Smoke on the Water

Duh duh duhhhh....duh duh da DUHHHHH

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TOPIC:

Fires and Recovery on North Andros Island

Background

- Dry season: January-May
- Pineland habitat
- Cause of fires
  - Historically, lightning or human activity
  - Now, mainly humans
- On average, pineland swaths burn ever 1-2 years

Burn Severity Panoramas

Question:

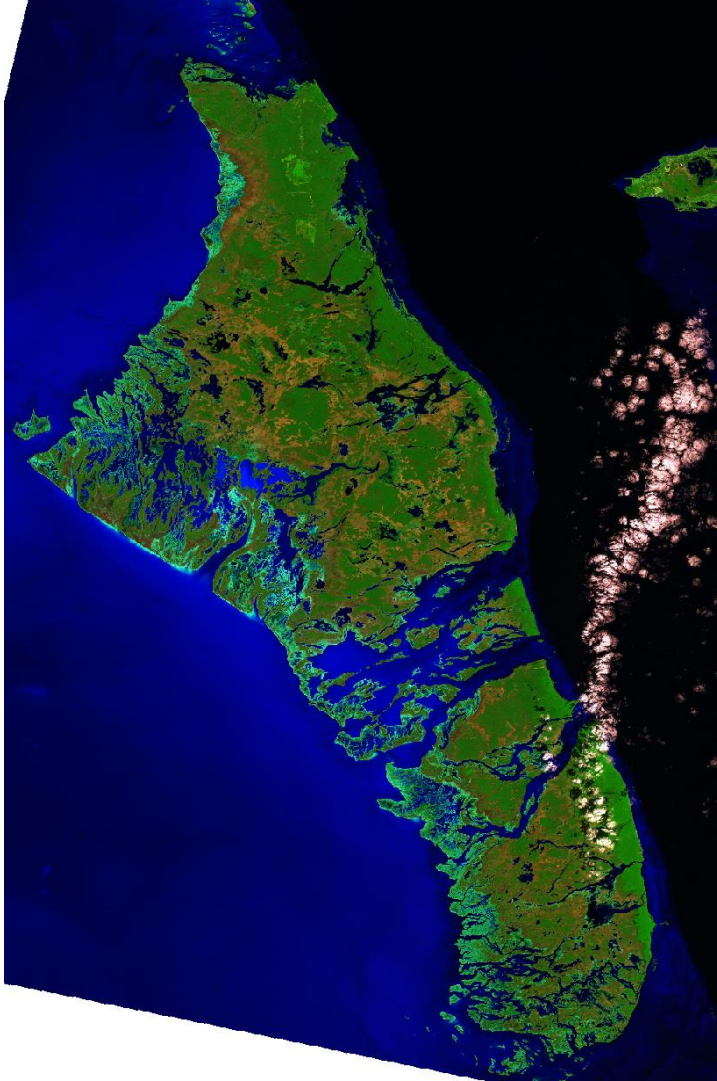
What determines recovery time for burned areas?

Possible Factors:

- Burn Severity
- Repeat Burns
- Burn Area Size

Hypothesis:

Recovery time will be longer for areas that were large, had more severe burns, and/or had additional burns before fully recovering.



Just(in)ification

- Purpose for studying fire, repeat burns, and recovery:
  - Land Management
    - Natural Regrowth Capabilities
    - Soil Erosion
  - Ecological Community Health
    - Degradation by Fire Regimes

Critically Endangered
Bahama Oriole

Data: Burn Areas

- Fire Information for Resource Management System (FIRMS) Fire Map
- MODIS Burned Area Product
  - Shapefiles
  - Rasters

Data: Imagery

- MOD13Q1 v006
  - MODIS/Terra Vegetation Indices 16-Day L3 Global 250 m SIN Grid
  - NDVI, EVI
  - NIR, MIR (2.105-2.155μm), Red, and Blue Surface Reflectance
  - Composite by view angle, cloud coverage, and/or highest EVI value

