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Session : Deep Dive Session on AI, ML, and Robotics Use Cases for Utilities

CHANGE DETECTION IN GIS USING SATELLITE IMAGERY AND IMAGE CLASSIFICATION TECHNIQUES FOR ELECTRICAL NETWORK PLANNING & MANAGEMENT

Presented By

PRAVEEN KUMAR GOYAL, SENIOR VICE PRESIDENT, NOIDA POWER COMPANY LIMITED

RP-Sanjiv Goenka Group
Growing Legacies

NPCL
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NPCL OVERVIEW

Serving as a "Power Distribution licensee" in Greater Noida (335 Sqkm.) area since 1993

Consumer	Energy Sales	Peak Demand	Network Length	No. 33/11KV Substations	No. Distribution Transformers
1.61 L	3000 MU+	750 MVA+	7500 CKM+	56 No.	7157 No.
Residential: 91% Commercial : 4% Industrial : 3% Others : 2%	Residential: 31% Commercial : 3% **Industrial : 62%** Others : 4%	**652 MW** **FY24**	HT : 4000 CKM LT : 3500 CKM	958 MVA Capacity	757MVA Capacity

INTRODUCTION

- NPCL covers the licensed area of approximately 400 square kilometers, extensively serving its consumers in Greater Noida with reliable power and excellent services.

- Efficient planning and management of distribution networks is critical for ensuring reliable energy delivery to its consumers.

- NPCL has achieved rigorous growth since its implementation and continues to expand through strategic planning, technological advancements, and efficient resource management to meet consumer demand and enhance customer satisfaction.

- To plan and manage electrical power distribution effectively, it is important to understand the surrounding area well. However, the dynamic nature of landscapes poses challenges for accurately monitoring and adapting to changes within these networks.

- Land Use Land Cover (LULC) classification plays a crucial role in assessing changes in land patterns, identifying potential risks, and aiding in strategic planning for sustainable urban and industrial growth.

CONTEXT

Rapid urbanization and environmental changes have significantly altered LULC patterns over time.

Expanding built-up areas, deforestation, and land conversion have altered natural landscapes, impacting power distribution and infrastructure planning.

Therefore, it is essential to analyze the changes that have occurred in the landforms.

These changes not only impact power distribution and infrastructure planning but also environmental sustainability.

Growing urban areas demand optimized electrical infrastructure to ensure reliable and sustainable energy distribution.

RELEVANCE

LULC analysis is essential for ensuring reliable power distribution and sustainable utility management.

Traditional methods struggle with complex land cover variations, increase man power, cost factors and maintenance.

Machine learning-based classification methods improve the accuracy and automation of land cover identification, enabling precise substation planning and network optimization.

This not only enable planning for implementing the electrical infrastructure, but also colonial infrastructure that could be developed in the future.

The integration of machine learning with remote sensing and GIS ensures a resilient and efficient electrical infrastructure, reducing operational costs and enhancing grid stability.

LULC Changes over the period from 2015 to 2024

- Worldview datasets of year 2015, 2019 along with latest Google Earth dataset is pre-processed & filtered using filtration techniques.
- Image classification techniques involving supervised classification using matrix union method is utilized to detect the changes.
- Approximately 80 sample points are provided to classes based on the spatial signature of features.
- Data is then classified into 5 classes i.e., Vegetation, Agriculture, Barren Land, Built-up, and Waterbody for each dataset.
- Thematic mapping is created to visualize all the changes in one dataset by manually analyzing the pixel classes defined to them.

