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

OBJECT-BASED CLASSIFICATION FOR VEGETATION ENCROACHMENT ANALYSIS AND CHANGE DETECTION IN GREATER NOIDA FOR ELECTRICAL NETWORK PLANNING AND UTILITY MANAGEMENT

Presented By

VIKAS GUPTA, DEPUTY GENERAL MANAGER, NOIDA POWER COMPANY LIMITED

INTRODUCTION

- NPCL has diligently served its customers in the approximate area of 335 square kilometers by meeting their needs with reliability and proficiency.
- The power services have reached approximately 1.8 Lacs consumers. NPCL continues to strive for further growth through enhanced infrastructure, efficient service delivery, and customer-centric initiatives.
- To sustain the efficiency of power network, monitoring of electrical infrastructure along with vegetation is crucial to avoid any potential issue that can lead to failure or safety hazards.
- Our project explores the potential of object-based classification algorithms for land-use changes over time through change detection from satellite imagery and monitoring vegetation encroachment through drone data.

Rapid Urbanization & Infrastructure Growth

- Greater Noida has witnessed rapid urban expansion, increasing the demand for understanding the land use pattern. Due to which, continuous monitoring and efficient planning for electrical infrastructure is a necessary requirement.

Power Distribution Optimization

- It is necessary to find a suitable and optimal local to lay the network and implement substation to perform network expansion based on spatial data.

Risk of Vegetation Encroachment

- Overgrown vegetation near electrical infrastructure can lead to power outages, equipment damage, and safety hazards, requiring efficient monitoring and management.

Need for Automated and Scalable Solutions

- Traditional manual inspections are time-consuming and costly. Object-based classification provides an automated, scalable, and data-driven approach for proactive vegetation management in electrical network planning.

Efficient Utility Planning and Management

- By integrating GIS-based change detection, the project provides data-driven insights for network expansion, maintenance scheduling, and resource optimization, improving overall efficiency.

Future Applications

- The LULC Change detection analysis helps in identifying a potential location for electrical infrastructure like Substation along with network planning.

Ensuring Electrical Network Safety

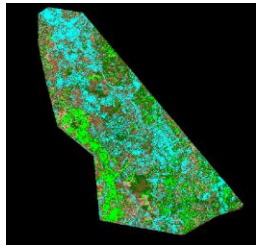
- Object-based Classification algorithm provides an insight to understand and identify the features mainly vegetation and overhead power lines & identify the encroaching areas that poses risk to power infrastructure.

Identification of Overgrownness of Trees

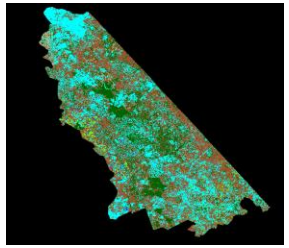
- The use of 3D point cloud data enhances the accuracy of vegetation identification by enabling measure of appropriate height of tress that can cause disruption to power outage.

LULC Change Detection over the period from 2015 to 2024

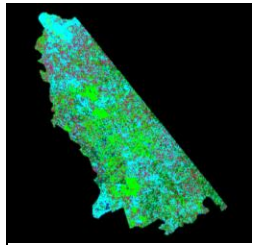
- The Worldview-3 dataset of year 2015, 2019, and google 2024 imagery is processed using supervised classification and image difference method.
- Supervised classification algorithm classifies the dataset into 5 classes based on the spatial signatures of the features i.e., Built-Up, Vegetation, Agricultural Plot, Barren land, and Water body.
- Thematic map is created to view and understand the changes that features have undergone.
- Image Difference algorithm differences the dataset into difference & highlight imageries.
- Analysis on the Thematic map & Image difference map is conducted to identify the changes that have occurred over the 10 year period.



