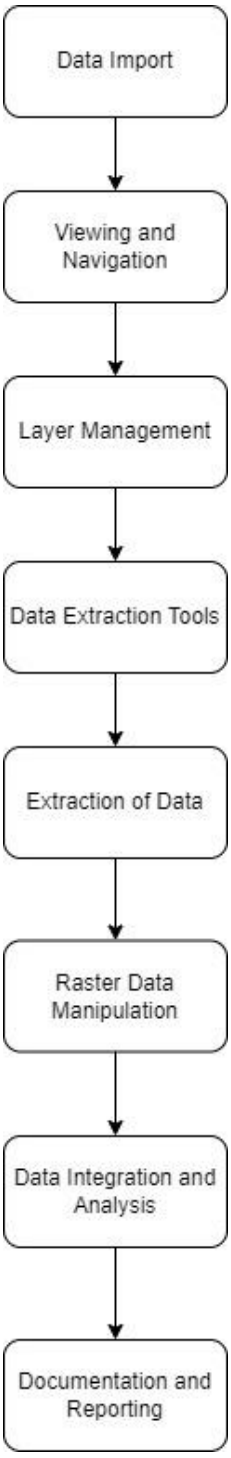
LACD MAP MARKING – 2023

- **Drawing and Annotation:**
- Trace the boundaries of the desired area by clicking on the map to create vertices that form the shape.
- Double-click to close the polygon or finish drawing the line, creating a defined area or boundary.
- Add annotations or labels to the marked areas for identification and reference.

- **Save and Export:**
  - Save the marked areas or drawn polygons as KML (Keyhole Markup Language) files within Google Earth.
  - Optionally, export the marked areas as KML/KMZ files for integration with Geographic Information System (GIS) software or other analysis tools.

- **Data Integration and Analysis:**
  - Import the saved KML/KMZ files into GIS software or the analysis tool of choice to incorporate the marked areas into the land cover analysis workflow.

- Utilize these delineated regions for specific land cover classification, change detection, or spatial analysis within the project.



- **Data Import:**

- Launch Global Mapper and import the required data layers, including satellite imagery (e.g., Landsat, Sentinel), shapefiles, or any relevant geospatial data covering the study area in Ghaziabad.

- **Viewing and Navigation:**
  - Navigate to the study area by zooming in and panning across the map display to focus on Ghaziabad and the surrounding regions.

- **Layer Management:**
  - Organize and manage layers by adjusting their visibility, transparency, and order to facilitate data extraction and analysis.

