Harvest-Ready Sugarcane Assessment via GIS and Earth Observation

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HR-SAGE

1 Abstract

Sugarcane's unique growth pattern necessitates accurate monitoring for effective management. This study presents HR-SAGE (Harvest-Ready Sugarcane Assessment via GIS and Earth Observation), a web-based app that detects, classifies, and visualizes sugarcane growth stages across the Philippines at 10m resolution. Using the GEDI-Sentinel-2 sugarcane map and Sentinel-2 NDVI, the system classifies pixel-level detections by growth stage and displays them in a GIS map. User testing via the System Usability Scale (SUS) showed high satisfaction with the UI's simplicity, and expert validation confirmed the scientific soundness of the classification logic. Suggested improvements include handling cloud cover, predictive modeling, and local field validation. HR-SAGE offers a scalable, user-friendly, and science-based approach to sugarcane monitoring in the Philippines.

2 Introduction

The Philippine sugarcane industry contributes ₱76 billion annually, with productivity dependent on accurate harvest timing. Traditional methods for assessing harvest-readiness are labor-intensive, error-prone, and inefficient. To address this, HR-SAGE (Harvest-Ready Sugarcane Assessment via GIS and Earth Observation) was developed. It is a web-based platform that classifies and maps sugarcane growth stages using satellite data (Sentinel-2 NDVI and GEDI-Sentinel sugarcane map). By automating detection and visualization, HR-SAGE reduces on-site visits and supports better crop management decisions.

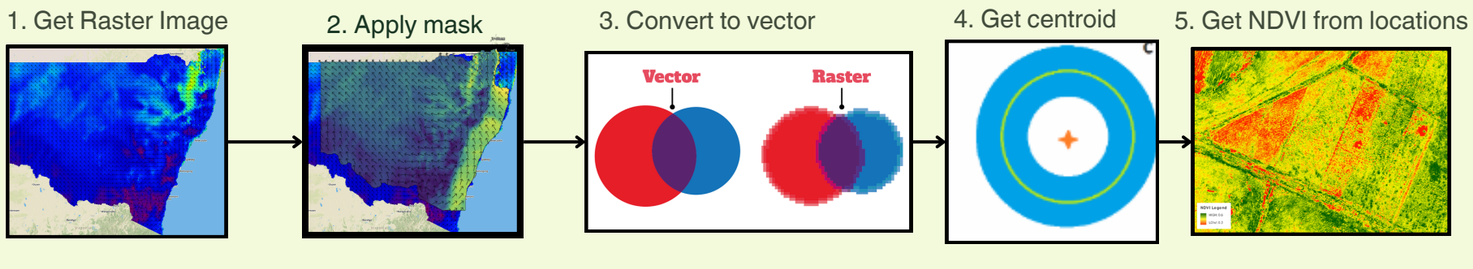
3 Objectives

1. Implement verified crop masking techniques using satellite imagery to detect and distinguish sugarcane crops from other vegetation.
2. Develop a web-based GIS mapping tool integrating satellite imagery data for sugarcane pixel visualization and growth stage analysis.
3. Provide nationwide information about the sugarcane location and growth stage; and
4. Assess the application's usability and acceptability using SUS.

4 Methodology

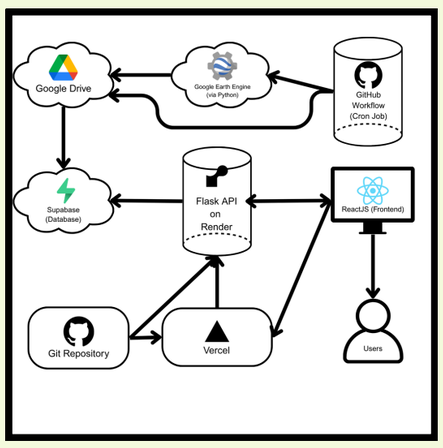
HR-SAGE was developed as a full-stack web application integrating satellite-based remote sensing and geospatial analytics. The system uses Sentinel-2 imagery to compute NDVI and the GEDI-Sentinel-2 global sugarcane map to isolate verified sugarcane pixels across the Philippines. Geospatial tasks such as cropland masking, NDVI calculation, and centroid extraction were automated using Google Earth Engine, with periodic scripts triggered every 5 days via GitHub Workflow. Detected sugarcane pixels were vectorized into centroids, classified into growth stages based on NDVI thresholds and canopy height frequency (nTallMonths), and exported in CSV format. Then, parsed by a Flask API, classified, and sent to a ReactJS, where sugarcane points are visualized on a Leaflet map. The platform was evaluated through user testing with 15 participants, employing the System Usability Scale (SUS) and open-ended feedback collection.