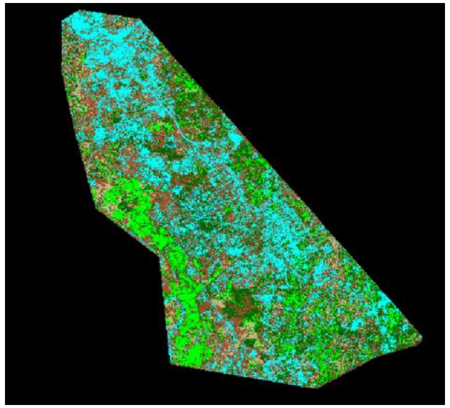


Image 2015

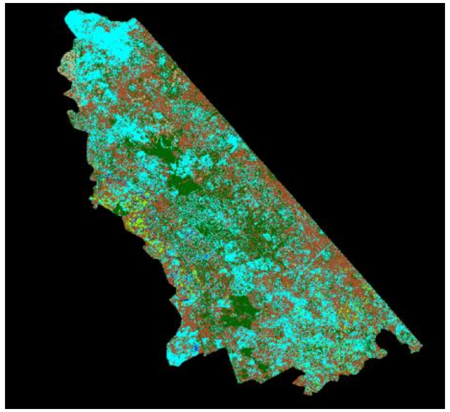


Image 2019

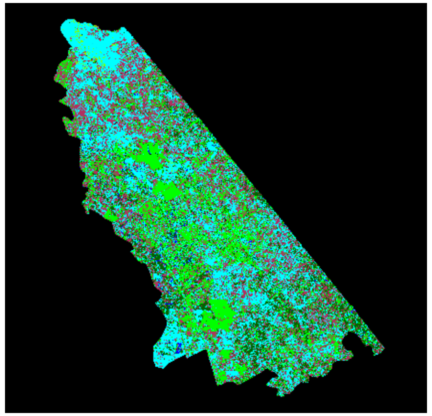
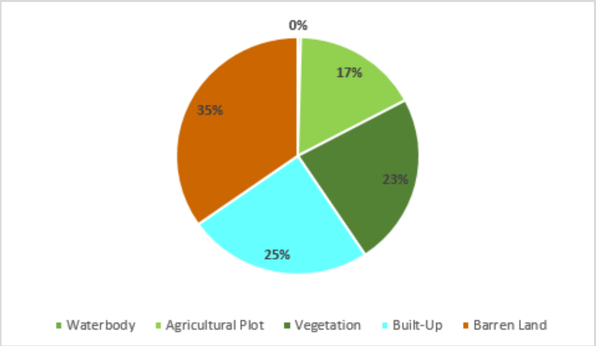


Image 2024

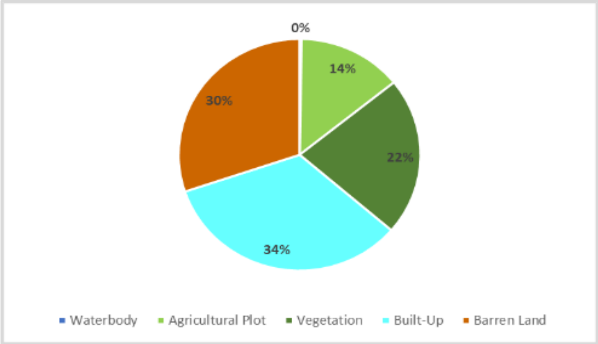
Symbology	Class	Class Description
	Built-up	Settlements and Roads
	Vegetation	Trees, shrubs, etc.
	Agriculture Plot	Irrigated agricultural area
	Barren Land with no grass	Areas scarce of vegetation
	Barren Land with grass	Little vegetative area grown on land
	Waterbody	Area covered by Hindon river

LULC Changes over the period from 2015 to 2024

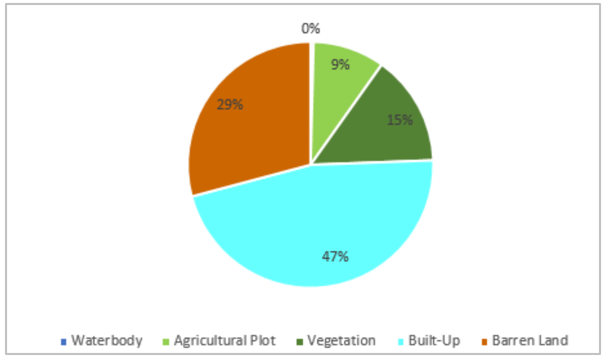
The circular graphics demonstrate the changes i.e., fraction of one field that has converted to other over the time period.



LULC classes of 2015 Dataset



LULC classes of 2019 Dataset



LULC Classes of 2024 Dataset

- Waterbody- As only Hindon river flows through Greater Noida, being conservative the graph shows a constant percentage in the study area.
- Agricultural Plot – Reduction of 3% suggests that agricultural land was either converted into built-up areas or became barren land due to urban expansion.
- Vegetation – 1% reduction, likely be due to deforestation and encroachment for infrastructure development.
- Built Up - Reflecting a 9% growth from 2015 to 2019, indicates rapid urbanization due to increment in population density in the region.
- Barren Land – Reduction of 5% suggests that some barren land was converted into built-up areas, while a portion may have undergone vegetation growth or agricultural usage.

USE CASE / CASE STUDY

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IDENTIFICATION OF A POTENTIAL LOCATION TO PROPOSE SUBSTATION IMPLEMENTATION

Through change detection, it has been identified that rapid urbanization is observed in areas like Girdharpur and Hatewa in the mentioned 10 year period.

This concludes that more consumers will reside in these urbanized regions in the future. The existing power infrastructure may experience load imbalances, thus impacting future network reliability.

Currently, only two substations exist in the region (contributing to approximately 60 square kilometer area) i.e., Girdharpur substation & Hatewa substation, which will be insufficient to balance the future needs.

To meet this future demand, a strategic substation location is identified for optimized power distribution in a way that it balances the existing distribution system. This ensures a future-ready power distribution system, capable of sustaining long-term urban expansion and consumer demand growth.

KEY TAKEAWAYS

- This project provides insights for capital expenditure (CAPEX), ensuring efficient investment is done in power infrastructure.
- With urbanization, increase in the consumer demand leads to network augmentation. LULC changes helps in identifying suitable routes for laying the distribution power lines by analyzing land type and existing infrastructure.
- Change detection aids in identifying a suitable location for substation installation & its asset planning using machine learning algorithms to meet growing consumer demand, also reducing the need of hard labour and field visits.
- The substation and network planning also allows seamless integration of new consumers that could come in the near-future into the power grid.
- LULC and network analysis will be conducted every two years to monitor changes, optimize grid expansion, and enhance service reliability in response to urbanization and increasing electricity demand.

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THANK YOU

For discussions/suggestions/queries email: isuw@isuw.in

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