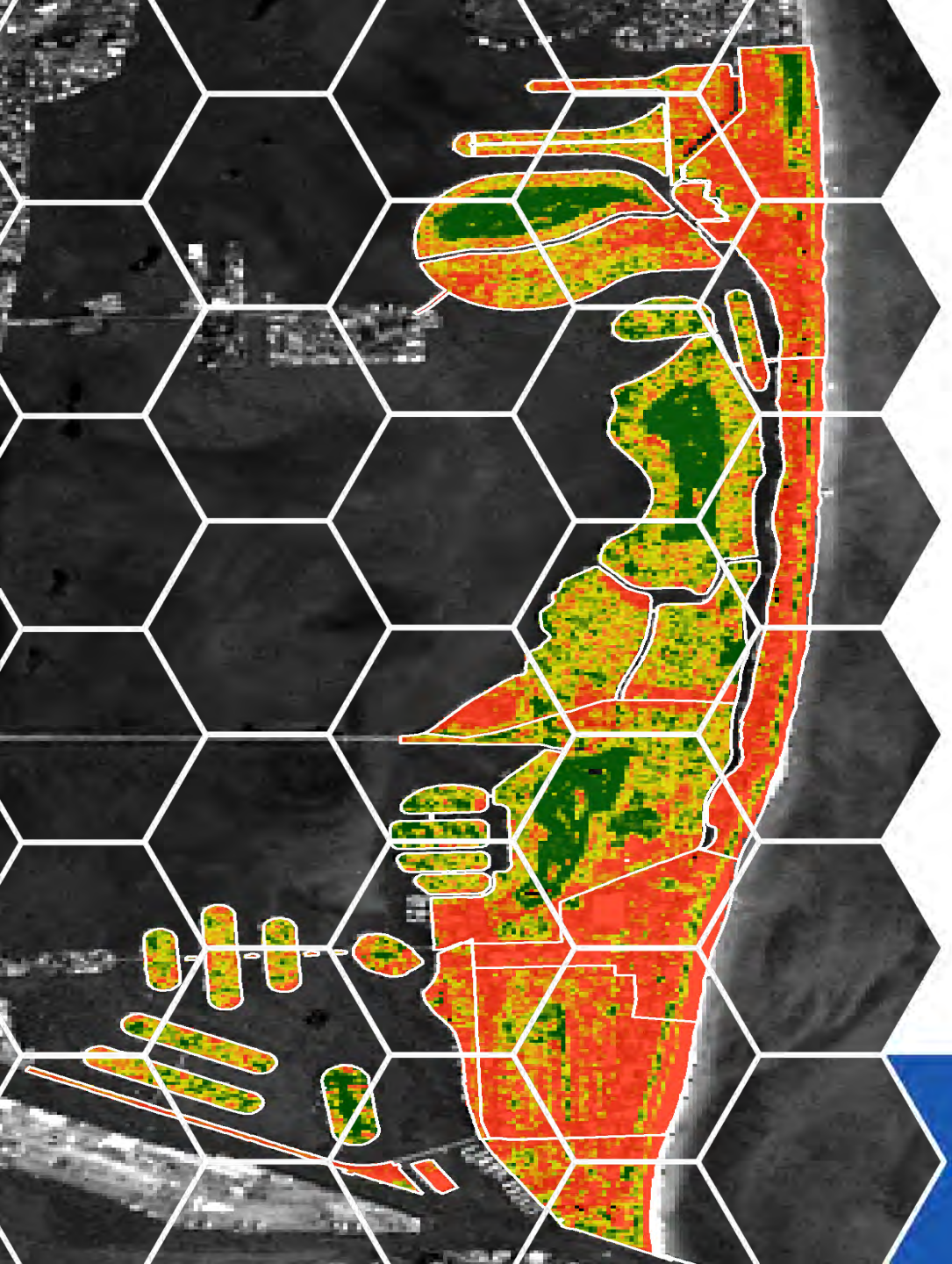


National Aeronautics and Space Administration

Utilizing NASA Earth Observations to Assess Sea Level Rise and Develop Optimal Green Infrastructure Plans to Restore Mangrove Habitat and Enhance Coastal Resiliency

Maria Luisa Escobar Pardo*, Christopher Cameron, Abhishek Kumar, Sonia Linton, David Rickless, Navid Hashemi Tonekabon, & Sam Weber

