Postfire Burn Severity and Four-Month Vegetation Recovery Assessment Using NBR and NDVI

A Case Study of the Eaton and Palisades Fires

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Abstract—This study analyzes the effects of wildfire and postfire vegetation recovery in Southern California through a remote-sensing-based case study of the Eaton and Palisades Fires. Burn-scar area was calculated using Landsat 8/9 satellite imagery from January 6 and January 14, while vegetation regrowth was assessed using imagery from May 30. The Normalized Burn Ratio and its differenced form were used to classify burn severity. Normalized Difference Vegetation Index and its differenced form were used to track postfire vegetation regrowth. Results showed that 76% of the Eaton Fire area and 86% of the Palisades Fire area experienced low to high burn severity. However, vegetation regrowth differed drastically: Only 25% of land burned by the Eaton fire showed signs of regrowth, compared to 74% in Palisades. The findings demonstrate how remote sensing enables postfire monitoring to support ecological assessment.

Keywords—wildfire; ArcGIS; burn severity; vegetation regrowth.

I. INTRODUCTION

Southern California's landscape has been shaped by fire for centuries. Many native California species have evolved to depend on periodic fire for regeneration, such as serotinous cones and heat-activated seeds [1]. However, climate change, prolonged drought, and urban expansion have increased wildfire frequency and intensity, posing challenges for land management and ecological recovery.

The goal of this study is to assess both fire impact and vegetation recovery following two Southern California fire events during January 2025: the Eaton Fire and the Palisades Fire. Using satellite imagery and spectral indices, this research evaluates the burned area extent and severity, as well as the regrowth of vegetation within a four-month period postfire.

Two primary research questions guide this work.

1. How many acres were affected by each fire, and what were the severity levels?
2. How much vegetation has regrown since the fire, and what were their regrowth levels?

Section 2 outlines the data used for this analysis. Section 3 describes the methodology used for the analysis. Section 4 details the results of the analysis, and Section 5 discusses those results. Section 6 concludes.

II. DATA

We sourced satellite imagery from United States Geological Survey (USGS) EarthExplorer, Landsat 8–9 Operational Land Imager and Thermal Infrared (OLI/TIRS) Sensor Level 2 data, for three dates: January 6 (prefire), January 14 (postfire), and May 30 (vegetation recovery). Each dataset included all 11 spectral bands in tagged image file (TIF) format. We obtained wildfire boundary polygons for both the Eaton and Palisades Fires from Esri's Living Atlas. We were primarily interested in Band 5 (Near Infrared), Band 7 (Shortwave Infrared 2), and Band 4 (Red), which are used in Normalized Burn Ratio (NBR) and Normalized Difference Vegetation Index (NDVI) calculations.

III. METHODOLOGY

A. Obtain Satellite Imagery

We downloaded Landsat 8/9 OLI/TIRS Level 2 surface reflectance data from USGS EarthExplorer. Three image sets captured prefire, postfire, and vegetation recovery stages (Figure 1–3).

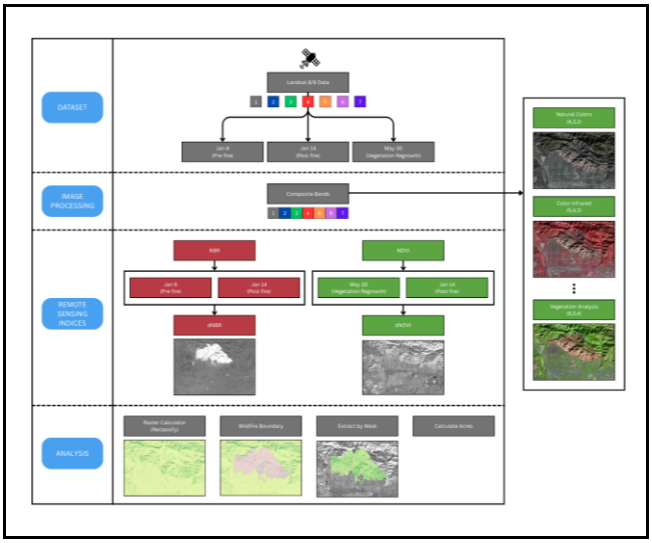

Figure 1. Workflow diagram showing image acquisition, processing, remote sensing indices, and spatial analysis steps.

- January 6, 2025 (Prefire)
- January 14, 2025 (Postfire)
- May 30, 2025 (Regrowth)

Each scene included 11 spectral bands in TIF format. Wildfire boundary shapefiles for the Eaton and Palisades Fires were obtained from Esri's Living Atlas.

