

Mapping Forest Burn Severity Using Non Anniversary Date Satellite Images

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Overview

- Wildfires
- Remote Sensing
- Burn Severity Mapping
- Study Area
- NBRI
- Comparisons
- Conclusions

Wildfires

- Part of the natural system
 - Allows for new growth
 - Clears dense stands of over-vegetation
 - Clears ground litter
- Can also cause damage to private and public property
 - Homes, utility poles, etc.
- Largely beneficial to the environment

Fires In The United States

- Approximately 26,042 fires reported yearly¹
- 925,170 acres burned by forest fires yearly¹
- 290 million metric tons of CO₂ a year²
- Cost
 - Suppression
 - Direct Costs (property damage, loss of revenue)
 - Rehabilitation
 - Indirect Costs (tax loss, property depreciation)
- Can Range from thousands to billions of dollars³

1. www.nifc.gov/fire_info/nfn.htm

2. www.livescience.com/1981-wildfires-release-cars.html

3. www.wflccenter.org/news_pdf/324_pdf.pdf

Fires We Remember

- Yellowstone 1988¹
 - 25,000 firefighters
 - Cost \$120 million
 - 67 structures burned
 - 1.2 million acres scorched
 - 793,000 acres burned



Burn Severity

- Areas burned are classified into 3 groups
 - Severe (vegetation completely burned)
 - Moderate (vegetation burned in small patches)
 - Low or Unburned (burning minor ground fuels)
- Used to assess overall damage and loss
 - Continued monitoring for regeneration/re-growth
- Collecting this information on the ground
 - Expensive, time-consuming, personnel

Remote Sensing

- Using satellite images to create an image of an area
- Advantages
 - Requires less field work
 - Easier monitoring for extended periods of time

Landsat

- Data/images collected from satellites are used for monitoring
- Landsat is a US civilian remote sensing satellite
 - Collects data in 6 spectral bands
 - Bands 4 and 7 or indices such as NBRI* are used in fire mapping applications

