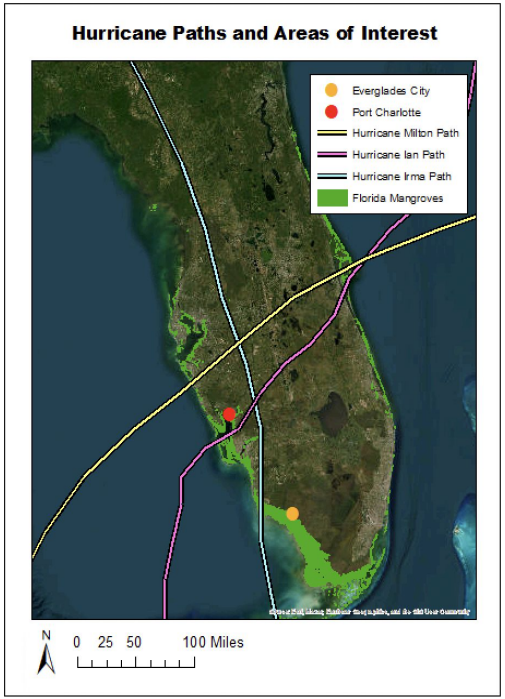
Impact of Hurricanes on Florida Mangrove Vegetation

2017 - 2024

By: Emily Wilhelm

Methods and Data



Satellites:

- Landsat 8 & 9

Sites & Software:

- ArcMap
- USGS Earth Data
- Google Earth Engine

Datasets:

- Landsat
  - Path 16, Row 42
- Florida Mangrove Shapefile, 2020
- ArcGis Online
  - Historical Hurricane Tracks
    - Irma, 2021
    - Ian, 2022
    - Milton, 2024
- Basemap

Skills:

- Mosaic Composite
- Reprojection
- Mask extract
- NDVI Calculations

Hurricane Wind Destruction to Mangroves

Category 1

- 74-95 mph

Category 2

- 96-110 mph

Category 3

- 111-129 mph

Category 4 → Irma, Ian

- **130-156 mph**

Category 5 → Milton

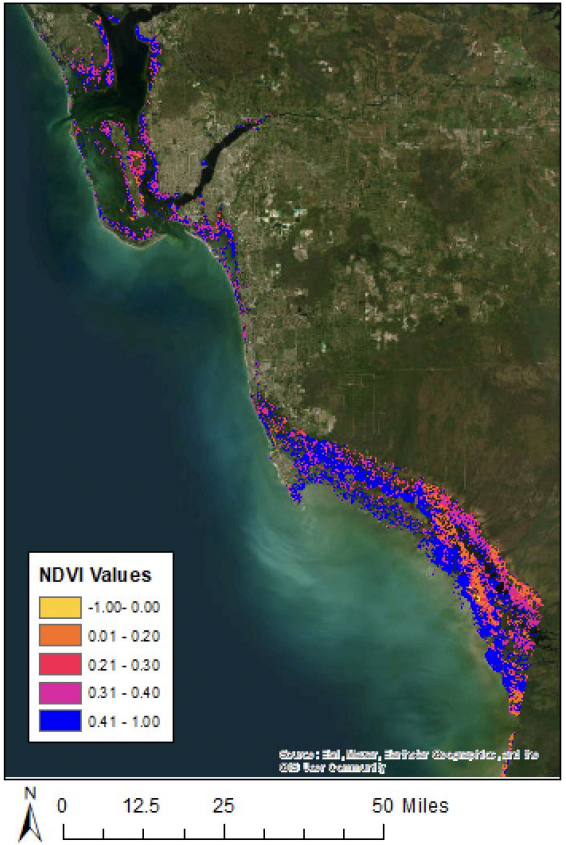
- **157+ mph**

Wind speed of a storm is directly related to mangrove damage extent. The most visible effects of mangrove wind speed damage is seen at 110 mph (Category 3) or higher , but can occur at lower wind speeds too. High wind speeds can cause uprooting, branch breaking, and defoliation.