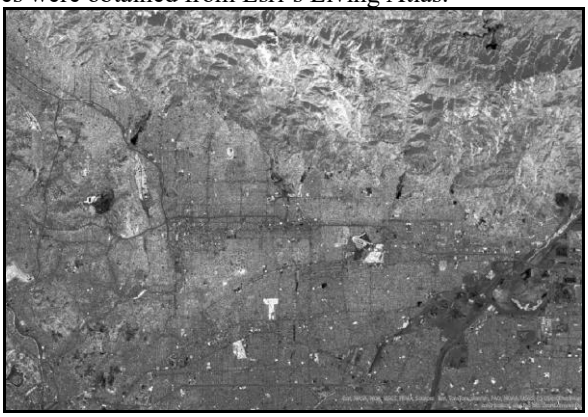

Figure 2. Eaton Fire. NBR of Jan 6th, Prefire

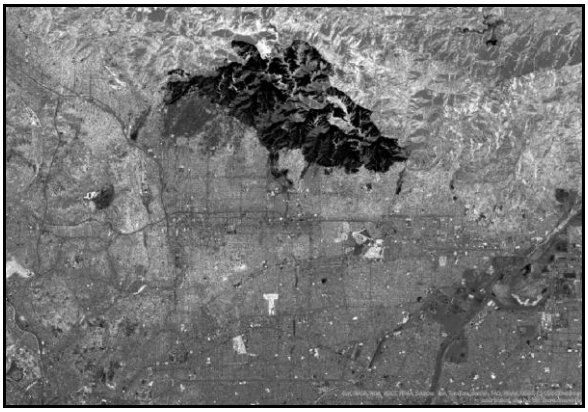

Figure 3. Eaton Fire. NBR of Jan 14th, Postfire

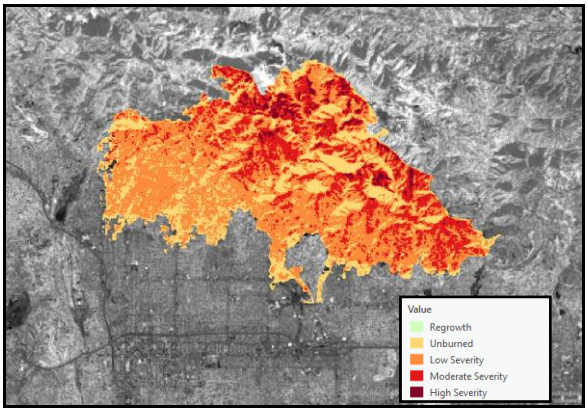

Figure 4. Eaton Fire. Burn Severity Classification.

B. Process Image Bands

Using ArcGIS Pro, we combined individual bands into composite raster images using the Composite Bands tool. To assist visual interpretation of landscape features and fire damage, we explored three band combinations.

- 4-3-2 (Natural Color)
- 5-4-3 (Color Infrared)
- 6-5-4 (Vegetation Analysis)

We used these visualizations to support manual inspection and confirmation of burn and recovery patterns (Figure 4).

C. Apply Remote Sensing Indices

We used two spectral indices to quantify burn severity and vegetation regrowth, burn severity and vegetation regrowth.

1) Burn Severity

We calculated the NBR for both prefire and postfire imagery using the formula

$$NBR = (NIR - SWIR) / (NIR + SWIR),$$

where *NIR* is Band 5 and *SWIR* is Band 7.

We then computed the differenced NBR (dNBR) by subtracting the postfire NBR from the prefire NBR. We applied classification thresholds using Raster Calculator, following USGS standards for burn-severity levels. This method is widely used in wildfire assessments and is recommended by the UN-SPIDER Knowledge Portal [2].

2) Vegetation Regrowth

We calculated the NDVI for postfire (January 14) and regrowth (May 30) imagery using the formula

$$NDVI = (NIR - Red) / (NIR + Red),$$

where *NIR* is Band 5 and *Red* is Band 4.

NDVI measures photosynthetic activity and plant health [3]. We computed the differenced NDVI (dNDVI) by subtracting postfire NDVI from regrowth NDVI using Raster Calculator to classify regrowth intensity. We based all calculations on surface reflectance data, following USGS best practices [4] (Figure 5–13).

