Remote sensing for assessing fire severity and combustion completeness in SoCal and AZ

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What is ‘severity’ and why measure it?

SEVERITY: degree of environmental change caused by a fire

Usefulness of fire severity data?

1) Planning of post-fire management (erosion control, rehabilitation)  
2) Improving emission estimates

Emission = Area × Mass × Combustion factor × Emission factor

Could be refined by fire severity data
RS solution for fire severity so far?
the Normalized Burn Ratio (NBR)

\[ NBR = \frac{NIR - SWIR}{NIR + SWIR} \]

\[ dNBR = NBR_{pre} - NBR_{post} \]
Criticism on the (d)NBR

1) Insensitivity to unburned pixels
2) Saturation at GeoCBI > 2.5
3) High dispersion of point cloud

Sub-optimal index design

Sensitive to soil brightness variations
Criticism on the (d)NBR (part 2)

Sensitive to illumination effects and phenological mismatch

Seasonal and topographic effects on estimating fire severity from Landsat TM/ETM+ data

David L. Verbyla\textsuperscript{a,c}, Eric S. Kasischke\textsuperscript{b} and Elizabeth E. Hoy\textsuperscript{b}

The dNBR does not account for pre-fire landscape heterogeneity

Results might be site-specific

What is the physical meaning of a (d)NBR value??
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Research overview

- An alternative spectral index for rapid fire severity assessments

- Evaluating spectral indices and SMA for assessing fire severity

- Synergizing VSWIR and MTIR data for post-fire assessments

- Estimating combustion completeness and carbon emissions by combining remote sensing and modeling
An alternative spectral index for rapid fire severity assessments

MASTER data over large 2011 Wallow fire, AZ

Impeded by smoke

Spectroscopy data

Fire severity data

A. GeoCBI = 0.85
B. GeoCBI = 1.95
C. GeoCBI = 3

Spectral indices

\[ NBR = \frac{NIR - LSWIR}{NIR + LSWIR} \]
\[ dNBR = NBR_{pre} - NBR_{post} \]
\[ RdNBR = \frac{dNBR}{\sqrt{\text{abs}(NBR_{pre})}} \]
\[ SMI = \frac{SSWIR - MIR}{SSWIR + MIR} \]
An alternative spectral index for rapid fire severity assessments

SMI has similar performance as dNBR, but is mono-temporal and not impeded by smoke
Evaluating spectral indices and SMA for assessing fire severity

Landsat imagery over large 2011 Wallow fire, AZ

Spectroscopy data

Fire severity data
Evaluating spectral indices and SMA for assessing fire severity

dNBR performs slightly better than the char fraction estimated by SMA, but the SMA provides a more ‘useful’ quantitative assessment
Synergizing VSWIR and MTIR data for post-fire assessments

Spectroscopy data

Fire severity data

MASTER data over Canyon fire, CA
Synergizing VSWIR and MTIR data for post-fire assessments

<table>
<thead>
<tr>
<th>Spectral region</th>
<th>R²</th>
<th>a</th>
<th>b</th>
<th>R²</th>
<th>a</th>
<th>b</th>
<th>R²</th>
<th>a</th>
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<tr>
<td>VSWIR</td>
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Discrimination between ground covers in post-fire environments is better with VSWIR data than with MTIR data, but their synergy yields the best results.
Estimating combustion completeness and carbon emissions by combining remote sensing and modeling.
Estimating combustion completeness and carbon emissions by combining remote sensing and modeling

<table>
<thead>
<tr>
<th>Fire</th>
<th>FCCS Code</th>
<th>n</th>
<th>GeoCBI = a + b × CC</th>
<th>% black = a + b × CC</th>
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</table>

Combined use of RS and modeling has potential for estimating CC

Significant differences in emission estimates whether or not within-burn heterogeneity is incorporated
Related publications


What’s next?

Landsat archive for SoCal 1985-2011

Analyzing spatio-temporal patterns of burned area, fire severity and carbon emissions

Analyzing the significance of Santa events versus ‘regular’ fires