Using Remote-Sensing Imagery to Measure Burn Severity in of The Dixie Fire, California

Grace Conway

Department of Earth and Environmental Sciences, SUNY Potsdam

Introduction

Remote sensing is the technique of detecting physical characteristics of an area by measuring reflected electromagnetic radiation at a distance. Mapping forest fires is one of the several remote sensing applications that can be used to facilitate prediction and effective management of fires. The Dixie Fire began beneath a power line in the Feather River Canyon in California on July 13, 2021. It burned 963,309 acres before it was contained on October 25, 2021. The fire is responsible for the destruction of 1,300+ structures and the death of 1 firefighter. 2021 was the hottest summer recorded in California, and megadrought conditions of high temperatures and low precipitation contributed to the size and intensity of the Dixie Fire.

Objectives

How can remote sensing imagery be used to analyze burn severity levels after the Dixie Fire in Northern California?

Method

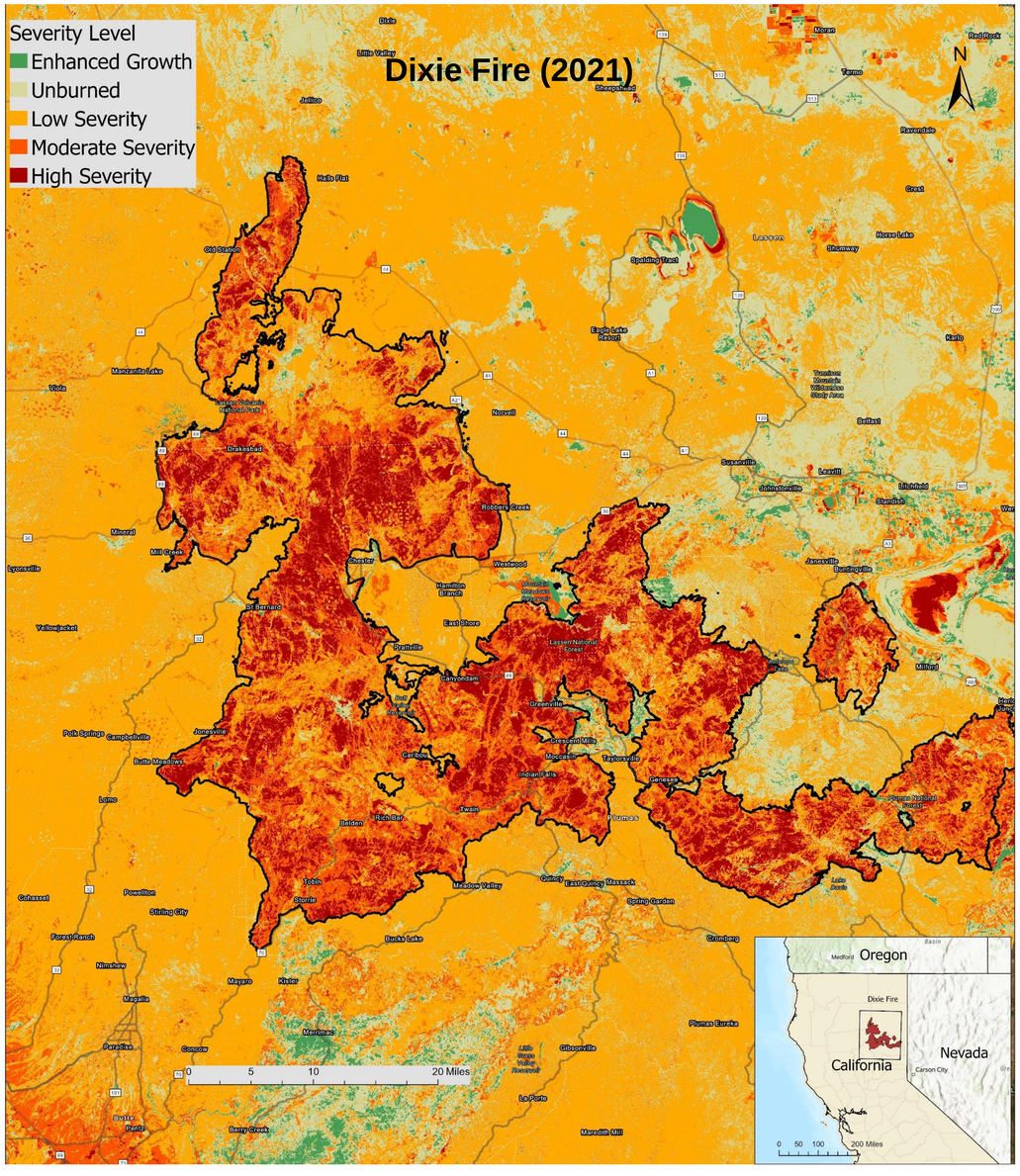
To identify burn severity in the Dixie Fire, I calculated Normalized Burn Ratio (NBR) in ArcGIS Pro. First, I downloaded cloud-free Landsat 8 images of the fire affected area in California right before the fire started (2021/07/11) and after one year of fire (2022/07/14). Among the several bands of Landsat 8, I used band 4 (Near Infrared- NIR) and band 7 (Shortwave Infrared - SWIR) to calculate NBR. Areas with high vegetation strongly reflect NIR portion of the electromagnetic spectrum whereas burned areas reflect strongly in SWIR portion. This difference in the reflective properties can be used to calculate NBR for the pre- and post-fire images:

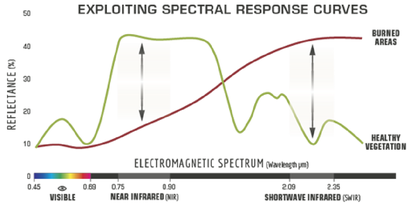
$$NBR = \frac{NIR - SWIR}{NIR + SWIR}$$

To identify the burn severity, I used the following formula:

$$dNBR = Prefire\ NBR - Postfire\ NBR$$

The results of this formula shows the areas of change from pre-fire to post-fire images. I then reclassified dNBR values into five categories of burn severity: enhanced growth, unburned, low severity, moderate severity, and high severity.






©Wall Street Journal


©Los Angeles Times

Table 1: Areas within Dixie Fire Perimeter Corresponding to Burn Severity Levels

Severity Level	Area (Acres)	% of Total
Enhanced Regrowth	3,022.57	0.31
Unburned	37,973.89	3.94
Low Severity	271,700	28.2
Moderate Severity	383,604.30	39.82
High Severity	267,124.70	27.73
Total	963,425.40	100.00

Results and Discussion

The Dixie fire burnt a total of 963,309 between July and October 2021. After a year of the fire, a very small proportion (0.31%) the burned area is growing back (Table 1). Unburned areas (3.94%) include areas with forests and water within the Dixie fire perimeter. More than a quarter of the area (271,700 acres) experienced the low severity burn whereas almost 40% of the area experienced with moderate severity which comprises the highest category of burn severity. The fire also burned 267,124.70 acres at high severity which means that more than ¼ of the fire in Northern California burned at the highest level of intensity. A total of 650,729 acres burned at the two most severe levels, representing 67.55% of all area burned. When compared to the level of regrowth at 0.31% or to the unburned portion at 3.94%, the scarred forest from the Dixie Fire is easily identifiable. Overall, the area experienced high intensity of burns where the vegetation may take multiple years to grow back.

Conclusion

Remote sensing techniques allows us to calculate spectral indices such as dNBR that can be used to analyze change in vegetation health or identify burn scars after a forest fire. Most of the burned areas experienced either moderate or high burn severity. The burned areas may take a long time to recover as evidenced by a very little regrowth after the year of fire. This causal factors for the high severity and large-scale burns could be the elongated drought season in California, high temperatures, and the accumulation of forest fuels over time. Remote sensing is an important tool to analyze the impact of fires over time and identify the fire affected areas that can eventually help in facilitating better management and conservation of forests.

References

(1) U.S Geological Survey (https://www.usgs.gov/)
(2) Dixie Fire- National Park Service (https://www.nps.gov/lavo/learn/nature/dixie-fire.htm)
(3) Difference Normalized Burn Index- Earth Lab (https://www.earthdatascience.org)