Methods: Identifying Burn Dates

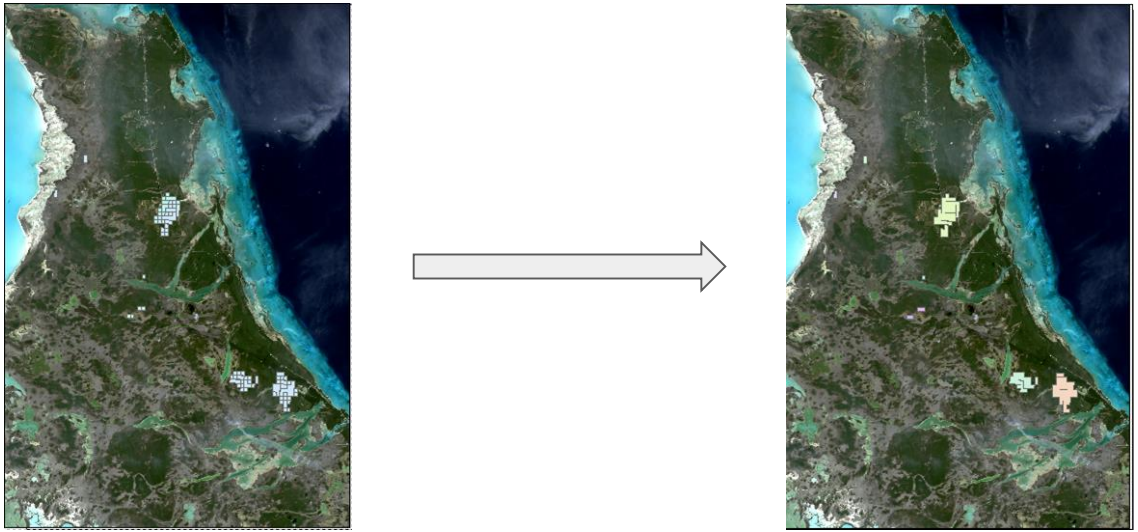
- Using FIRMS to narrow date range to Jan - Jun
- We only need MOD13Q1 and MODIS BA data from this range