- **Data Extraction Tools:**

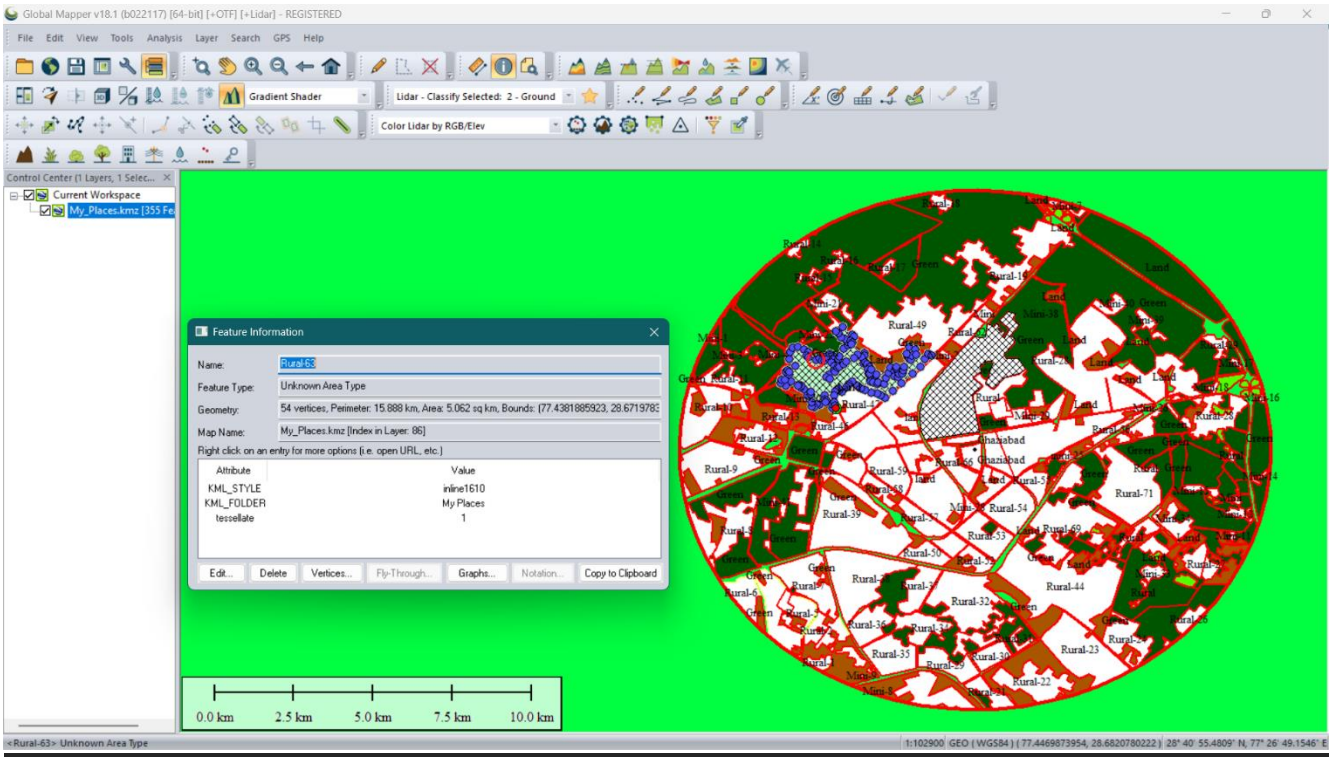
  Utilize the extraction tools available in Global Mapper:
  - **Feature Info Tool:** Use this tool to click on specific points or areas to retrieve attribute information from the underlying layers.
  - **Digitizing Tools:** Employ digitizing tools (point, line, polygon) to create new features or draw boundaries around areas of interest.

- **Extraction of Data:**
  - **Attribute Query:** Perform attribute queries to extract specific data based on attribute filters (e.g., land cover classes, administrative boundaries) from imported layers.
  - **Selection and Export:** Select specific features or areas using the digitizing tools and export them to new files or formats (e.g., shapefile, KML) for further analysis.

- **Raster Data Manipulation:**
  - **Clip Raster Data:** Use the clip or crop function to extract raster data (such as satellite imagery) within defined boundaries or polygons drawn on the map.
  - **Export Raster Data:** Export the clipped raster data into the desired format for analysis or integration with other software.

- **Data Integration and Analysis:**
  - Integrate the extracted data (vector or raster) into the land cover analysis workflow within Global Mapper or other GIS software for further analysis, classification, or change detection.

- **Documentation and Reporting:**
  - Document the extraction process, detailing the extracted datasets, methods used, and the relevance of the extracted data to the land cover analysis project.



Data Extraction using Global Mapper Tools and Techniques

CHAPTER 5

CONCLUSION

The land cover analysis and change detection project in Ghaziabad have provided valuable insights into the dynamic transformations occurring within the region over the study period. Through the integration of remote sensing techniques, and change detection methodologies, a comprehensive understanding of land cover changes has been attained.

The classification of land cover types, ranging from urban areas and agricultural lands to natural ecosystems and water bodies, has allowed for a detailed assessment of the evolving landscape. The analysis revealed significant changes across multiple temporal intervals, highlighting areas experiencing rapid transitions and alterations of agriculture and forest land decrementation.

