Texas Disasters II

Utilizing NASA Earth Observations to Assist the Texas Forest Service in Mapping and Analyzing Fuel Loads and Phenology in Texas Grasslands

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Objective

Assist the Texas Forest Service in **Mapping** and **Analyzing** Fuel Loads and Phenology in Texas Grasslands
Study Area

Study Period

January 2000 - November 2015

Background image: MODIS false color composite 6/17/14
Partners

Texas Forest Service

USDA Forest Service

Image Credit: Texas Forest Service

Image Credit: USDA Forest Service
Environment
Texas vegetation are **highly susceptible** to wildfires. The risk of severe wildfires related to **weather phenomena** has increased due to climate change and recent development.

The combination of **El Nino** and **La Nina** events, which can lead to more intense fire seasons.

The **Texas Forest Service** is tasked with **evaluating** and **reducing** potential fire risk.
Background

Increased Biomass

Increased Fuel Loads
Background

- In 2011, 31,453 wildfires burned 4 million acres & destroyed 2,947 homes
- 80% of wildfires occur within 2 miles development areas
- Six of the 10 largest documented wildfires in state history occurred in April 2011
NASA Satellites/Sensors

AQUA MODIS

TERRA MODIS

Landsat 8 OLI
**NDVI**

**Normalized Difference Vegetation Index**

\[ \text{NDVI} = \frac{\text{NIR} - \text{Red}}{\text{NIR} + \text{Red}} \]

Measure **plant productivity** based on greenness of vegetation

\[ \frac{(0.50 - 0.08)}{(0.50 + 0.08)} = 0.72 \]
\[ \frac{(0.4 - 0.30)}{(0.4 + 0.30)} = 0.14 \]
NDVI

Maximum Vegetation Index Value

Left 80% Max

Left 20% Max

Left Minimum

Spring
Growing Season
Fall

Right 80% Max

Right 20% Max

Right Minimum

Images Credit: Steve Norman, USFS ForWarn
Methodology

Precipitation

What precipitation conditions create hazardous wildfire conditions?

Phenology

What phenological parameters do different areas have in common?

Soils

Do soil types drive the swings in phenology?
Methodology

Climatology

Average Precipitation – 28-40 in/year

2010 – 4 inches above normal
2011 – 10 inches below normal
Methodology

Phenology

- NDVI and DOY averaged for study period
- Median filter applied to DOY
Methodology

Phenology

Parameters from each year were compared to the mean.
Methodology

Phenology

Parameters from each year were compared to the mean.
Methodology

Phenology

Parameters from each year were compared to subsequent years.
Methodology
Phenology – Large Integral NDVI

2001

2002

2003

2004

2005

2006

2007

2008

2009

2010

2011

2012

2013

2014
Landsat and MODIS land cover classification
Methodology
Classification

High-Risk Vegetation Classes

- Young
- Jack
- Wise
- Stephens
- Paleo Pinto
- Parker

High-Risk Vegetation classes
Methodology
Classification

High-Risk Vegetation Classes

- Young
- Jack
- Wise
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High-Risk Vegetation classes
Methodology
Classification

High-Risk Vegetation Classes

[Map showing high-risk vegetation classes across different regions]

- Young
- Jack
- Wise
- Stephens
- Palo Pinto
- Parker

High-Risk Vegetation classes
Methodology

Classification

High-Risk Vegetation Classes

- Young
- Jack
- Wise
- Stephens
- Pale Pinto
- Parker

High-Risk Vegetation classes
Methodology

Classification

High Risk Area

High-Risk Vegetation classes
Methodology

Classification

High Risk Area

Possum Kingdom Complex Fire, 2011
High-Risk Vegetation classes
Methodology

Climatology

Average Precipitation – 28-40 in/year
2010 – 4 inches above normal
2011 – 10 inches below normal
NDVI

Season Max NDVI

Left 80% Max

Right 80% Max

Left 20% Max

Right 20% Max

Left Minimum

Right Minimum

Spring

Growing Season

Fall

Images Credit: Steve Norman, USFS ForWarn
Results

Selected phenology parameters for high-risk area

- NDVI values scaled by 10,000
- 2010 considerably more productive than mean
- 2011 considerably less productive than mean
Results

Selected phenology parameters for high-risk area

- Day of year values
- **2010** had a much longer growing season than mean
- **2011** had a much shorter growing season than mean
Results

Selected phenology parameters for high-risk area

Day of Year

<table>
<thead>
<tr>
<th>Year</th>
<th>Left 80%</th>
<th>Max</th>
<th>Right 20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>136</td>
<td>179</td>
<td>284</td>
</tr>
<tr>
<td>2011</td>
<td>129</td>
<td>177</td>
<td>321</td>
</tr>
</tbody>
</table>

NDVI Magnitude

<table>
<thead>
<tr>
<th>Year</th>
<th>Left 80%</th>
<th>Max</th>
<th>Right 20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>6,003</td>
<td>6,354</td>
<td>6,801</td>
</tr>
<tr>
<td>2011</td>
<td>5,081</td>
<td>5,281</td>
<td>4,930</td>
</tr>
</tbody>
</table>

Selected phenology parameters for high-risk area
Results

- If by mid-May the NDVI value has not reached close to 0.6 within the majority of the High-Risk Area, there is a greater risk of wildfires.
- If the previous year had a growing season near 200 days long combined with a max NDVI of 0.7, the fuel load may contribute to more severe wildfires.
Conclusion

- There is a high-risk area within the study area that has an enhanced phenological response to both wet and dry years relative to the surrounding area.
- This high risk may be driven more by soil type than climate (though the latter does contribute to risk).
- This area should experience greater risk for large, damaging wildfires given a La Nina climatic event after a previously lush year (e.g., 2011 versus 2010).
- As yearly climate swings grow more pronounced and growth continues in the area, this risk may escalate.
Limitations and Future Work

• Look at all points in the growing season “NDVI” curve
• Consider temperature on a monthly basis
• Timing of first freeze
• Look at current El Nino to assess wildfire risk and impacts of this climatic event
• Assess alternative MODIS/Landsat data fusion methods (e.g., STAR FM)
Acknowledgements

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References


• All images courtesy of NASA unless stated otherwise.
Questions?