Community Concerns

- Shoreline **changes significantly** impact local **economies**
- **Extreme weather** is a major **threat** to coastal communities
- Implementation of **green infrastructure** as a **mitigation** technique
- **Increase** storm water **drainage capacity** and **pump stations**



Image Credit: Sevag Mehterian

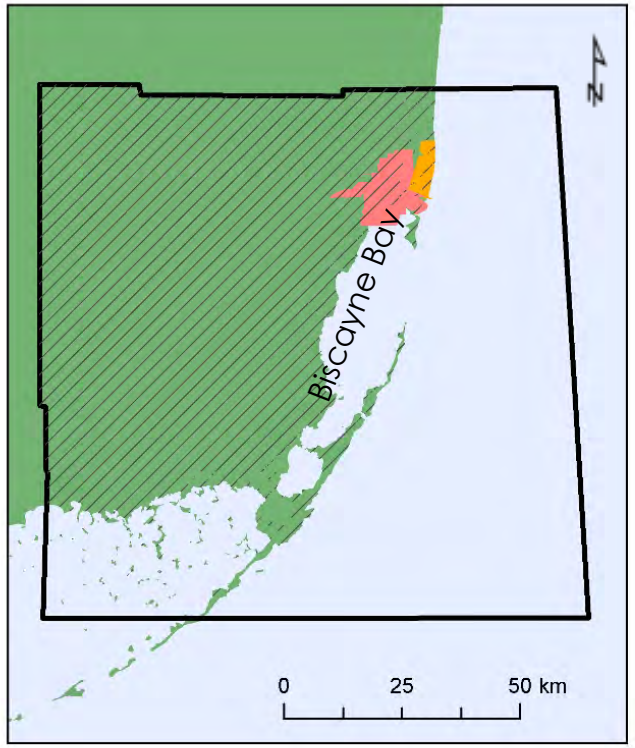
Project Partner

City of Miami Beach, Public Works Department



Study Area & Period







Miami-Dade County

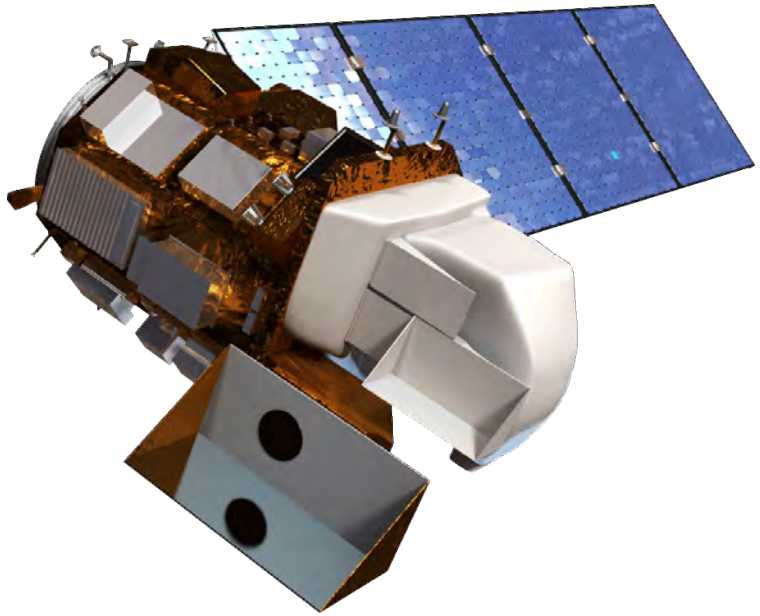
- Biscayne Bay Area
- City of Miami Beach
- 1984-2017

Objectives

- **Examine coastal damage** in Miami Beach following **Hurricane Irma**
- **Map** the **distribution** of **historic urban vegetation** in Miami Beach
- **Assess** the **range** and **health** of **coastal wetlands** in **southeast Florida** using Landsat 5 TM, Landsat 8 OLI, and Terra MODIS data products



