# 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.
- Dates 11/25/2011 and 11/24/2012 and the preceding 16 days.
- 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
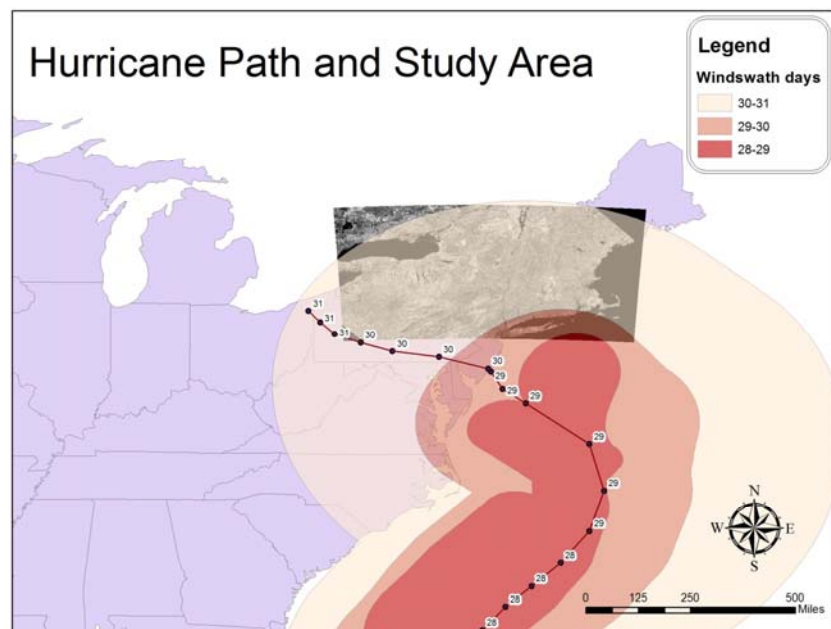
HURRICANE SANDY

- $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)

Hurricane Sandy Impact Zones

Sandy FEMA Impact Zones
- Very High
- High
- Moderate
- Low

Service Layer Credits: FEMA, Esri
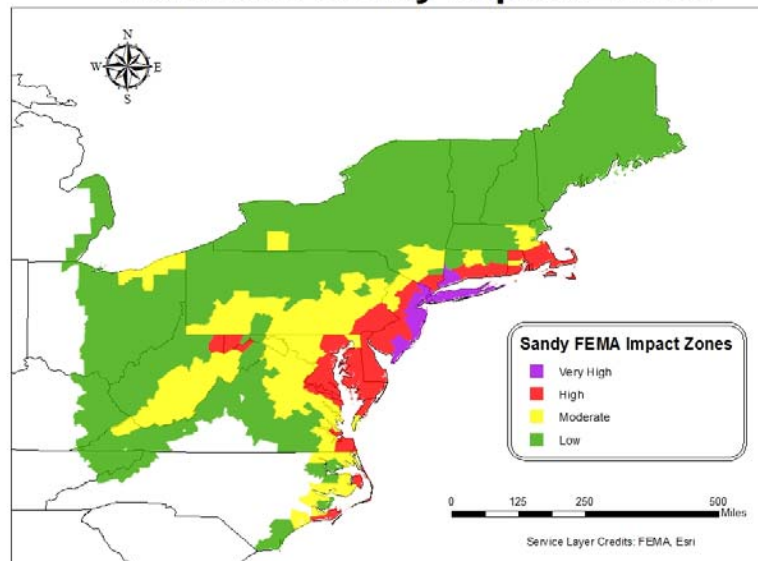
VEGETATION INDICES

- NDVI – Normalized Differencing Vegetation Index
  - "A spectral transformation that describes the reaction of two electromagnetic bands to healthy green photosynthesizing vegetation." (Phillips, Hansen & Flatthers, 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)
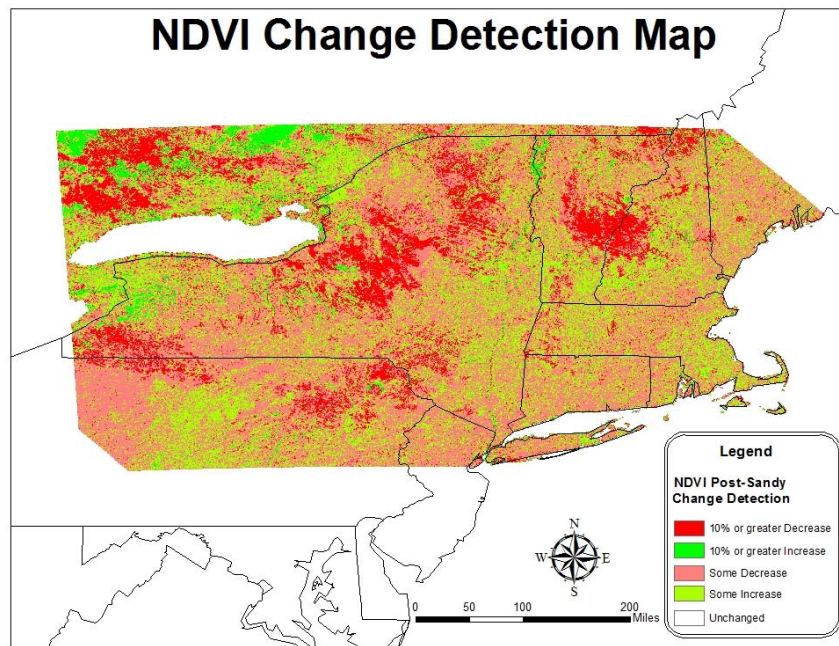
VEGETATION INDICES CONT.