Jan - Jun 2010

Jul - Dec 2010

Methods: Shapefile Creation

- Download MODIS Burn Date Shapefile
- Aggregate to Monthly Burn Area



Methods: Equations

- Calculating NBR from MODIS Bands

$$NBR = \frac{(NIR - MIR)}{(NIR + MIR)}$$

- Severity Calculations

$$dNBR = NBR_{pre-fire} - NBR_{post-fire}$$

$$dEVI = EVI_{pre-fire} - EVI_{post-fire}$$

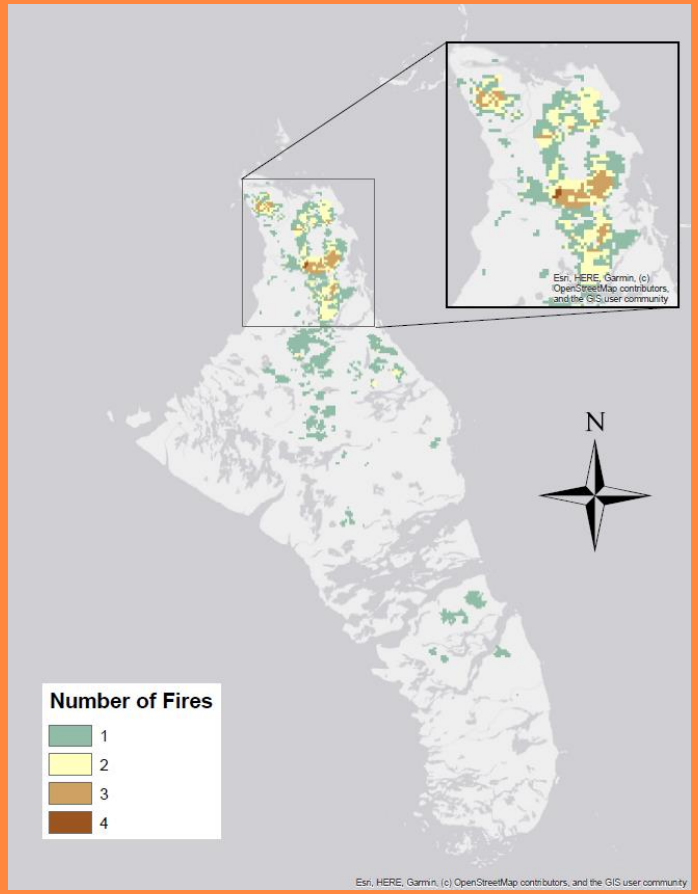
- Recovery Calculations

$$RI_{NBR} = \frac{Mean\ NBR}{Mean\ NBR_{pre-fire}} \qquad RI_{EVI} = \frac{Mean\ EVI}{Mean\ EVI_{pre-fire}}$$

Methods: Image Extraction

- Use first image dated after latest burn pixel
- Create Rasters: NBR, dNBR, dEVI
- Values for Burn Areas: Mean value of pixels under burn polygon
- Calculate Repeat Burns from number of times a pixel in the burn area has burned since initial burn
- Burn Area considered recovered when RI > 0.95