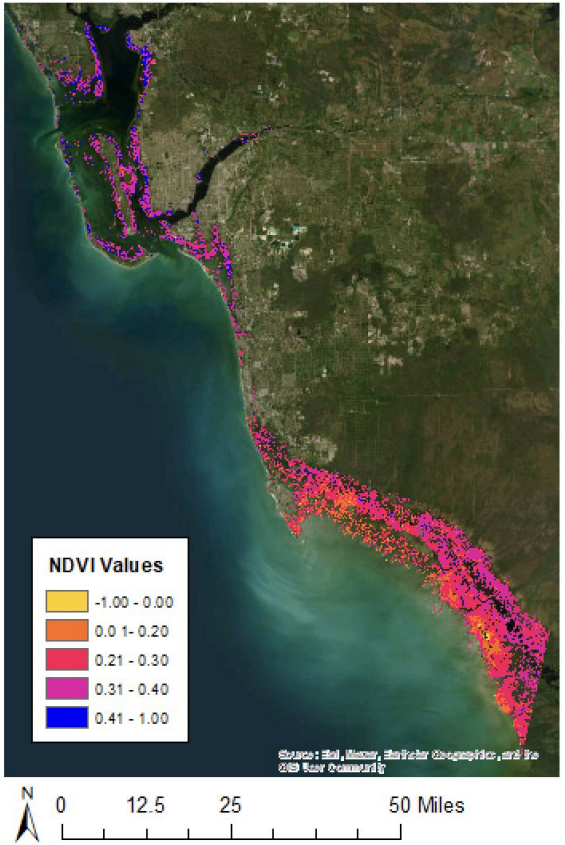
Increased salinity, water height, and turbidity can also damage mangrove's health during a hurricane.

Hurricane Irma, 2017 - Category 4

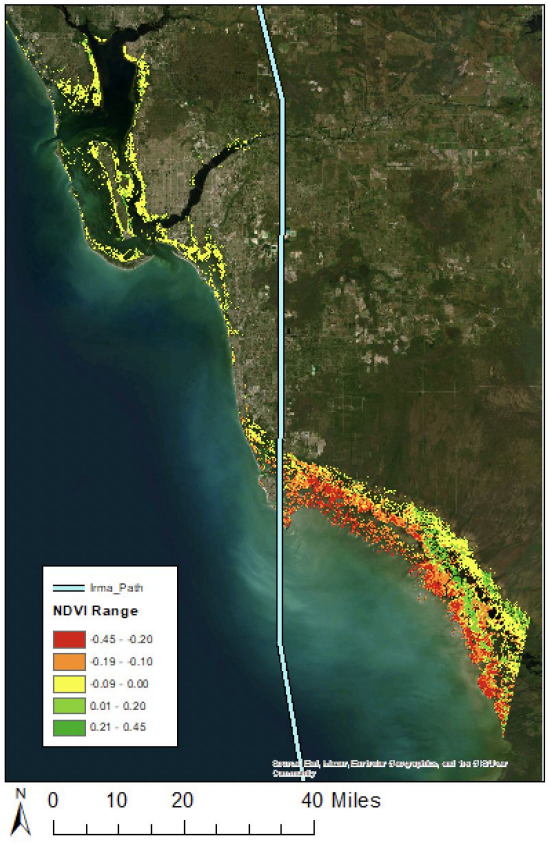
Mangrove NDVI Before Hurricane Irma - 8/29/2017



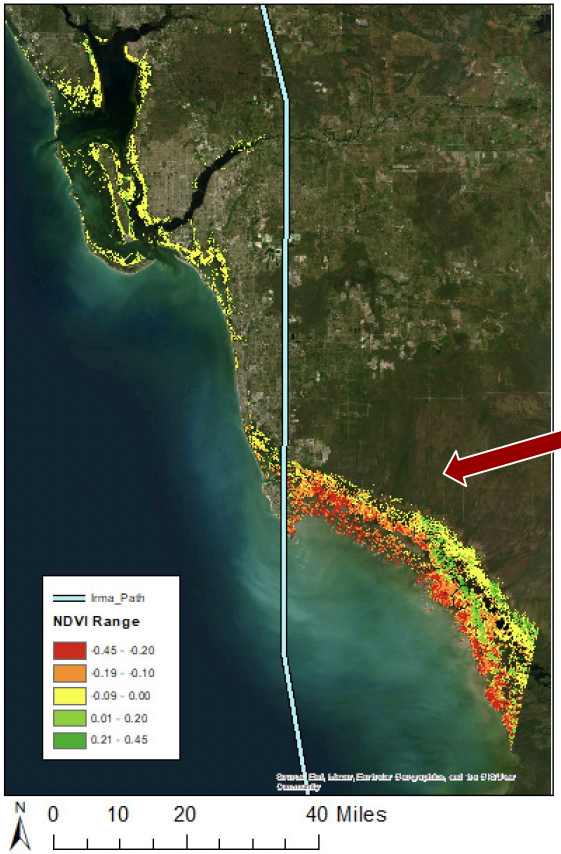
Mangrove NDVI After Hurricane Irma - 11/01/2017

