Potential of HyspIRI for post-fire assessments

Sander Veraverbeke, S. Harris, G. Hulley and S. Hook (JPL)
Some terminology

SEVERITY: degree of environmental change caused by a fire

FIRE SEVERITY
direct impact

BURN SEVERITY
direct impact &
regeneration

ECOSYSTEM RESPONSES
regeneration

Importance

Trace gas emission estimates and carbon sequestration → Earth’s carbon budget

Post-fire management (erosion prevention, rehabilitation)

Are they changing?
Airborne MASTER

As a surrogate to study HyspIRI’s potential...

<table>
<thead>
<tr>
<th>MASTER</th>
<th>HyspIRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 VNIR bands</td>
<td>Hyperspectral</td>
</tr>
<tr>
<td>14 SWIR bands</td>
<td>VSWIR</td>
</tr>
<tr>
<td>15 MIR bands</td>
<td>8 MTIR bands</td>
</tr>
<tr>
<td>10 TIR bands</td>
<td></td>
</tr>
<tr>
<td>5-50 m pixel size</td>
<td>60 m pixel size</td>
</tr>
</tbody>
</table>
Application 1: Burned area mapping

Whole bunch of indices currently in use, most of them relying on the VSWIR region

e.g. NDVI, NBR, BAI, SAVI, etc.

Which indices are the best to map burned areas?

And what could the MIR-TIR regions add?

Spectral separability measured by:

\[ M = \frac{\mu_B - \mu_N}{\sigma_B - \sigma_N} \]

The higher M, the better

Application 1: Burned area mapping
Application 1: Burned area mapping

Potential of MIR and TIR data in synergy with the traditionally used NIR and SWIR regions

Slightly better results than NBR

Tough currently unavailable on moderate resolution spaceborne sensors

HyspIRI will meet the requirements
Application 2: Fire severity

Traditionally assessed with Landsat dNBR

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

Caveats
- bi-temporal differencing requires image-to-image normalization
- rapid assessments over active fires impeded as the NIR band is affected by smoke

MASTER imagery over the active Wallow fire, AZ
Application 2: Fire severity

We want maximal discrimination between fire-related and non-fire related terrain features. Does NBR do so?

An alternative index, unimpeded by smoke, the SWIR-MIR index:

\[
SMI = \frac{SSWIR - MIR}{SSWIR + MIR}
\]

<table>
<thead>
<tr>
<th></th>
<th>NIR</th>
<th>SSWIR</th>
<th>LSWIR</th>
<th>MIR</th>
<th>NBR</th>
<th>SMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Char</td>
<td>0.107</td>
<td>0.235</td>
<td>0.316</td>
<td>0.241</td>
<td>-0.494</td>
<td>-0.013</td>
</tr>
<tr>
<td>Green vegetation</td>
<td>0.517</td>
<td>0.225</td>
<td>0.124</td>
<td>0.012</td>
<td>0.612</td>
<td>0.899</td>
</tr>
<tr>
<td>Non-photosynthetic vegetation</td>
<td>0.577</td>
<td>0.595</td>
<td>0.453</td>
<td>0.122</td>
<td>0.120</td>
<td>0.660</td>
</tr>
<tr>
<td>Soil</td>
<td>0.501</td>
<td>0.610</td>
<td>0.494</td>
<td>0.139</td>
<td>0.007</td>
<td>0.629</td>
</tr>
</tbody>
</table>
Application 2: Fire severity

SMI

SMI-approach

BARC-approach

<table>
<thead>
<tr>
<th>SMI approach</th>
<th>Unburned</th>
<th>Low FS</th>
<th>Moderate FS</th>
<th>High FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMI-approach</td>
<td>0.54</td>
<td>0.03</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>BARC-approach</td>
<td>0.08</td>
<td>0.08</td>
<td>0.03</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Total agreement: 0.68
Kappa coefficient: 0.43
Application 2: Fire severity

Benefits of SMI:
- not impeded by smoke
- mono-temporal

Allows timely assessments

Further testing required (field data, different ecosystems)

Tough currently unavailable on moderate resolution spaceborne sensors

HyspIRI will fill the gap
Summary

Current post-fire effects rely heavily on the VSWIR region, especially NBR.

MIR and TIR data can add valuable information.

Tough the VSWIR-MIR-TIR combination is current not available in moderate resolution (< 100 m).

The VSWIR-MTIR synergy will be available on HyspIRI.
WILDFIRE MOVES QUICKER THAN YOU THINK