Dataset 2015



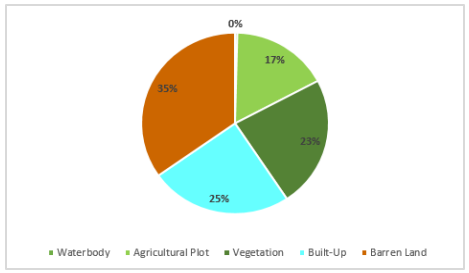
Dataset 2019



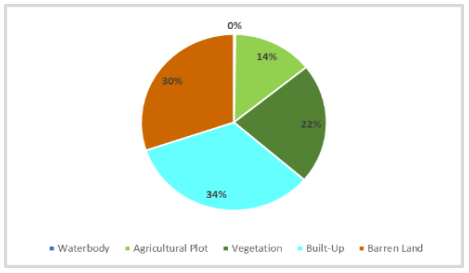
Dataset 2024

CONCLUSION

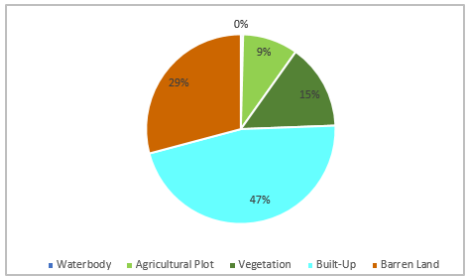
Rapid urbanization is observed as barren land and agriculture has transformed into developed structures by 22%.



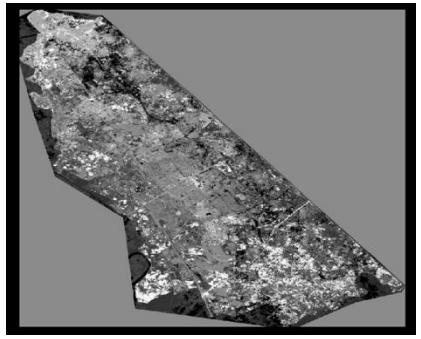
LULC classes of 2015 Dataset



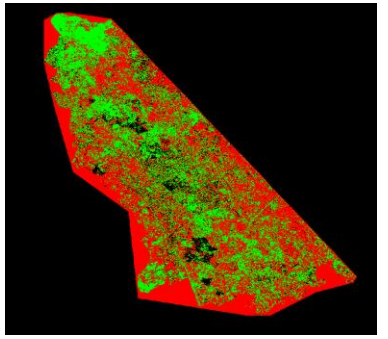
LULC classes of 2019 Dataset



LULC Classes of 2024 Dataset



Difference Image

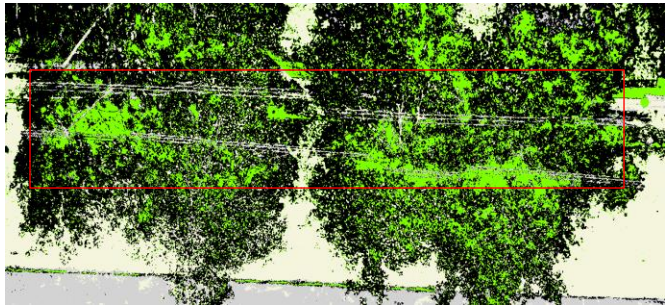


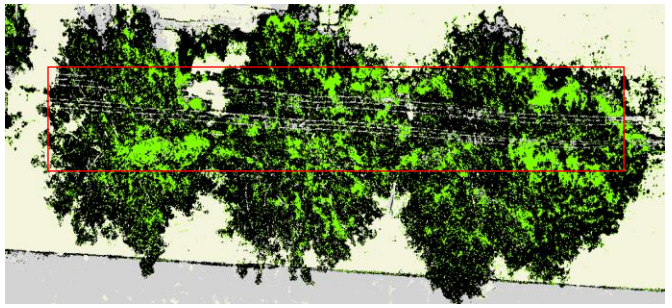
Highlight Image

Feature Class	Changes from 2015 to 2019
Waterbody	Only Hindon River exists
Agricultural Plot	8% Decrease
Vegetation	8% Decrease
Built-Up	22% Increase
Barren Land	6% Decrease

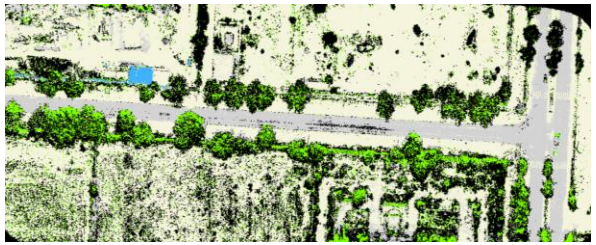
Vegetation Encroachment over Tusyana Region

- Drone is deployed over the Tusyana region to capture 360° view with approximately 280 images with an overlapping portion of a minimum of 70% at regular standard intervals.
- Processing involving orthomosaicing and 3D point cloud generation is conducted on the captured imageries.
- Unsupervised classification algorithm is applied which divided the orthomosaic dataset into six distinct classes based on spatial properties and characteristics of features i.e., vegetation, road, building, overhead network, soil, and barren land.
- A 10-meter offset from the ground surface is applied to the 3D point cloud data to indicate the onset of vegetation encroachment if it extends beyond this threshold near power lines.