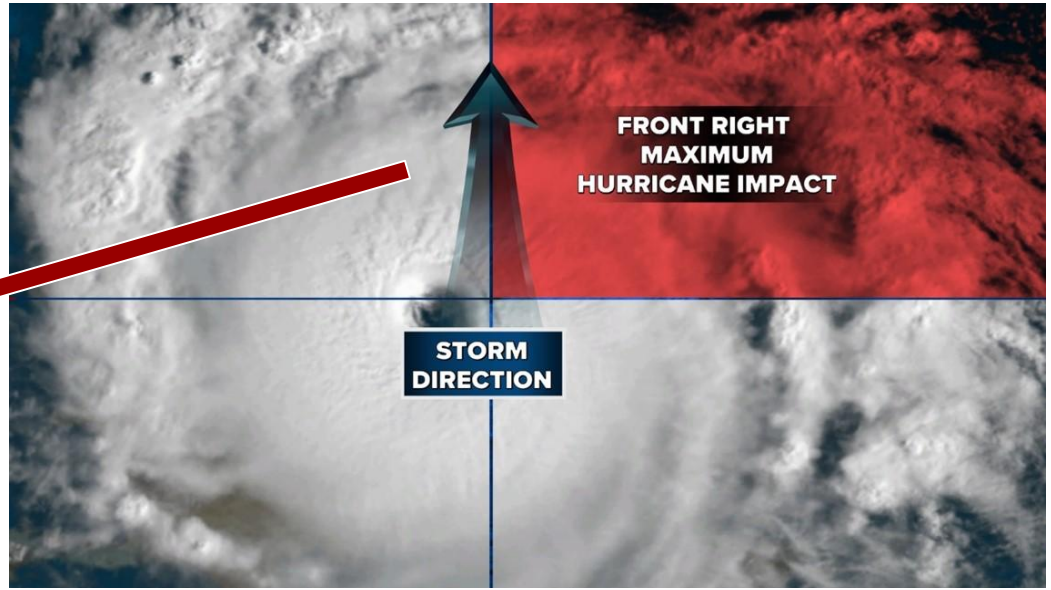


Total Mangrove NDVI Difference Between 8/29/2017 and 11/28/2024



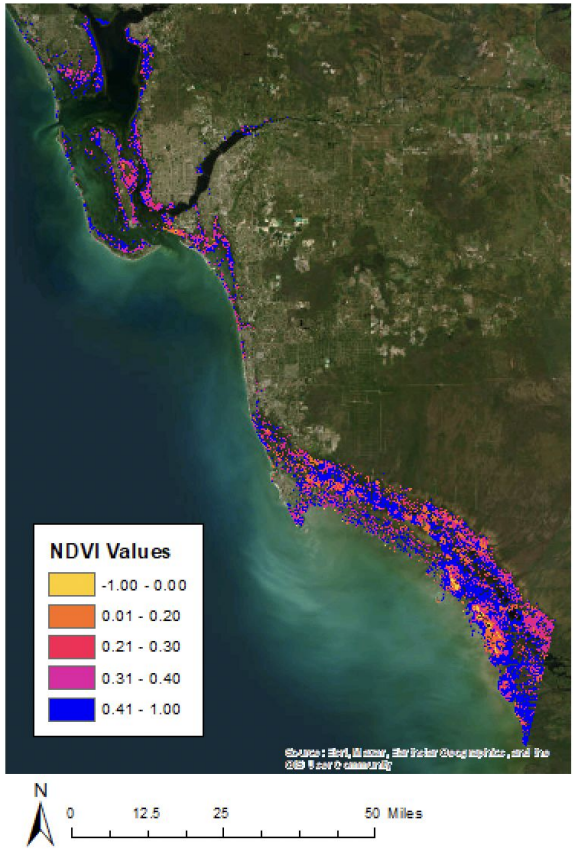
Total Mangrove NDVI Difference
Between 8/29/2017 and 11/28/2024