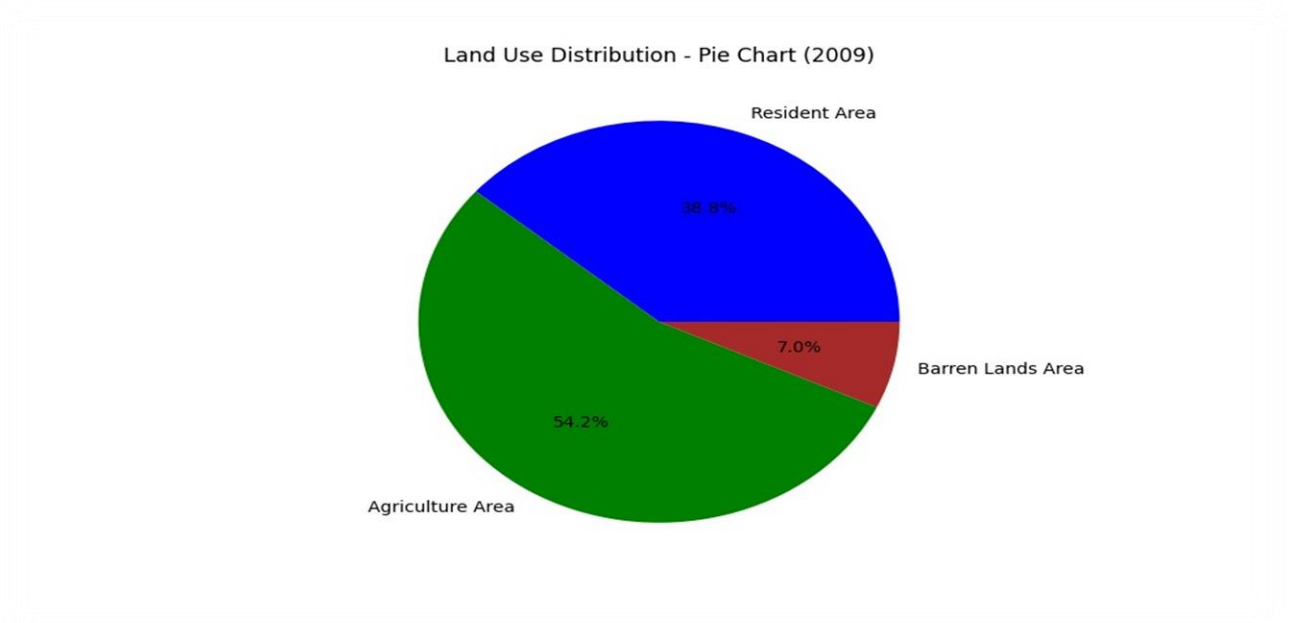
Spatial and temporal analyses uncovered intricate patterns and trends in land cover changes, indicating the impacts of urbanization, agricultural expansion, and natural processes on the region's ecosystems. Drivers behind these changes were identified, emphasizing the interplay of human activities and environmental factors in shaping the landscape.

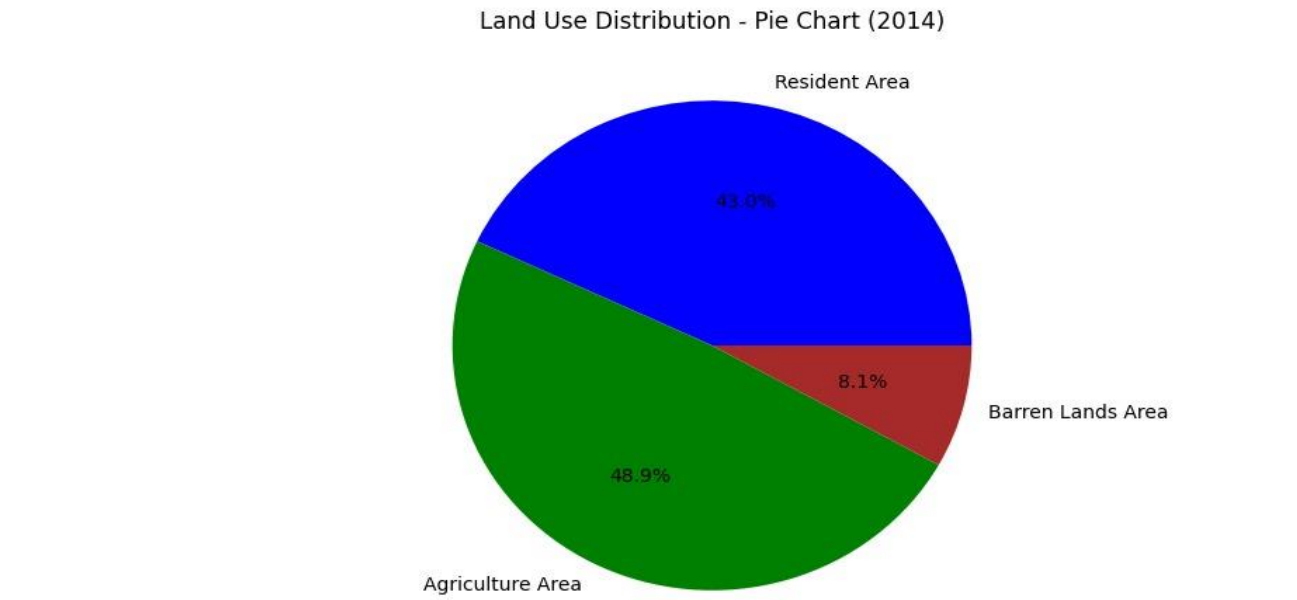
The project's findings underscore the importance of informed decision-making for sustainable land management and urban planning. The actionable recommendations derived from this analysis serve as a crucial guide for policymakers, local authorities, and stakeholders in fostering sustainable development practices and conservation efforts.