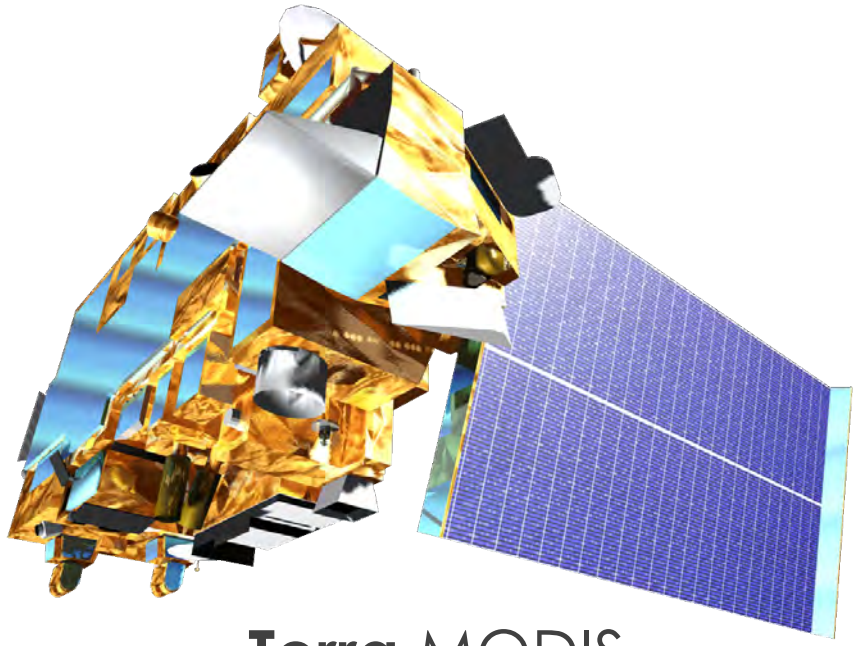
NASA Earth Observations



Landsat 8 OLI

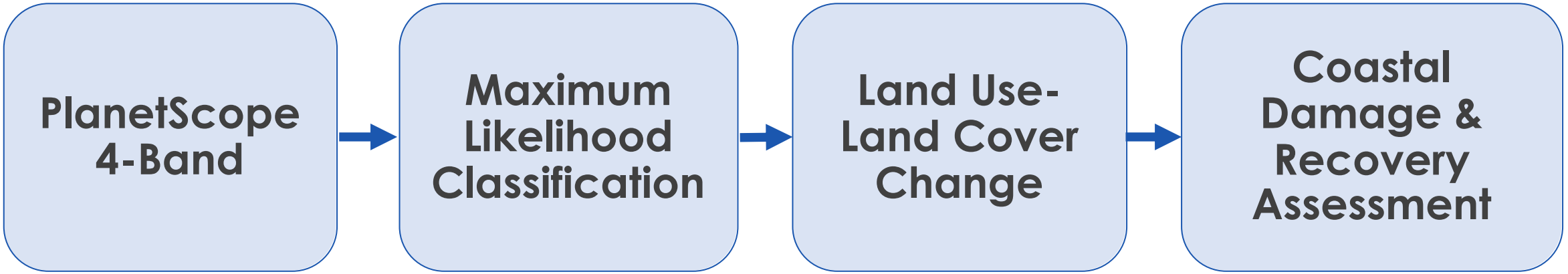


Landsat 5 TM

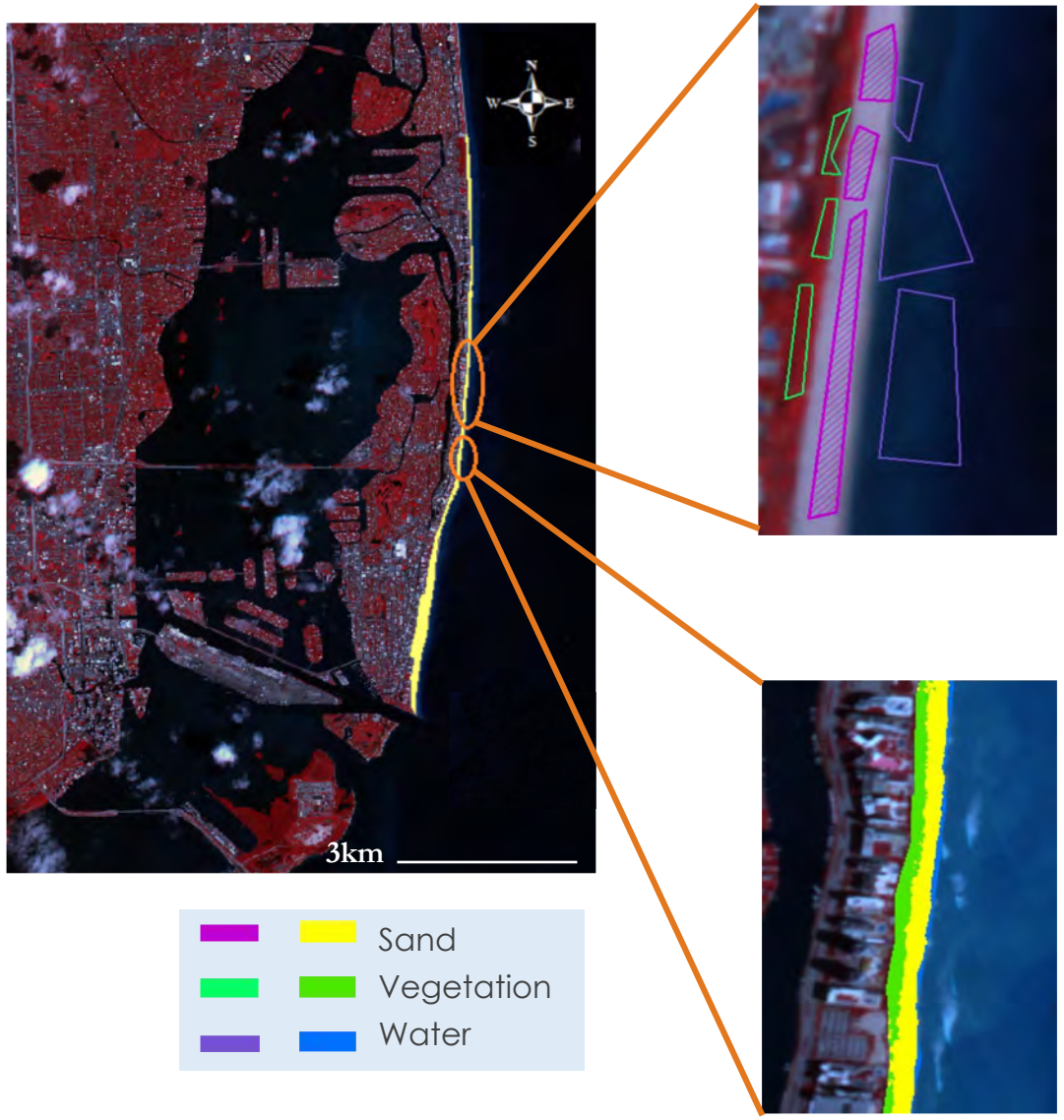