*Normalized burn ratio index

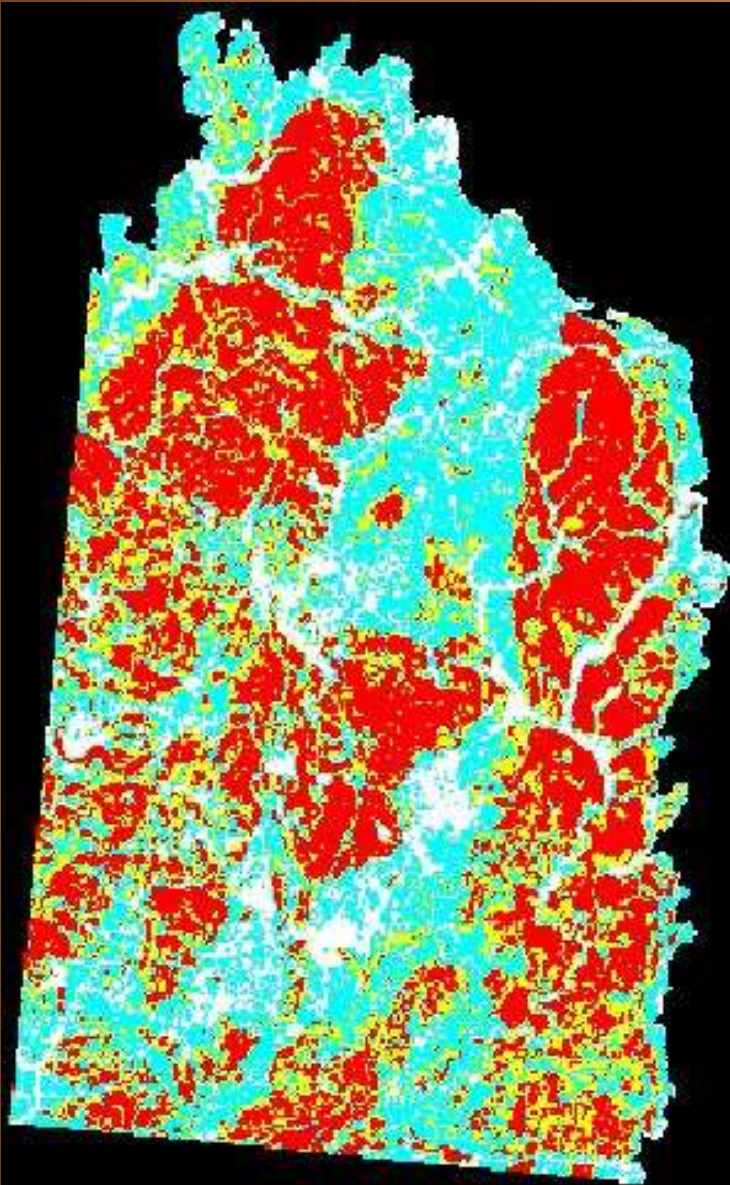
Introduction to Burn Severity Mapping

- Used by land agencies like
 - USFS, BLM, NRCS
- Start with a raw image and convert it into an NBRI image
 - Recode into a Delta-NBRI image
 - Re-classify value ranges and re-color to make a burn severity map
- USFS uses anniversary date images for comparison

USFS Burn Severity Maps

- Anniversary date pre- and post- fire images
 - Images from same month but different years
- Advantage
 - Eliminates difference in vegetation cycles
- Disadvantages
 - Several years between images
 - Vegetation regrowth post fire

USFS Burn Severity Map



- June 5, 2001
- Area (hectares)
 - Severe: 7722
 - Moderate: 4601
 - Low: 7023
 - Bare ground: 3446
 - (includes vegetation)

Objectives of This Research

- Compare burn severity map derived from an image acquired immediately after the fire
 - Advantage
 - Very close in time after the fire
 - Disadvantage
 - Difference in vegetation cycles might affect reflectance values

Study Area

- Jasper fire
- NE Wyoming
- Ignited: Aug 24th 2000
 - Arson
- 83,508 acres
- Image: Sept 5th 2000
 - 90% total containment



Raw Image (Landsat)