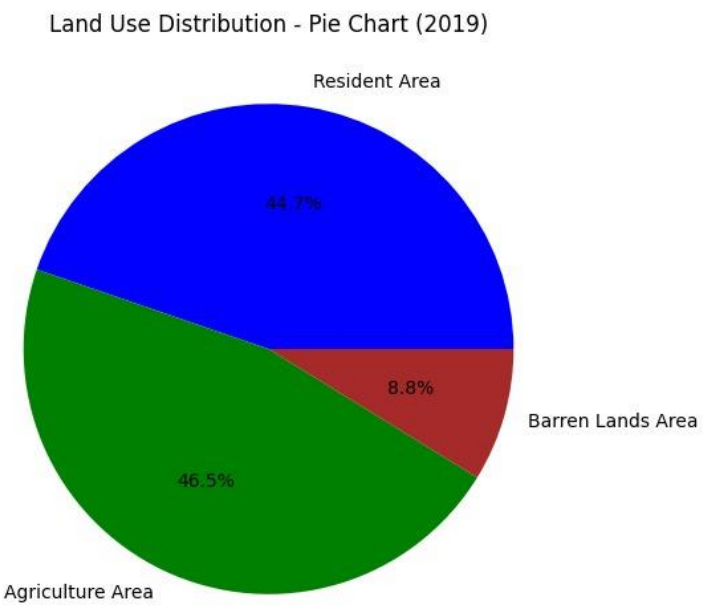
Moving forward, the establishment of a long-term monitoring framework based on these findings is imperative for continuous assessment and adaptive management strategies. Moreover, engagement with local communities and stakeholders remains vital for the successful implementation of suggested measures and fostering a shared responsibility towards environmental stewardship.

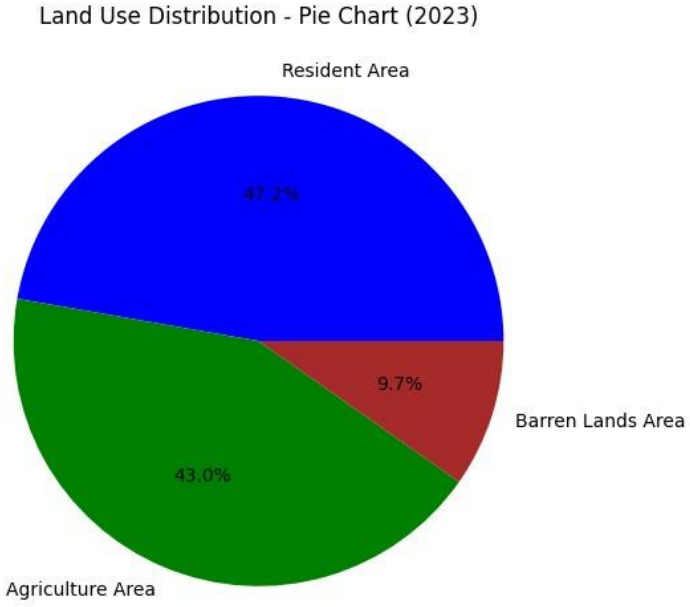
In conclusion, this project serves as a foundational step towards understanding the complex dynamics of land cover changes in Ghaziabad. Its outcomes pave the way for informed interventions, fostering resilience, and guiding the region towards a more sustainable and harmonious coexistence with its changing landscape.

