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

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

Study Period

January 2000 - November 2015

Young County
Jack County
Wise County
Stevens County
Palo Pinto County
Parker County
Environment

Texas vegetation are **highly susceptible** to wildfires. The risk of severe wildfires related to **weather phenomena**

**Wildfire risk 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
In 2011, 31,453 wildfires burned 4 million acres & destroyed 2,947 homes.

80% of wildfires occur within 2 miles of development areas.

Six of the 10 largest documented wildfires in state history occurred in April 2011.
NDVI

Normalized Difference Vegetation Index

**NDVI = (NIR - Red)/(NIR + 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
Methodology

Landsat and MODIS land cover classification
Methodology

Classification

High-Risk Vegetation Classes

High-Risk Vegetation classes
Methodology
Classification

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 Vegetation Classes

- Young
- Jack
- Wise
- Stephens
- Palo 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
Methodology

Soils

Soil Type

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

Scale: 0 - 60 Miles
NDVI

Season Max

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
NDVI

Left 80% Max

Season Max NDVI

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></th>
<th>2010</th>
<th>2011</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left 80%</td>
<td>136</td>
<td>129</td>
<td>160</td>
</tr>
<tr>
<td>Max</td>
<td>179</td>
<td>177</td>
<td>184</td>
</tr>
<tr>
<td>Right 20%</td>
<td>284</td>
<td>235</td>
<td>321</td>
</tr>
</tbody>
</table>

**NDVI Magnitude**

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2011</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left 80%</td>
<td>6,003</td>
<td>6,354</td>
<td>6,801</td>
</tr>
<tr>
<td>Max</td>
<td>6,003</td>
<td>6,411</td>
<td>5,281</td>
</tr>
<tr>
<td>Right 20%</td>
<td>4,930</td>
<td>4,985</td>
<td>5,081</td>
</tr>
</tbody>
</table>
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

Advisors

Joseph Spruce, NASA Stennis Space Center
Dr. Kenton Ross, NASA Langley Research Center

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration.

This material is based upon work supported by NASA through contract NNL11AA00B and cooperative agreement NNX14AB60A.
Acknowledgements

Partners
Tom Spencer, Texas Forest Service
Curt Stripling, Texas Forest Service
Williams “Bill” Hargrove, USDA Forest Service

Others
Benjamin Beasley, NASA DEVELOP at Stennis Space Center
Alex Holland, NASA DEVELOP at Stennis Space Center
Kristen Kelehan, NASA DEVELOP at Stennis Space Center

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References

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