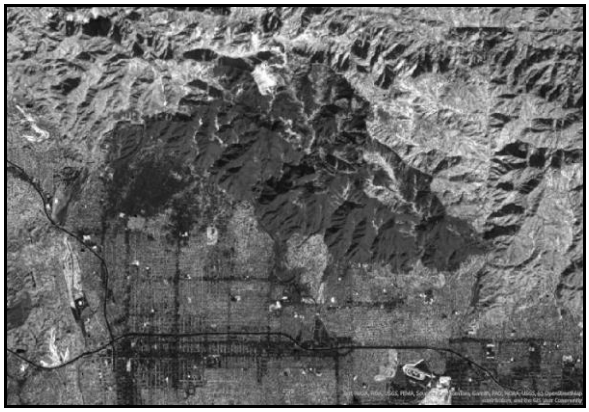

Figure 5. Eaton Fire. NDVI of Jan 14th, Postfire

D. Perform Spatial and Acreage Analysis

To isolate and quantify burned and recovered areas, we used several spatial analysis tools in ArcGIS Pro.

- We applied wildfire boundaries using Extract by Mask.

- We generated classified rasters via Raster Calculator to assign severity and regrowth levels.
- We performed acreage calculations by converting pixel counts (900 m² per pixel at 30m resolution and 1 acre is 4046.86 m²) using the formula

$$Area\ (\text{acres}) = Pixel\ Count \times 900 / 4046.86,$$

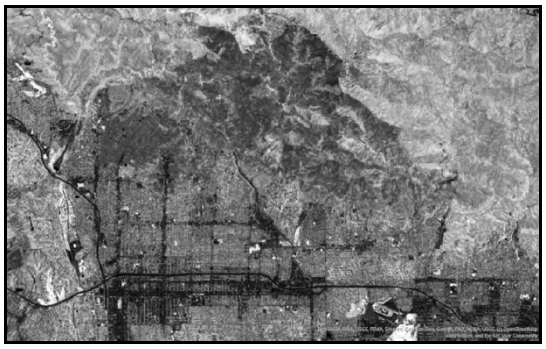

Figure 6. Eaton Fire. NDVI of May 30th

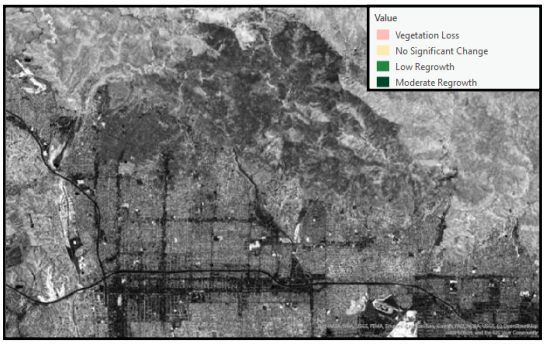

Figure 7. Eaton Fire. Vegetation Regrowth Classification.

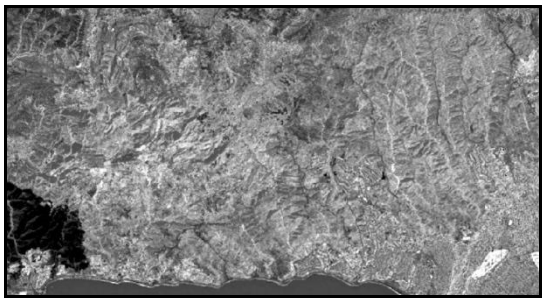

Figure 8. Palisades Fire. NBR of Jan 6th, Prefire

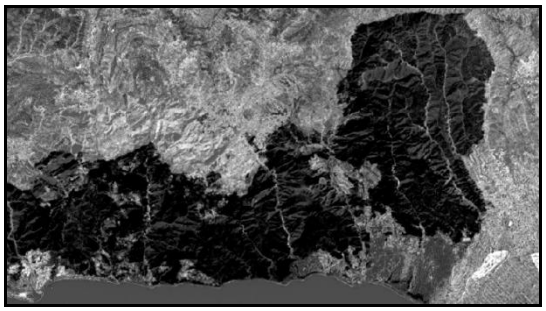

Figure 9. Palisades Fire. NBR of Jan 14th, Postfire

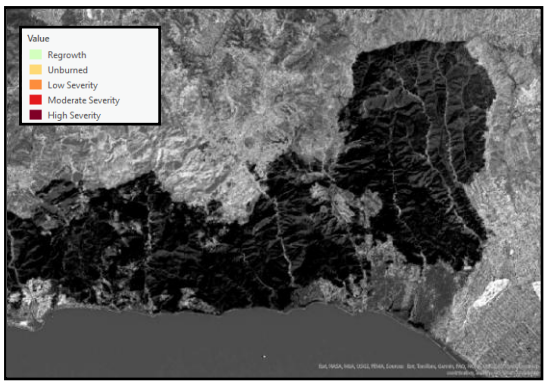

Figure 10. Palisades Fire. Burn Severity Classification.