CHANGE DETECTION BY PIE CHART

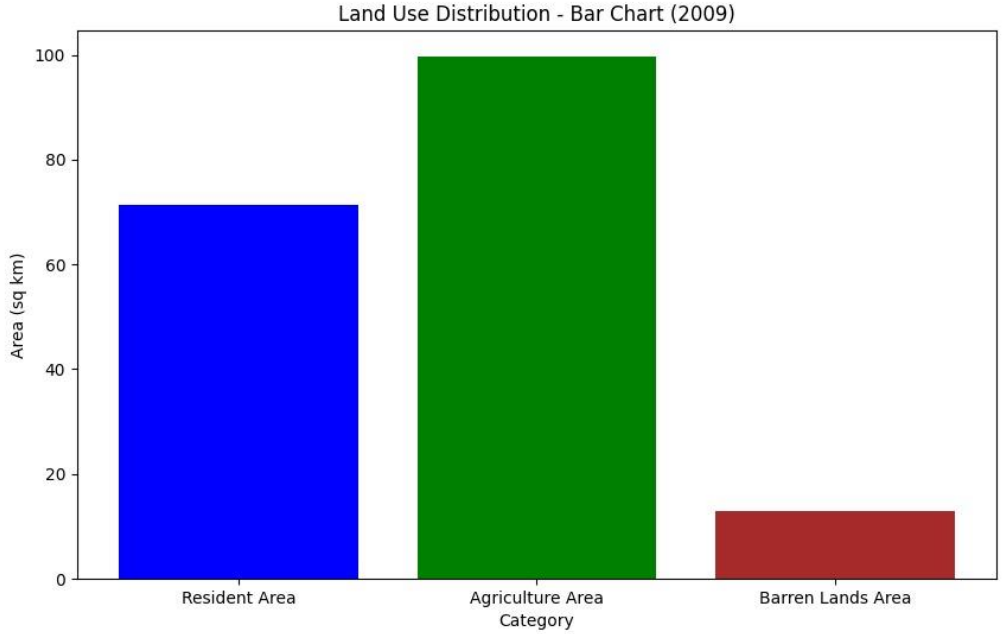


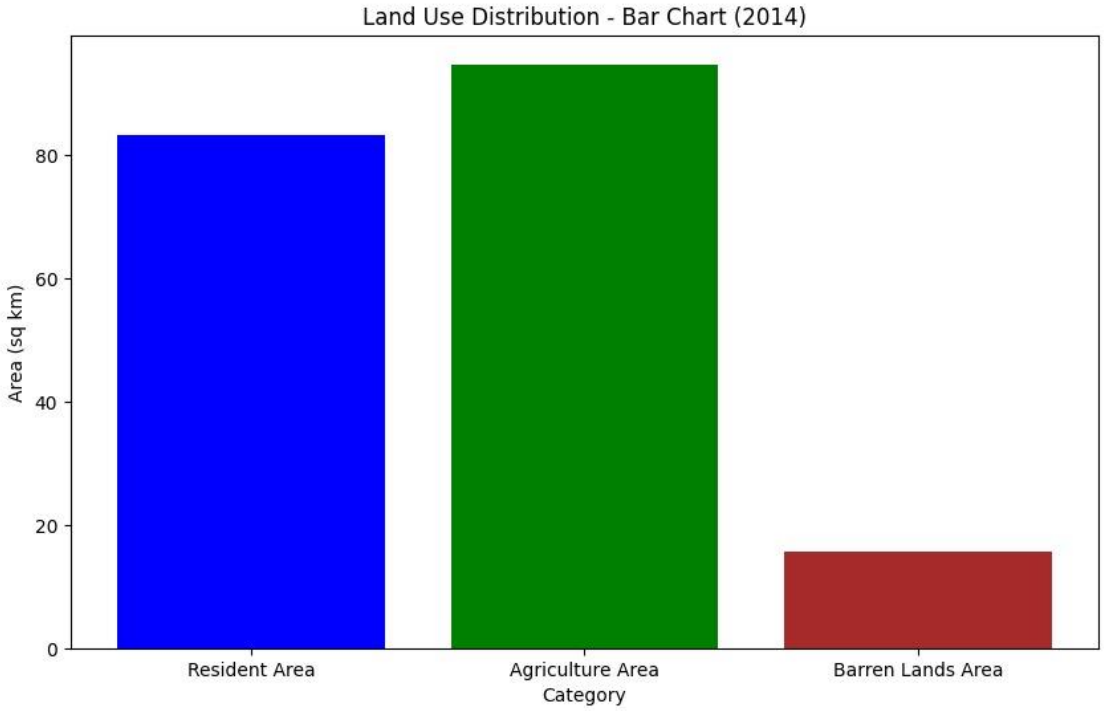


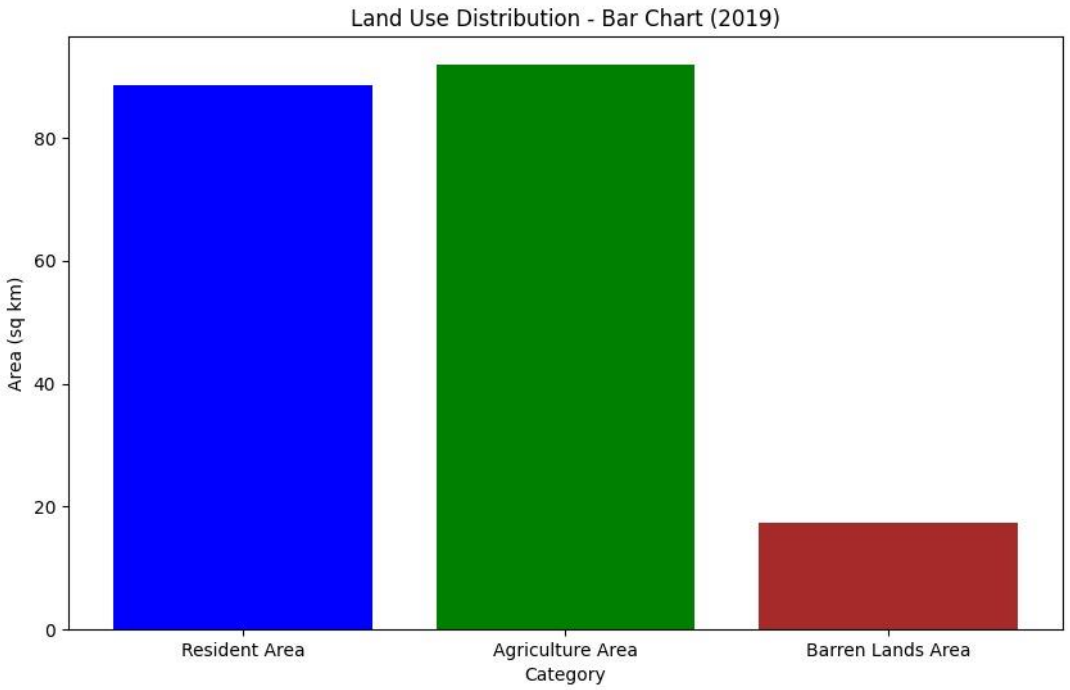

Land Use Distribution - Pie Chart (2019)
Resident Area
44.7%
8.8%
Barren Lands Area
46.5%
Agriculture Area