Satellite Data Processing Flow

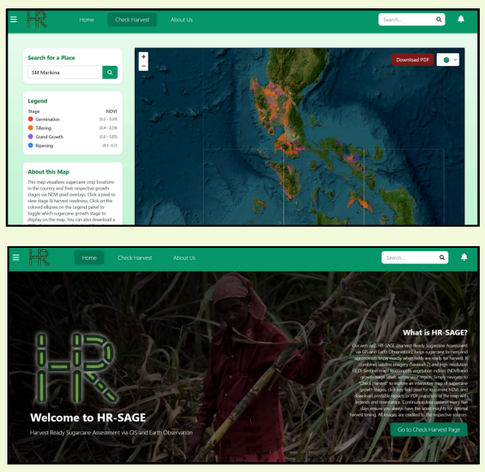


Technology Used

System Architecture



Page Layout

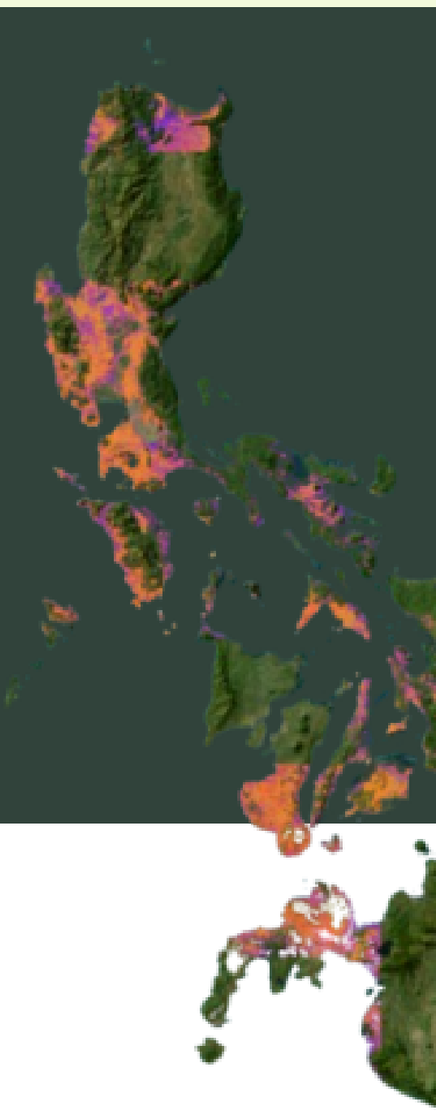


5 Results and Discussion

- **Expert Validation:** An agricultural engineer confirmed the scientific soundness of the detection, vectorization, and classification logic.
- **Usability:** HR-SAGE scored an average SUS of 83 (Grade A), indicating excellent user satisfaction, especially for simplicity and interface clarity.
- **Feedback:** Users praised the intuitive design and spatial accuracy, though some reported slow loading for large data visualizations.
- **Visual Accuracy:** Centroid-extracted sugarcane points closely matched Di Tommaso et al.'s dataset, confirming spatial precision.

6 Conclusion

HR-SAGE was developed as a full-stack web application integrating satellite-based remote sensing and geospatial analytics. The system uses Sentinel-2 imagery to compute NDVI and the GEDI-Sentinel-2 global sugarcane map to isolate verified sugarcane pixels across the Philippines. Geospatial tasks such as cropland masking, NDVI calculation, and centroid extraction were automated using Google Earth Engine, with periodic scripts triggered every 5 days via GitHub Workflow. Detected sugarcane pixels were vectorized into centroids, classified into growth stages based on NDVI thresholds and canopy height frequency (nTallMonths), and exported in CSV format. Then, parsed by a Flask API, classified, and sent to a ReactJS, where sugarcane points are visualized on a Leaflet map. The platform was evaluated through user testing with 15 participants, employing the System Usability Scale (SUS) and open-ended feedback collection.



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