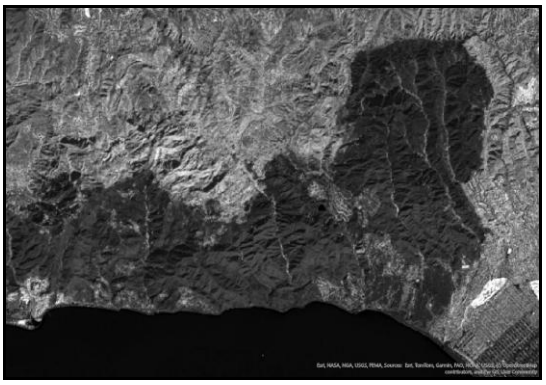

Figure 11. Palisades Fire. NDVI of Jan 14th, Postfire

Figure 12. Palisades Fire. NDVI of May 30th.

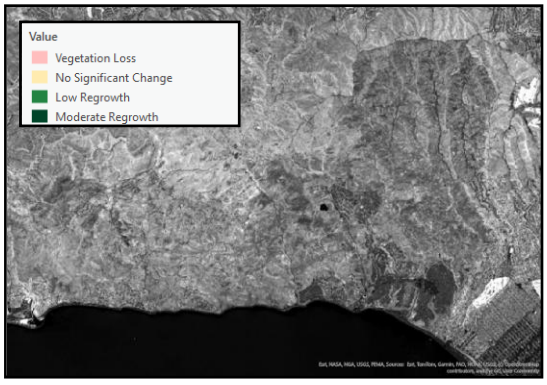

Figure 13. Palisades Fire. Vegetation Regrowth Classification.

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IV. RESULTS

The Eaton Fire burned 14,070 acres: 50% experienced low, 22% moderate, and 3% high severity. In contrast, the Palisades Fire affected 23,442 acres, with 55% low, 30% moderate, and 1% high severity. Despite its larger size, Palisades had a smaller proportion of high-severity burn. These total acres closely align with official incident reports from CAL FIRE, which reported 14,021 acres burned for Eaton and 23,448 for Palisades [5] (Tables 1 and 2).

TABLE I. BURN SEVERITY

	Eaton		Palisades	
Severity level	**Acres**	**%**	**Acres**	**%**
Unburned	3,434	24%	3,284	14%
Low severity	7,022	50%	12,855	55%
Moderate severity	3,159	22%	7,077	30%
High severity	455	3%	226	1%
Total (low-high severity)	10,636	76%	20,158	86%
Total	14,070	100%	23,442	100%

TABLE II. VEGETATION RECOVERY

	Eaton		Palisades	
Regrowth level	**Acres**	**%**	**Acres**	**%**
Vegetation loss	18	0%	3	0%
No significant change	10,473	74%	6,057	26%
Low regrowth	3,555	25%	17,093	73%
Moderate regrowth	25	0%	288	0%
High regrowth	0	0	0	0
Total (low–high regrowth)	3,580	25%	17,381	74%
Total	14,070	100%	23,442	100%

NDVI analysis revealed a stark contrast in recovery: only 25% of burned land in Eaton showed low to moderate regrowth, whereas 74% of burned land in Palisades showed vegetation rebound. Most of Eaton's area showed no significant change. No areas in either fire demonstrated high regrowth.

V. DISCUSSION

The difference in regrowth may be attributed to environmental and topographic variation between the two regions. The Palisades Fire may have burned in areas with higher native vegetation resilience or better postfire precipitation. On the other hand, the Eaton Fire may have burned hotter or in areas already stressed by drought.

dNBR and dNDVI indices, while effective for rapid assessment, are limited by Landsat's 30-meter spatial resolution, which can miss fine-scale changes. Moreover, we conducted no field validation, so spectral interpretations may not fully reflect on-the-ground conditions.

VI. CONCLUSION

This study demonstrates that such remote sensing indices as dNBR and dNDVI can help evaluate wildfire impact and vegetation recovery. While both the Eaton and Palisades Fires had similar severity patterns, their regrowth trajectories differed significantly. These findings offer an important guide for land restoration strategies and for enhancing postfire decision-making frameworks in fire-prone regions.

Future work could incorporate higher resolution imagery, field validation, 1-year revisits, and such climatic variables as rainfall or soil moisture to improve regrowth predictions.

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