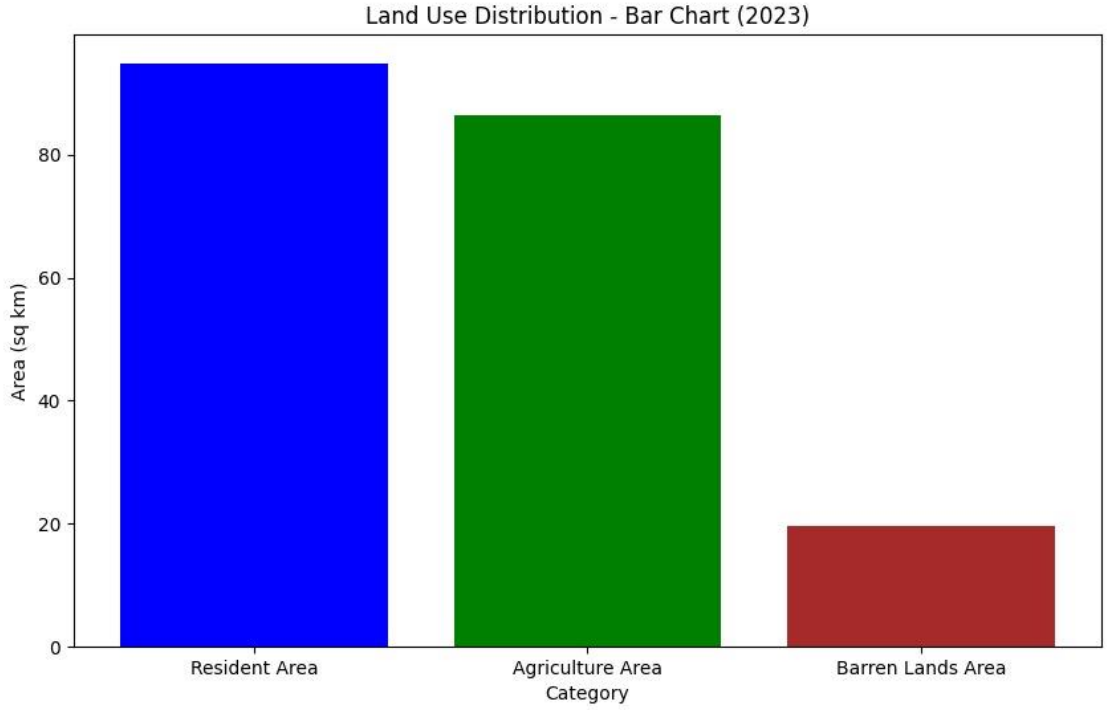

Land Use Distribution - Pie Chart (2023)
Resident Area
47.2%
9.7%
Barren Lands Area
43.0%
Agriculture Area