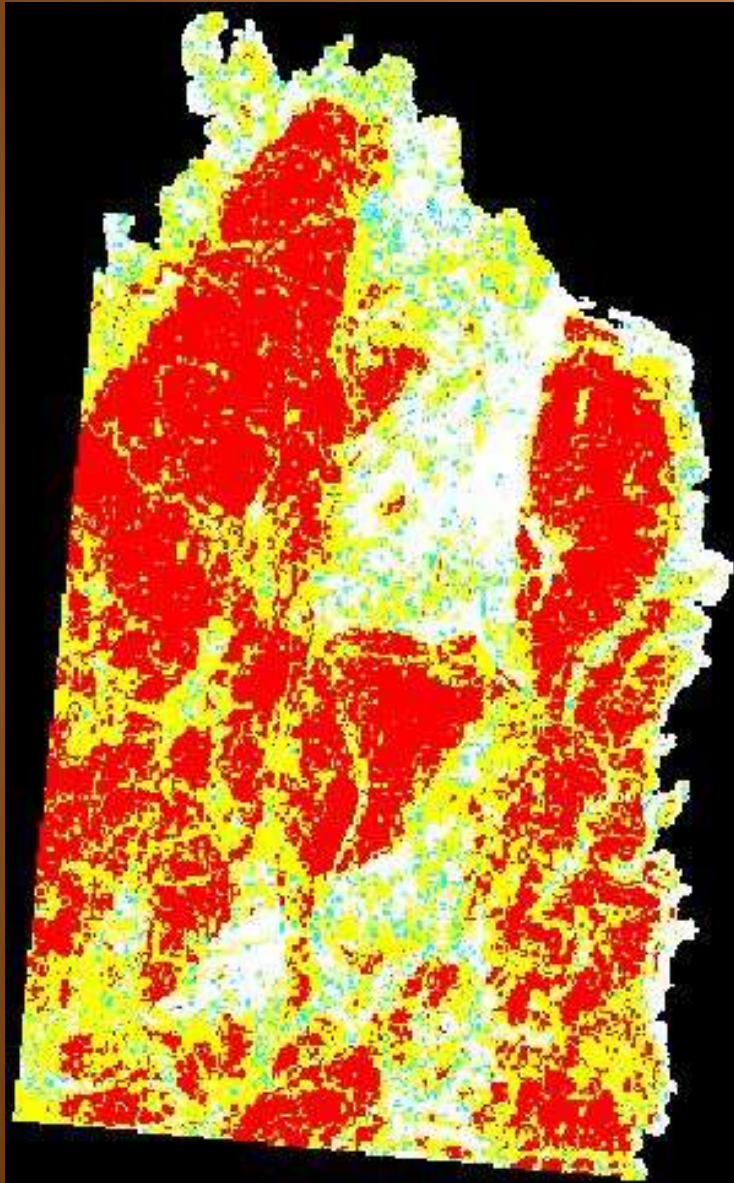
NBRI Computation

- Computed NBRI for post-fire image
 - $(\text{Band 4} - \text{Band 7}) / (\text{Band 4} + \text{Band 7})$
 - Ranges from -1 to +1
- Negative NBRI values indicate different degrees of burn
 - Values closer to -1 indicate severe burn
- Positive NBRI values indicate no burn

Categorizing Burned Areas

- Visually compared locations in the raw image and obtained their NBRI values
 - Personal monitoring/involvement
- Determined ranges of NBRI values
 - Severe: $>-0.730 - \leq -0.500$
 - Moderate: $>-0.500 - \leq -0.233$
 - Low: $>-0.233 - \leq -0.192$
 - Unburned and no-burn: $>-0.192 - \leq 1.000$

Burn Severity Map



- Area (hectares)
 - Severe: 9215
 - Moderate: 8057
 - Low: 952
 - Bare ground: 4567
 - (includes vegetation)

Area Comparison

- Post-fire
- Sept 5, 2000
- Area (hectares)
 - Severe: 9215
 - Moderate: 8057
 - Low: 952
 - Bare ground: 4567
 - Total: 22791
- Post-fire USFS Subset
- June 5, 2001
- Area (hectares)
 - Severe: 7722
 - Moderate: 4601
 - Low: 7023
 - Bare ground: 3446
 - Total: 22793

Sources of Difference: Severe

	Immediate after fire (Sept 2000)	USFS map (June 2001)
	1500 hectares more	
Riparian areas were classified as:	High burn	No- or low-burn

- Could be due to the deciduous trees in the riparian zone
 - Quaking aspen are found in the riparian zones
 - Also in the low elevation areas with abundant water sources
- Damage to aspen leaves from the wildfire
 - Also less reflectance in fall (Sept 2000 image)
- Potential re-growth in spring (USFS map) is possible

Sources of Difference: Moderate to Low

	Immediate after fire (Sept 2000)	USFS map (June 2001)
	3464 ha more	
Possible spring vegetation classified as:	High Burn & Bare ground	Moderate to Low

- Could be due to vegetation re-growth in spring
 - Shrubs and invasive species
 - Chokecherry and thistles
- Most vegetation is lush in USFS map

Sources of Difference: Low

	Immediate after fire (Sept 2000)	USFS map (June 2001)
		6071 hectares more
Possible spring vegetation classified as:	High Burn or no-burn	Low

- Could be attributed to re-growth of native grasses and native range vegetation
 - Western wheat, crested wheat, other native species

Conclusion

- Both images are providing different but useful information
 - Images acquired immediately after the fire
 - Not affected by vegetation re-growth
 - Over estimate areas of severe burn
- Both images can be used for monitoring
 - One shows damage immediately after the fire
 - Second one shows where vegetation is not regenerating (potential long-term damage)

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