Introduction

- Burned landscapes present difficult hydrologic forecasting challenges for National Weather Service Offices
- Burned soils and landscapes can be conducive to the development of flash flooding and landslides from heavy precipitation events (Ramsmeier and Arrowsmith 2001)
- The severity of the burn scar can be directly related to the risk for debris flows (Cannon and DeGraff 2009) and flash flooding (Lewis et al. 2006)
- Burned Area Reflectance Classification (BARC) map is generated to indicate the degree of burn severity, which is generated initially by high-resolution satellite imagery from sources such as Landsat, and later by labor-intensive efforts conducted at the burn scar by Burned Area Emergency Response (BAER) teams
- The challenge for operational meteorologists is that these sources of information are not readily available in near real-time

NBR imagery also has low reflectance, while healthy vegetation has high reflectance.

A couple of examples:
- Healthy Vegetation...
  - 0.86 = 38%
  - 2.25 = 15%
- Burned Vegetation...
  - 0.86 = 18%
  - 2.25 = 32%

\[
\text{NBR} = \frac{(0.86-18\%)}{(18+32\%)} = 0.28
\]

- The change in pre-fire and post fire NBR is known as dNBR

\[\text{dNBR} = \text{Prefire NBR} - \text{Postfire NBR}\]

- dNBR is used to assess burn severity and vegetation regrowth
- Prefire imagery will have very high near infrared band values and very low mid infrared band values
- Postfire imagery will have very low near infrared band values and very high mid infrared band values
- It can be difficult to distinguish between burned and non-vegetated areas in dNBR imagery


dNBR = Prefire NBR – Postfire NBR

GOES-16/17 NBR imagery available first, minutes to hours (clouds permitting)

<table>
<thead>
<tr>
<th>NBR Value</th>
<th>Burn Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; -0.25</td>
<td>High post-fire regrowth</td>
</tr>
<tr>
<td>-0.25 to -0.1</td>
<td>Low post-fire regrowth</td>
</tr>
<tr>
<td>-0.1 to 0.1</td>
<td>Unburned</td>
</tr>
<tr>
<td>0.1 to 0.27</td>
<td>Low-severity burn</td>
</tr>
<tr>
<td>0.27 to 0.44</td>
<td>Moderate-low severity burn</td>
</tr>
<tr>
<td>0.44 to 0.66</td>
<td>Moderate-high severity burn</td>
</tr>
<tr>
<td>&gt; 0.66</td>
<td>High-severity burn</td>
</tr>
</tbody>
</table>

Conclusions

- Developed a process in collaboration with NWS to assess burn scar severity with new generation satellites in the near stages of fire development and growth
- Limited feedback due to lack of fires in initial test WFO (ABO), but future users in ABO and APRFC have provided feedback that data are sufficient to aid in decision-making

Woodbury Fire in Arizona June-July 2019

In the GOES-17 NBR images above, notice the spread of the burn scar from 17 June to 27 June. Burn scar severity in SW portion of the Woodbury Fire remains fairly stable through the period, but the scar has spread due to the ongoing fire and the worst burn severity developed after 17 June. The fire perimeter is also shown for this fire (right) as of 27 June 2019. False NBR returns can be seen along Theodore Roosevelt Lake to the north of the Woodbury Fire. However, other burn scar can be seen in the imagery on the 27 June image (right).

In this comparison between GOES-17 NBR imagery (left) and S-NPP NBR imagery (right), notice the higher spatial resolution of the S-NPP imagery. Also, issues with false returns, such as those along Theodore Roosevelt Lake to the north of the Woodbury Fire do not occur in the S-NPP imagery as the case with GOES imagery. However, GOES imagery has the advantage of higher temporal resolution (every 5 min), vs the S-NPP imagery, which will only generally be available once per day at any given location (clouds permitting).

Timeline of Analysis for Burn Scar Severity

- GOES-16/17 NBR Image above indicates burned areas in bright yellow-reds (S-NPP NBR and/or dNBR imagery)
- GOES-17 NBR image with visible (0.64 µm) imagery overlays provides context for clouds and smoke, and makes the imagery appear more intuitive. Notice that smoke can be observed from the ongoing fire. The visible imagery is set to partial transparency (75%).

Next Steps

- Continued testing with and feedback from NWS Western Region HQ and Albuquerque Forecast Office, planned discussions this fall
- Employ NPP bands in AWIPS, information about the burned vegetation can be observed in near real-time
- Low values (bright yellow-orange-red) indicate burned vegetation severity, colors shifted to red with increased negative difference in NIR and SWIR
- High values (light green-dark green) indicate healthy vegetation, colors shifted to darker green with increased positive difference in NIR and SWIR
- Ongoing fires will generally show up as red to dark brown colors due to higher emissions in the 2.2 µm band
- Detecting active fires requires information from near-infrared (~2.2 µm)/(0.86 um + 2.2 um) imagery (e.g., Landsat, MODIS, and VIIRS)

References

- Lewis, C. and Voss, S. (2016). Suomi-NPP VIIRS imagery is set to partial transparency (75%).
- National Weather Service Huntsville, AL
- Jacobs ESQA
- National Weather Service Albuquerque, NM