CHANGE DETECTION BY BAR CHART

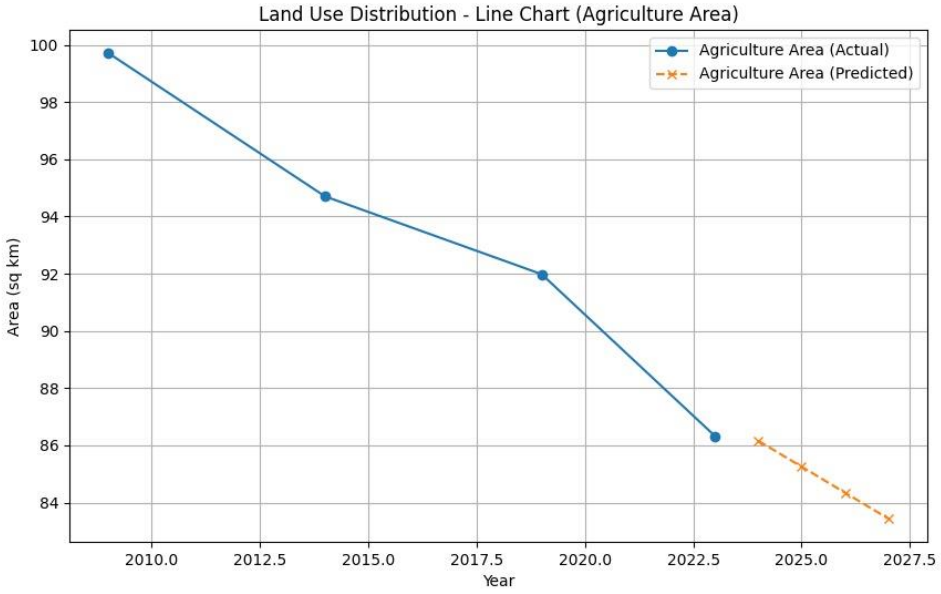


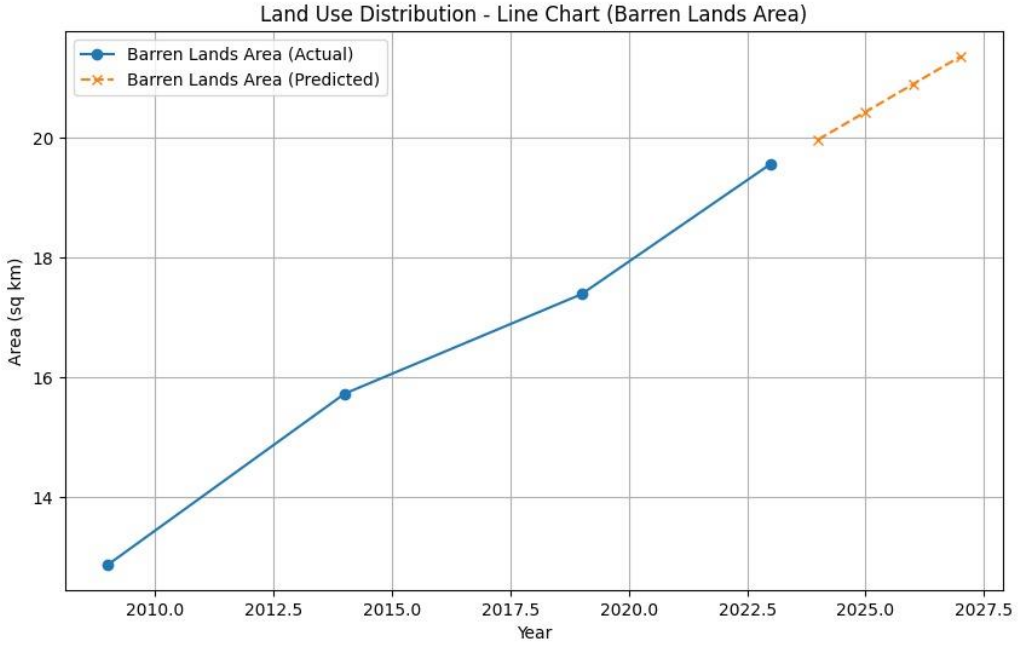


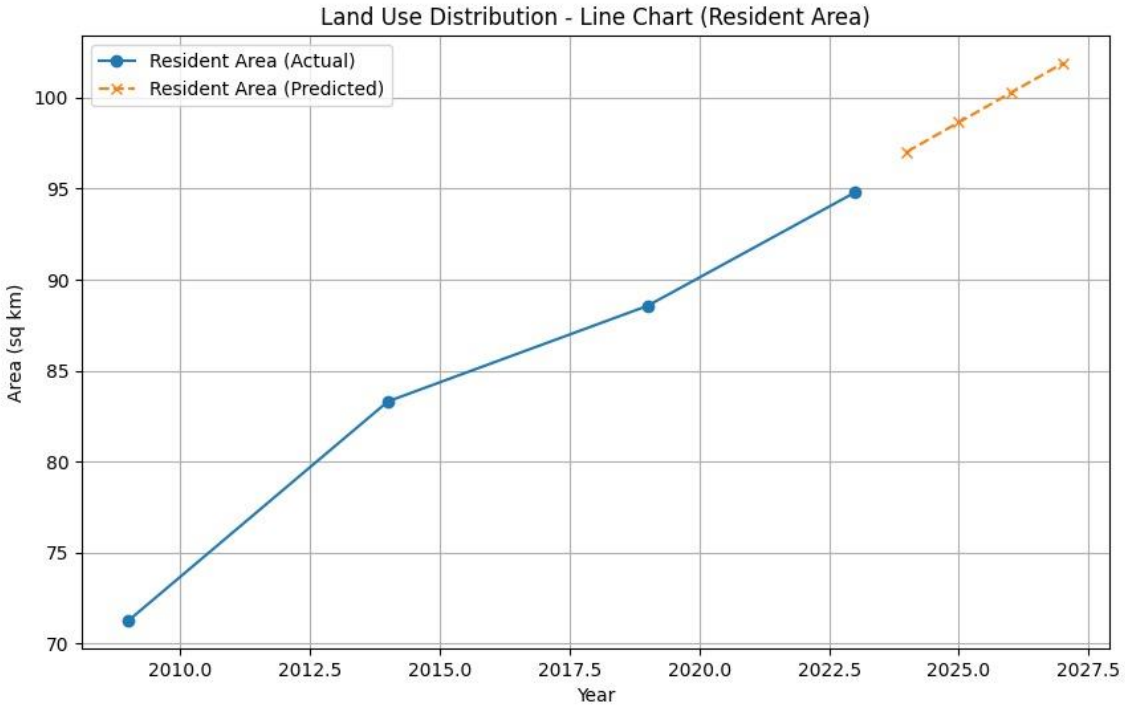

Land Use Distribution - Bar Chart (2019)
Area (sq km)
0
20
40
60
80
Resident Area
Agriculture Area
Barren Lands Area
Category


Land Use Distribution - Bar Chart (2023)
Area (sq km)
0
20
40
60
80
Resident Area
Agriculture Area
Barren Lands Area
Category

LINEAR REGRESSION PREDICTIONS







OVERALL PREDICTION

YEAR/AREA	RESIDENCE AREA	AGRICULTURE AREA	BARRENS AREA
2009	71.274688 sq km	99.710163 sq km	12.869 sq km
2014	83.3163 sq km	94.702804 sq km	15.72501 sq km
2019	88.56435 sq km	91.98304 sq km	17.38569 sq km
2023	94.79886 sq km	86.3276 sq km	19.56338 sq km

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