- NDVI has been show 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)
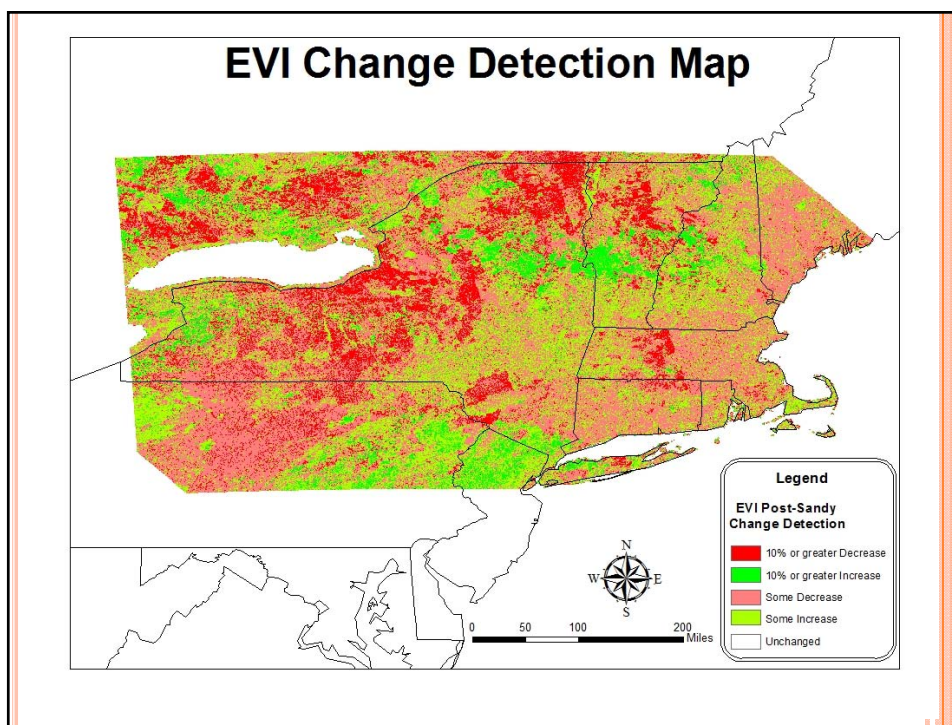