MODIS – NDVI AND EVI
CHANGE DETECTION

MODIS

- Onboard the EOS – Earth Observing System
- Moderate Resolution Spectroradiometer (MODIS)
- 1-2 day temporal resolution
  - Two sensors on separate satellites
    - Terra
    - Aqua
- Red and Near Infrared bands in 250m spatial resolution, more spectral bands at 500m and 1km
  (Wang, 2013)
DATA PRODUCTS

- MODIS has many data products focused on land, oceans, and the atmosphere.
- This paper looked at MODIS13Q1 data product.
- MODIS13Q1 is a 16 day composite of utilize the 250 m spatial resolution bands, and has NDVI and EVI calculated.
- Extent was reduced by cropping out Canada.
  - West Bounding: -79.839  East Bounding: -69.0286
  - North Bounding: 45.163  South Bounding: 40.393

Hurricane Path and Study Area
**HURRICANE SANDY**

- $50 Billion in economic damage
- Maximum of 9 ft inundation
- Maximum sustained winds of 65 kt
- Maximum gusts 83 kt
- Storm left 285 people dead
- Hurricanes have a great impact not only on cities, but also forests understanding this impact is important.

(Blake, 2013)
**Vegetation Indices**

- **NDVI – Normalized Differencing Vegetation Index**
  - “A spectral transformation that describes the reaction of two electromagnetic bands to healthy green photosynthesizing vegetation.” (Phillips, Hansen & Flathers, 2008)

- **EVI – Enhanced Vegetation Index**
  - Includes additional spectral information, a soil coefficient and two variables that utilize the blue band to control for atmospheric aerosols (Huete, Justice & Leeuwen, 1999)

**Vegetation Indices cont.**

- NDVI has been shown to covary with LAI, and total green biomass (Phillips, Hansen & Flather, 2008)
- The index was found to accurately detect 78% of all change over 20 ha, derived from the Maine logging industry (Jin & Sader, 2005)
- Wang et al., used MODIS data to detect forest disturbance from Hurricane Katarina (2009)
- NDVI has also been used to quantify hurricane impacts to wetlands with success (Steyer, Couvillion & Barras, 2013)
THE STAGES OF CHANGE DETECTION

- Preprocessing
  - Radiometric- MODIS data products are already corrected
  - Multiple day composite images allowed for high quality images of the entire study area but have been found less accurate (Jin & Sader, 2005)
  - Geographic – Utilized MODIS Reprojection Tool Web Interface (MRTWeb)
    - Sinusoidal

- Determining algorithm
  - ERDAS imagine – Univariate Differencing

- Accuracy assessment

NDVI Change Detection Map

Legend
- NDVI Post-Sandy Change Detection
  - 15% or greater Decrease
  - 15% or greater Increase
  - Some Decrease
  - Some Increase
  - Unchanged
**THE DIFFERENCE**

<table>
<thead>
<tr>
<th></th>
<th>NDVI Pixels</th>
<th>EVI Pixels</th>
<th>NDVI Area (Km²)</th>
<th>EVI Area (Km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10% or greater decrease</td>
<td>935,697</td>
<td>1,034,057.00</td>
<td>58,481.06</td>
<td>64,628.56</td>
</tr>
<tr>
<td>10% or greater increase</td>
<td>301,640</td>
<td>534,297</td>
<td>18,853</td>
<td>33,393.56</td>
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<tr>
<td>some decrease</td>
<td>3,315,652</td>
<td>3,063,891</td>
<td>207,228</td>
<td>191,493.19</td>
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<tr>
<td>some increase</td>
<td>2,028,525</td>
<td>1,948,386</td>
<td>126,783</td>
<td>121,774.13</td>
</tr>
</tbody>
</table>
THE DIFFERENCE

- NDVI is documented as having problems with accurately detecting low and high vegetation landscapes (Phillips, Hansen & Flathers, 2008)
  - Due to these being leaf off season this should be mitigated
- EVI detected more significant change especially positive change.
- NDVI detected more slight change
- Wang & Xu found the Soil Adjusted Vegetation Index (SAVI) to be less accurate than NDVI (2010)
NDVI vs EVI

- EVI found more areas of significant increase and decrease
- Some overlap between the two categories of 10% or greater decrease.
- The numbers for each category are similar but the geographic areas are different.
- Next step create a mask of biomass and compare number of NDVI vs. EVI within that mask
- It is unclear which sensor was more accurate and both appear to have problems requiring further investigation
MODIS CHANGE DETECTION

**Advantages**
- Storm events have small windows of activity making the high temporal resolution of MODIS a huge advantage
- Data products are easily accessible and are easy to use
- Shown to be accurate at detecting areas of change both for hurricanes and other disturbance events (Wang & Xu, 2010)
- The spatial resolution is a useful scale for looking at regional change

**Disadvantages**
- Coarse spatial resolution
  - Only useful on the region level
- The projection is difficult to work with
- The spectral resolution is very low especially for the 250m resolution images

ACCURACY ASSESSMENT

- Not able to ascertain the accuracy
- Options would be to verify with higher resolution data
- Forest Inventory and Analysis Data utilized in previous studies (Wang et al., 2009)
- Ground Truthing
- Accuracy assessment is the only way to know which index was better at detecting change
CONCLUSIONS

- MODIS data products are a useful first step for understanding a storm event and its impact on regional forests.
- Vegetation Indices simplify the differencing process but important to utilize the best possible index.
- The frequency of hurricanes is expected to increase (Stanturf, Goddick & Outcalt, 2007)
- This could impact a huge source of carbon sequestration (Chambers et al., 2007)

QUESTIONS?
WORKS CITED

- Wang, Y.Q. 2013, “Class Lectures: NRS415”.