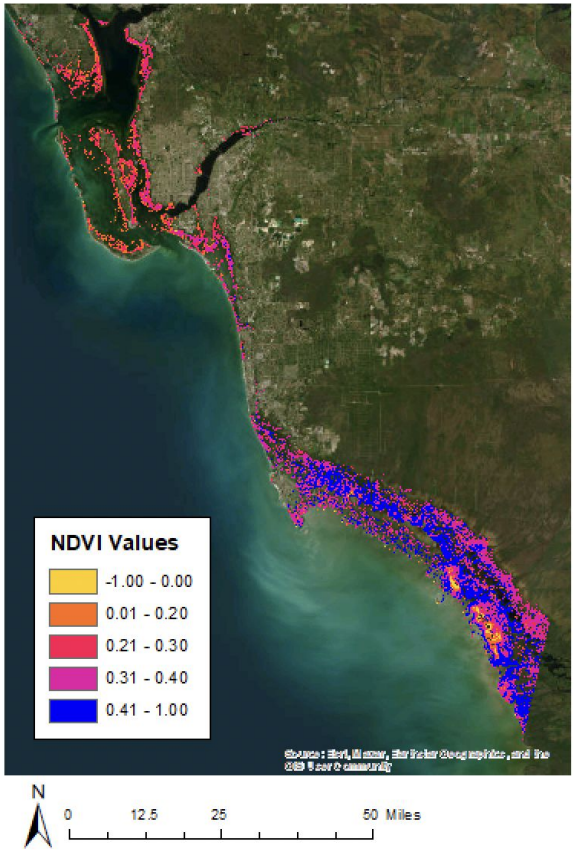


Hurricane Ian, 2022 - Category 4

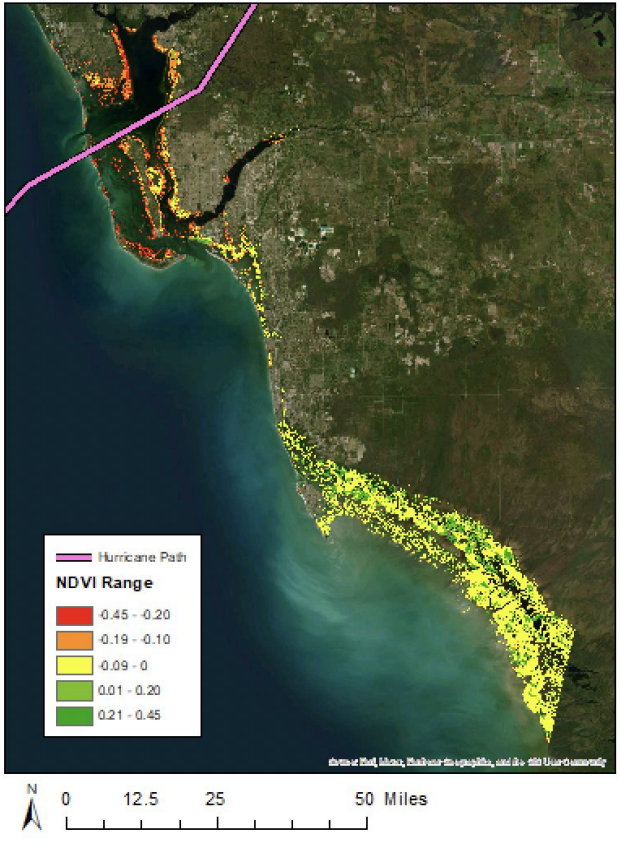
Mangrove NDVI Before Hurricane Ian - 9/04/2022