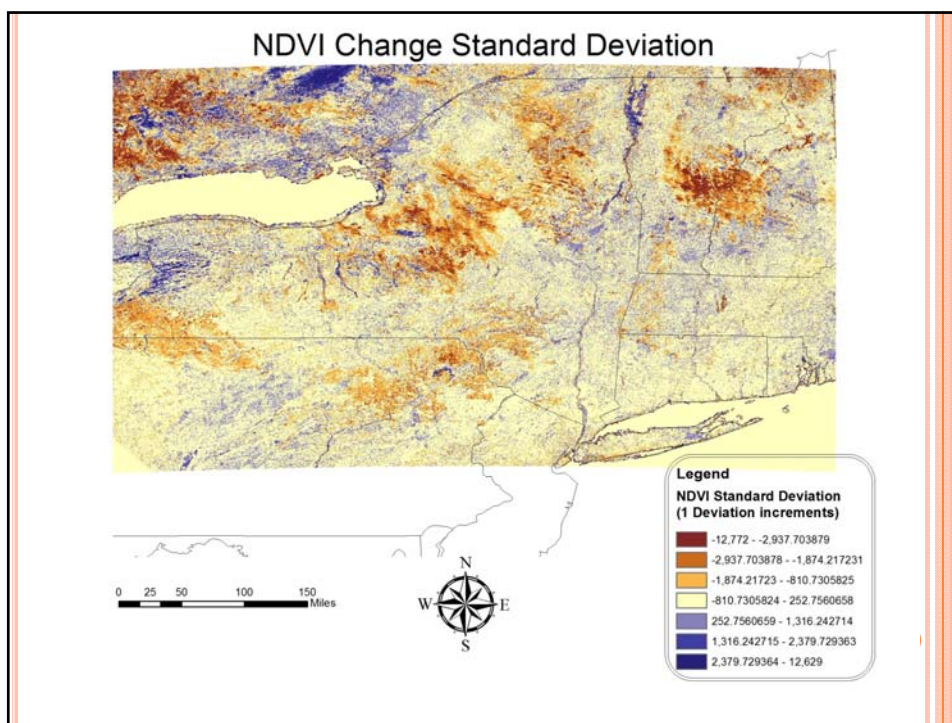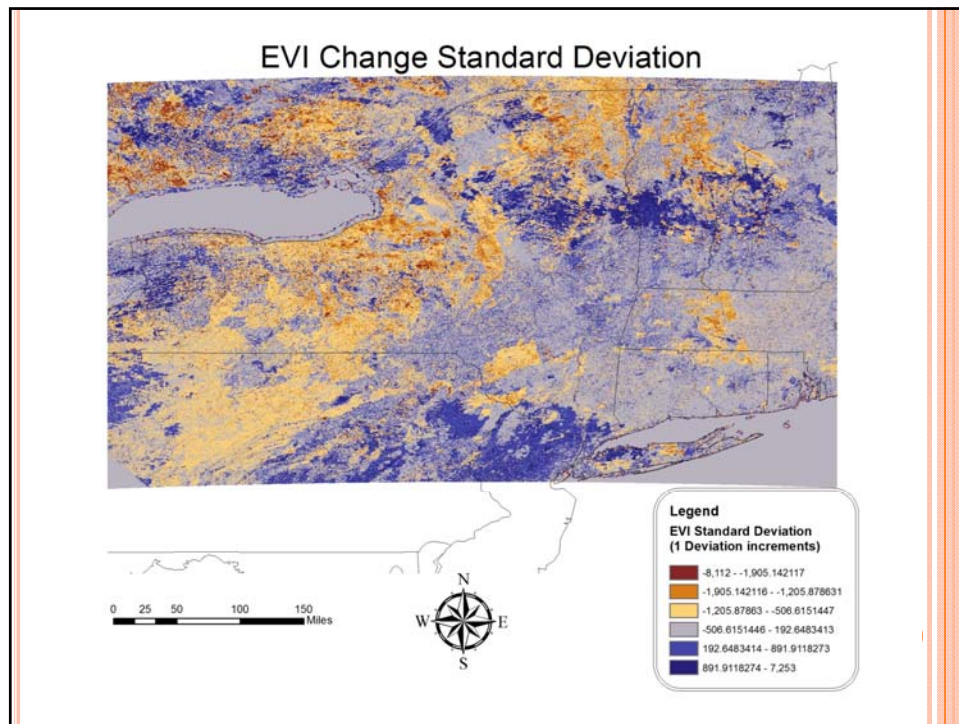
THE STAGES OF CHANGE DETECTION