Point Cloud Data



Classified Dataset

Symbology	Class
	Vegetation
	Road
	Building
	Overhead Network
	Soil
	Barren Land

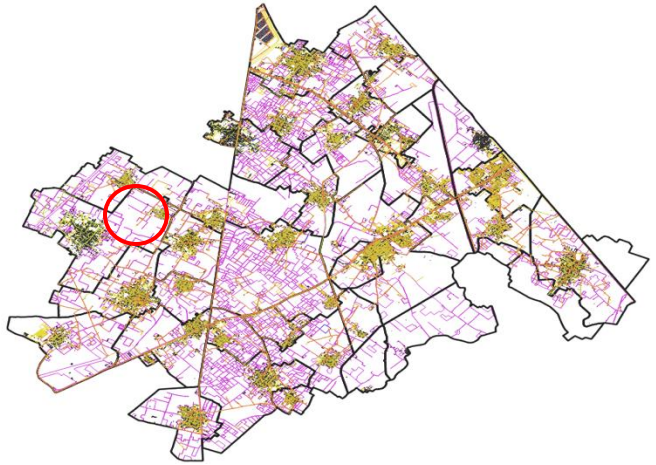
USE CASE / CASE STUDY

1 IDENTIFICATION OF POTENTIAL LOCATION FOR PROPOSED SUBSTATION

ISSUE
- LULC analysis helped in identification of regions like Girdharpur & Hatewa, where urbanization is observed.
- More consumers are expected to reside in those region in the near-future.

IMPACT
- As only 2 substations exist in those regions currently, high consumer demand leading to load imbalance will occur in the state of power infrastructure.

SOLUTION
- Through utilization of Object-based algorithms, Dadupur has been identified as the optimal location for the proposed substation and network to optimize power distribution so as to balance the existing system.

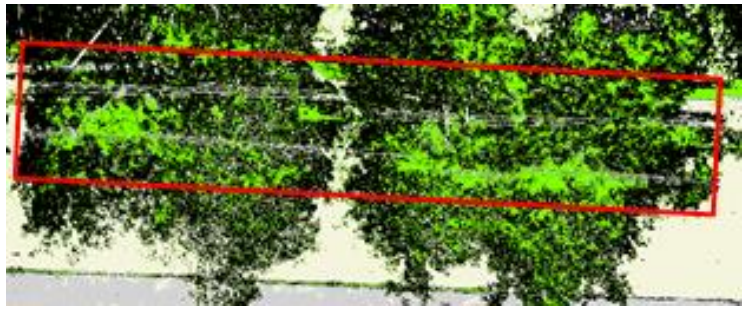


2 IDENTIFICATION OF POWER LINES ENCROACHED BY VEGETATION

ISSUE
- Dense vegetation in Tusyana region, encroaching power distribution lines.

IMPACT
- Potential disruption of power infrastructure.

SOLUTION
- Pixel-based analysis along with 3D point cloud analysis used to assess vegetation density, finally leading to pruning and tree removal.



KEY TAKEAWAYS / RECOMMENDATIONS

- This project provides insights for capital expenditure (CAPEX), ensuring efficient investment is done in power infrastructure. This process can be conducted every 2 years to monitor and manage the changes.
- 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 techniques used for identifying vegetation encroached regions are further applied on other feeder network so that tripping can be avoided & network can be maintained.
- In cases like theft vegetation, where vegetation can act as an obstruction, this technique is a crucial measure. Process of pruning can be scheduled at regular intervals to avoid the damage completely.
- The 3D point cloud data can be utilized to analyze the growth pattern of trees so that vegetation monitoring can be conducted.

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THANK YOU

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

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Links/References (If any)