Repeat Burns from 2010 to 2019

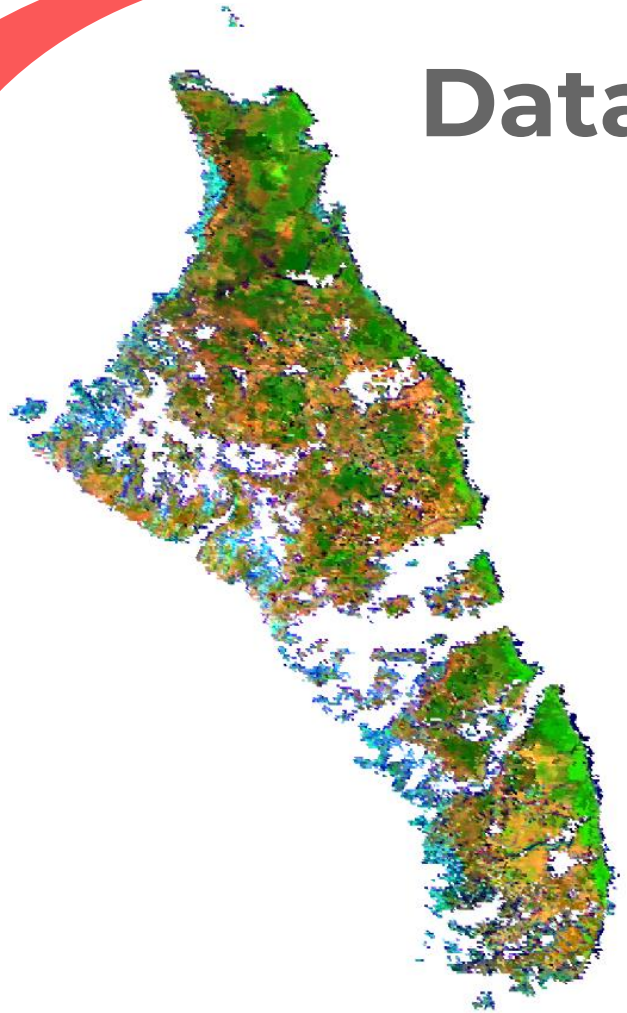


Extract Maximum, Subtract One

Results

Burn Date	dNBR	dEVI	Size (m^2)	Repeat Burns prior to EVI Recovery	Years Until EVI Recovery	Repeat Burns prior to NBR Recovery	Years Until NBR Recovery
2010091	0.1098	0.027	431,875	0	1	0	0
2010092	0.5066	-0.09	432,011	0	0	0	4
2010113	0.2068	0.1681	8,438,455	0	5	0	2
2010086	0.0871	0.1645	9,289,586	0	2	0	2
2010046	NA	NA	431,276	NA	NA	NA	NA
2010040	0.1162	0.0624	432,440	0	1	0	1
2010120	0.3346	0.1527	5,192,489	0	2	0	3
2010010	-0.1334	-0.0057	432,470	0	0	0	0
2010057	NA	NA	216,160	NA	NA	NA	NA
2009097	0.3007	0.1255	12,824,475	0	2	0	6
2009097	0.6027	0.0512	217,398	0	2	0	5
2009067	0.2406	0.1473	20,299,239	0	1	0	1
2009073	0.1741	0.0907	12,519,059	0	1	0	1
2009077	0.175	0.0859	6,692,586	0	1	1	2
2009079	0.2778	0.134	432,560	0	3	0	3
2009082	0.2645	0.1997	648,660	1	7	0	3

Data Problems



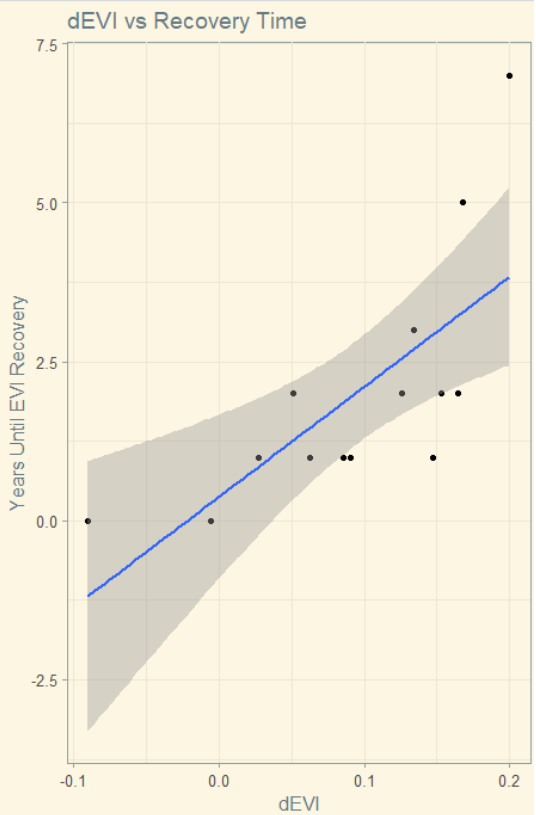
- Pixel Resolution
- Other Areas of Missing Data

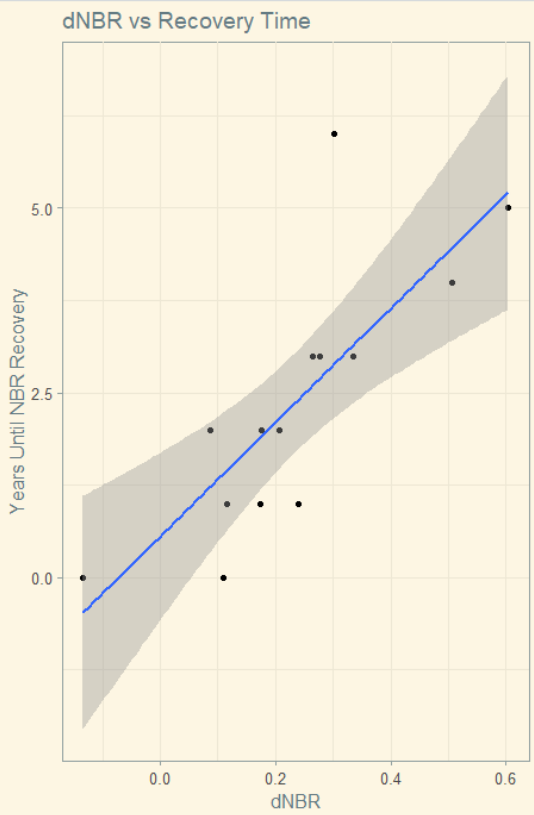
Predictor Problems

- For either metric, only one burn area had a repeat burn
- We had no ground truth data
  - To measure recovery, we used a ratio of VIs
  - To measure severity, we used a difference of VIs
- Predictors need to be independent of the response