- 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)
    - Sinusoidial

- Determining algorithm
  - ERDAS imagine – Univariate Differencing

- Accuracy assessment

NDVI Change Detection Map

Legend

NDVI Post-Sandy Change Detection

- 10% or greater Decrease
- 10% or greater Increase
- Some Decrease
- Some Increase
- Unchanged

0   50   100   200 Miles

NDVI Change Standard Deviation

EVI Change Detection Map

EVI Change Standard Deviation

THE DIFFERENCE

	NDVI Pixels	EVI Pixels	NDVI Area (Km^2)	EVI Area (Km^2)
10% or greater decrease	935,697	1,034,057.00	58,481.06	64,628.56
10% or greater increase	301,640	534,297	18,853	33,393.56
some decrease	3,315,652	3,063,891	207,228	191,493.19
some increase	2,028,525	1,948,386	126,783	121,774.13

THE DIFFERENCE

- NDVI is documented as having problems with accuractly 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 Change

Biomass overlay for NDVI and EVI Change
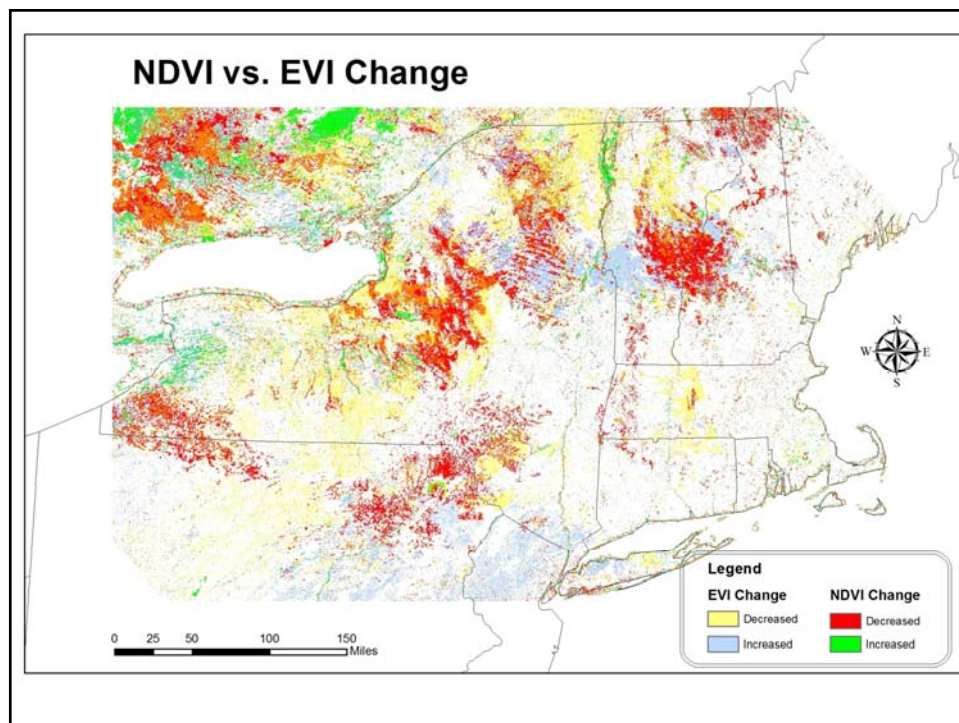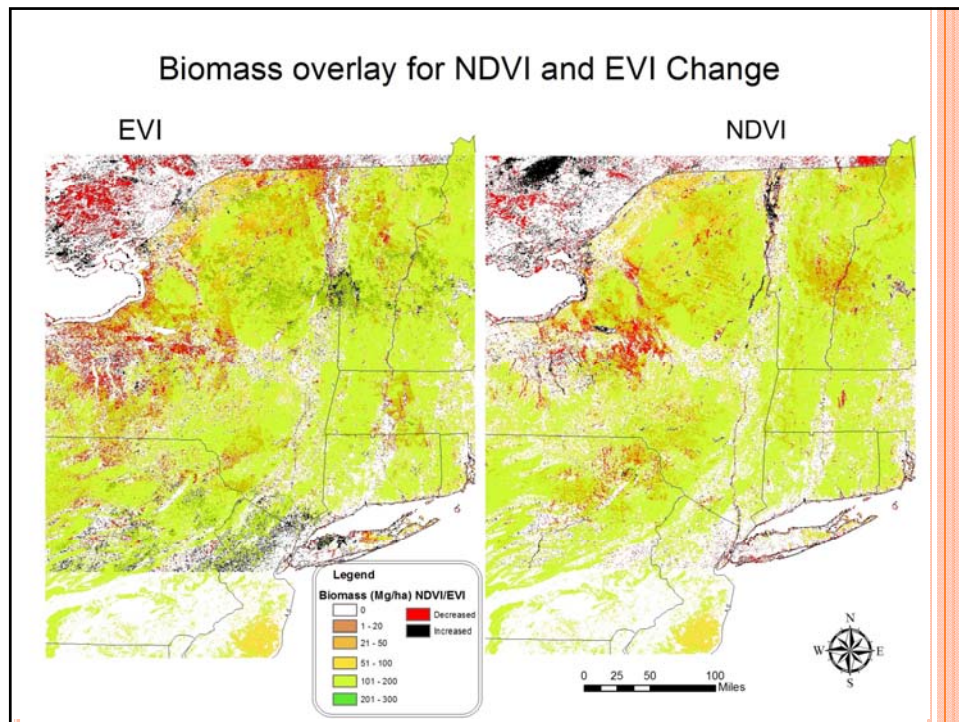
NDVI vs EVI

- 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	Disadvantages
o Storm events have small windows of activity making the high temporal resolution of MODIS a huge advantage o Data products are easily accessible and are easy to use o Shown to be accurate at detecting areas of change both for hurricanes and other disturbance events (Wang & Xu, 2010) o The spatial resolution is a useful scale for looking at regional change	o Coarse spatial resolution • Only useful on the region level o The projection is difficult to work with o The spectral resolution is very low especially for the 250m resolution images

Accuracy Assessment

- o Not able to ascertain the accuracy
- o Options would be to verify with higher resolution data
- o Forest Inventory and Analysis Data utilized in previous studies (Wang et al., 2009)
- o Ground Truthing
- o 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?

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