Mangrove NDVI After Hurricane Ian - 10/22/2022

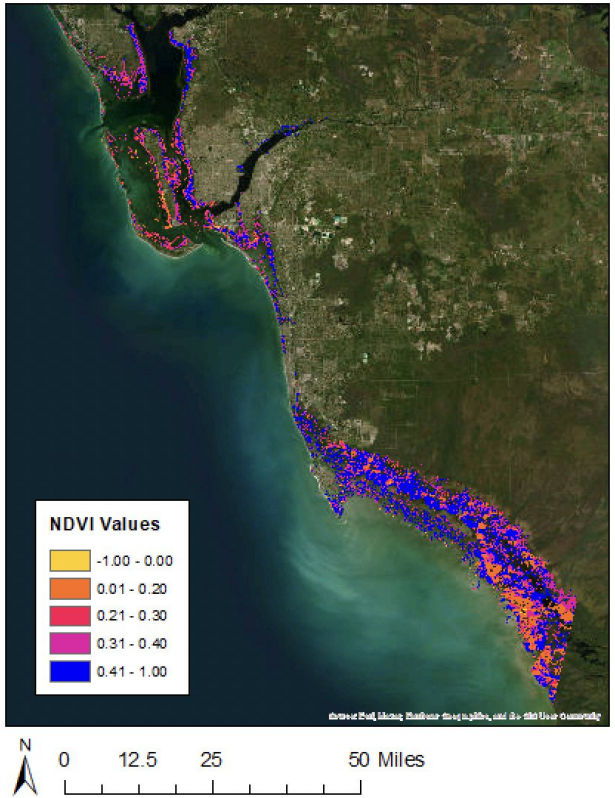


Change In Mangrove NDVI Before and After Hurricane Ian - 9/28/2022

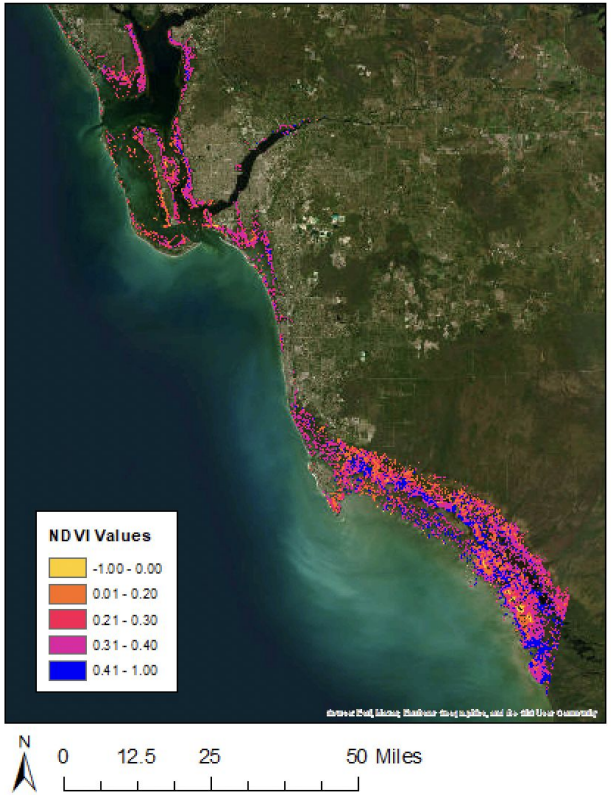


Hurricane Milton, 2024 - Category 3

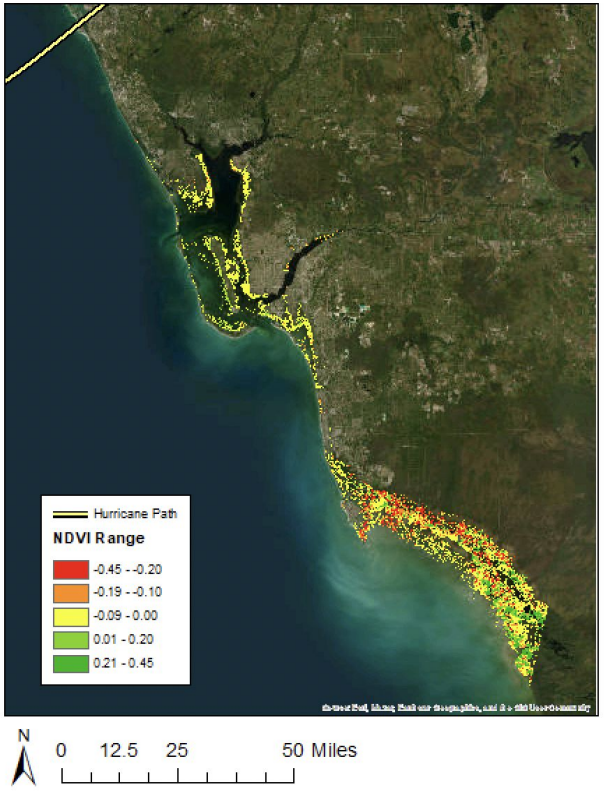
Mangrove NDVI Before Hurricane Milton - 6/05/2024



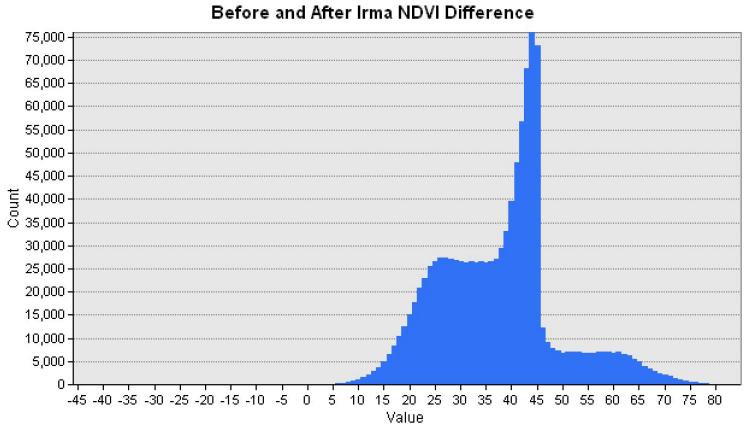
Mangrove NDVI After Hurricane Milton - 11/28/2024