Difference VI and Recovery

The Strength of this Relationship is Self-Explanatory





Significance of Burn Size

- We know our Recovery measure is not independent of our Severity measure
- This gives us a reasonable framework to determine if Size is a significant factor in determining recovery with EVI or NBR

ANOVA Tables

```
Model 1: Recovery_Time_EVI ~ dEVI
Model 2: Recovery_Time_EVI ~ dEVI + Size
Model 3: Recovery_Time_EVI ~ dEVI + Size + dNBR
```

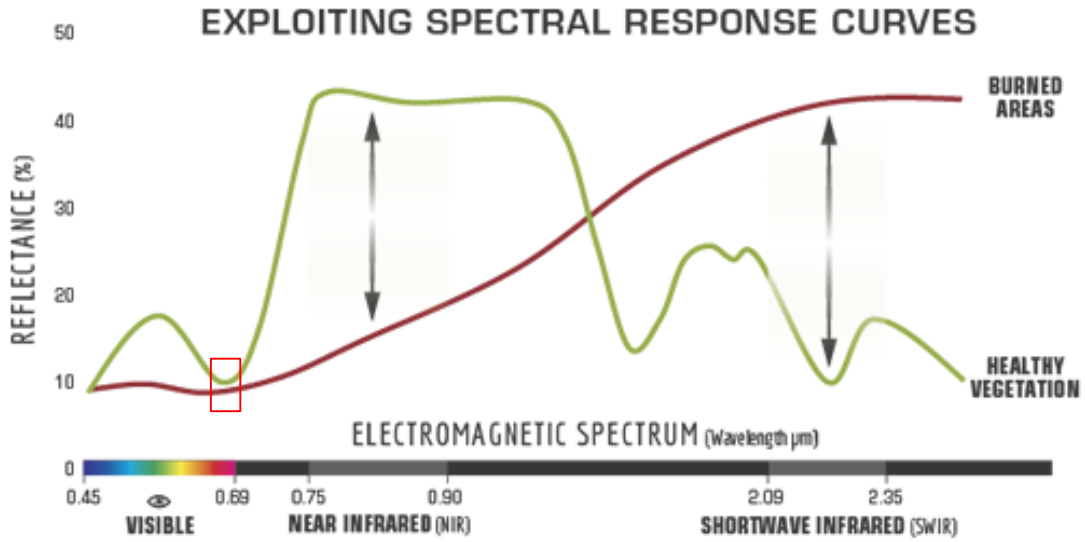
	Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)
1	12	23.498				
2	11	14.008	1	9.4896	7.4485	0.02588
3	10	12.336	1	1.6718	1.3552	0.27139

```
Model 1: Recovery_Time_NBR ~ dNBR
Model 2: Recovery_Time_NBR ~ dNBR + Size
Model 3: Recovery_Time_NBR ~ dNBR + Size + dEVI
```

	Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)
1	12	16.118				
2	11	16.065	1	0.053138	0.0364	0.8522
3	10	15.172	1	0.89242	0.5882	0.4608

The Use of EVI vs NBR in Burn Monitoring

- The difference in SWIR is much larger than that in Red
- Corresponds to structural change rather than greenness



Next Steps

- Closer examination of relationship between EVI and Burn Size
- Further examine land cover differences
- Consider proximity to human settlements
- Go further back in time

Conclusion / Closing Thoughts

- The size of a burn area affects how fast it regreens, but not how long it takes for a full recovery to pre-fire conditions
- Even without objective data for severity and recovery time, it still seems reasonable that more severe burns take longer to recover
- Repeat burns are not a problem for ecosystems with an established fire regime

References

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Image References

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- Map: https://www.cleanpng.com/free/dora-the-explorer-map.html
- Spectral Response Graph: https://www.earthdatascience.org/courses/earth-analytics/multispectral-remote-sensing-modis/normalized-burn-index-dNBR/

Questions?

Oh wait!. ;-)
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