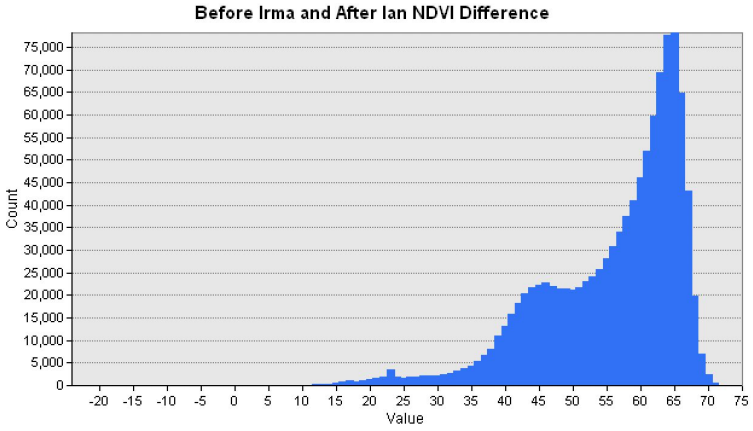


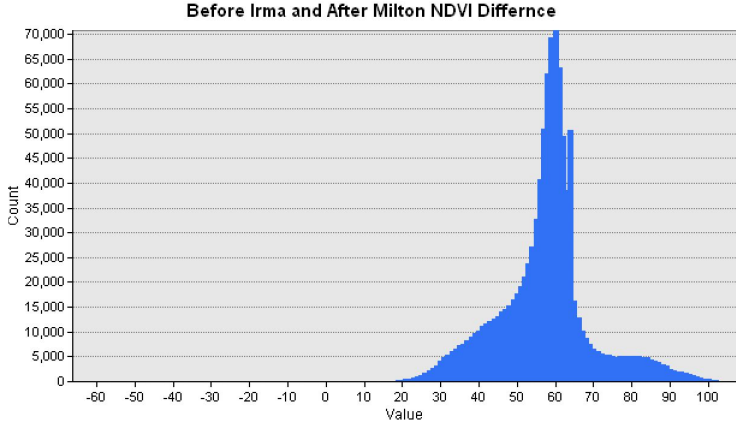
Change in Mangrove NDVI Before and after Hurricane Milton - 10/10/2024



Regrowth


Before and After Irma NDVI Difference
Count
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
-45 -40 -35 -30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80
Value


Before Irma and After Ian NDVI Difference
Count
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
-20 -15 -10 -5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
Value


Before Irma and After Milton NDVI Differnce
Count
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
-60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100
Value

Limitations and Further Investigation

Limitations

- Noise in NDVI
  - Cloud coverage of Landsat data only <15%, but some cloud coverage over area of interest.
  - Water
  - Other vegetation in the mangrove ecosystems
- Factors not accounted for
  - Salinity, windspeed, tidal height
  - Anthropogenic factors (development)
  - Stochastic

Further Investigation

- Statistical Analysis
- More in depth time scale change
- Use and comparison of other vegetation health indices
- Categorization of mangrove species, mangrove height, zonal comparison of mangrove density or proximity to water.

References

https://earthexplorer.usgs.gov/

Feng, Y., Negrón-Juárez, R. I., & Chambers, J. Q. (2020). Remote Sensing and statistical analysis of the effects of hurricane maría on the forests of Puerto Rico. *Remote Sensing of Environment*, *247*, 111940. https://doi.org/10.1016/j.rse.2020.111940

Yang, X., Zhu, Z., Kroeger, K. D., Qiu, S., Covington, S., Conrad, J. R., & Zhu, Z. (2024). Tracking mangrove condition changes using dense landsat time series. *Remote Sensing of Environment*, *315*, 114461. https://doi.org/10.1016/j.rse.2024.114461

Zhang, K., Thapa, B., Ross, M., & Gann, D. (2016). Remote sensing of seasonal changes and disturbances in mangrove forest: A case study from south Florida. *Ecosphere*, *7*(6). https://doi.org/10.1002/ecs2.1366