Terra MODIS

Methods – Coastal Damage



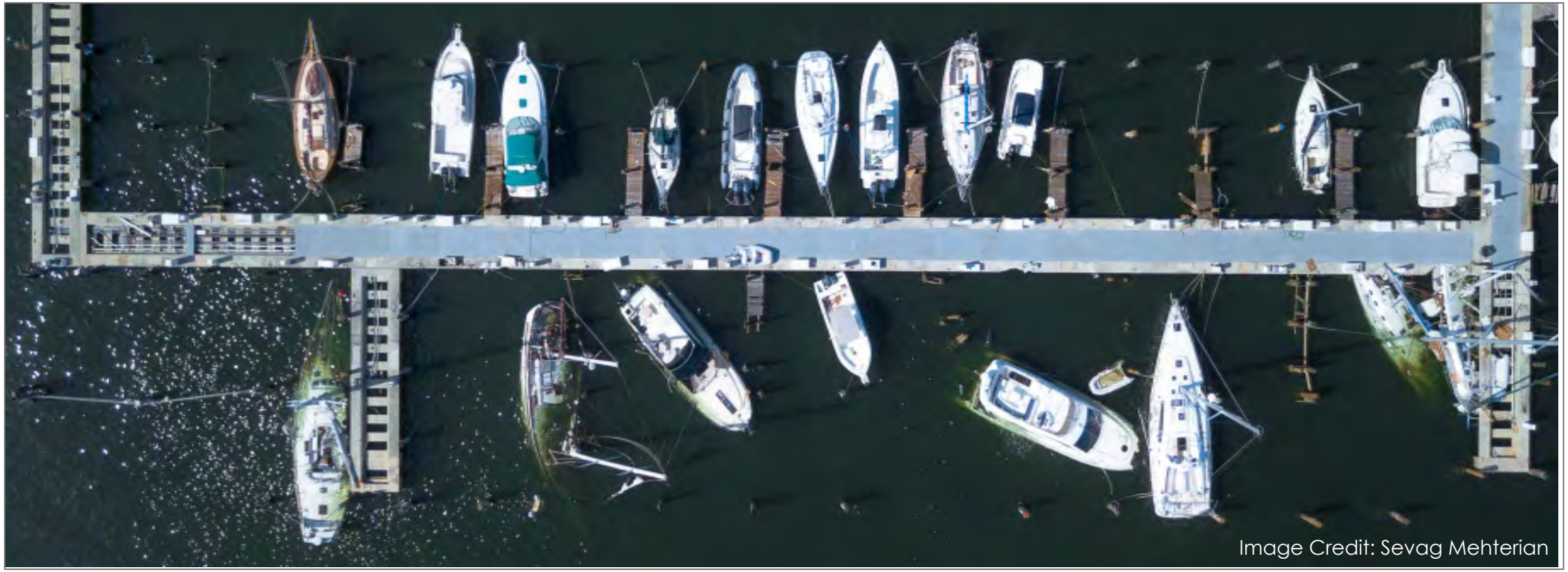
Results – Coastal Damage



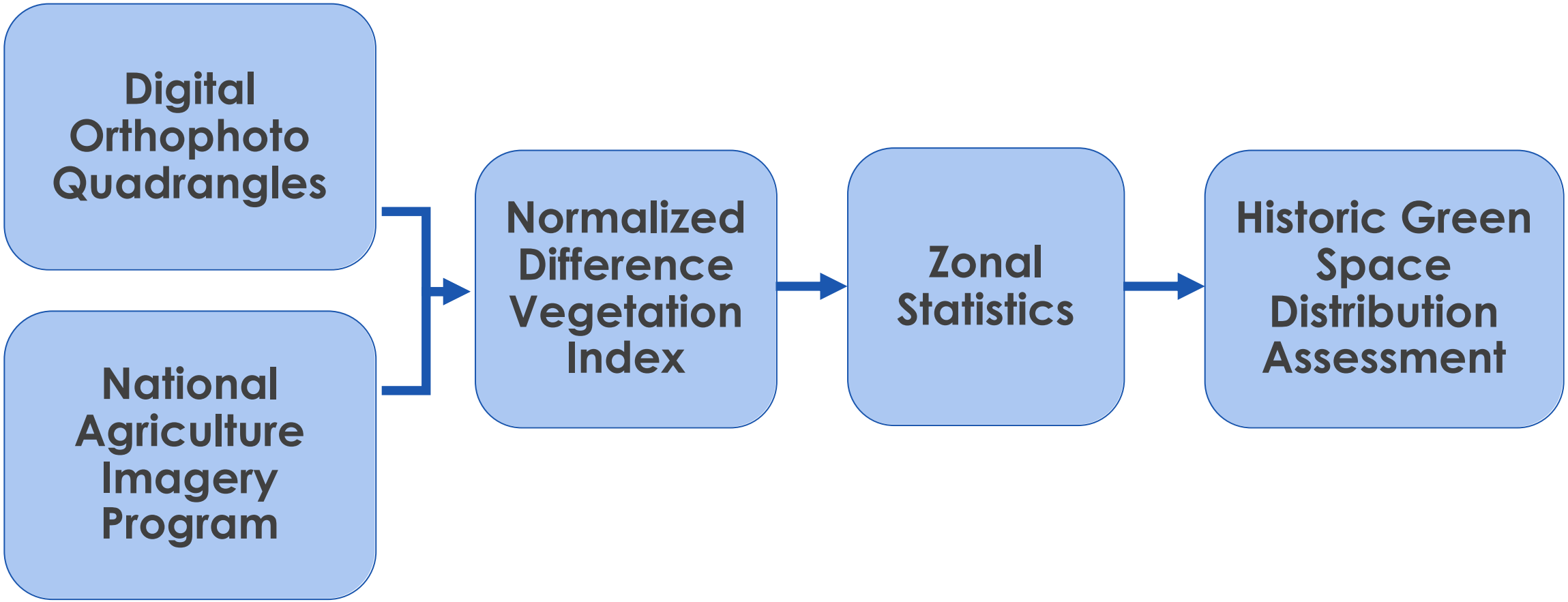
Dates	Class	Area (km^2)
09/07 (3 days before Irma)	Sand	0.71
	Vegetation	0.48
09/12 (2 days after Irma)	Sand	0.92
	Vegetation	0.26
10/30 (40 days after Irma)	Sand	0.79
	Vegetation	0.39

Conclusions – Coastal Damage

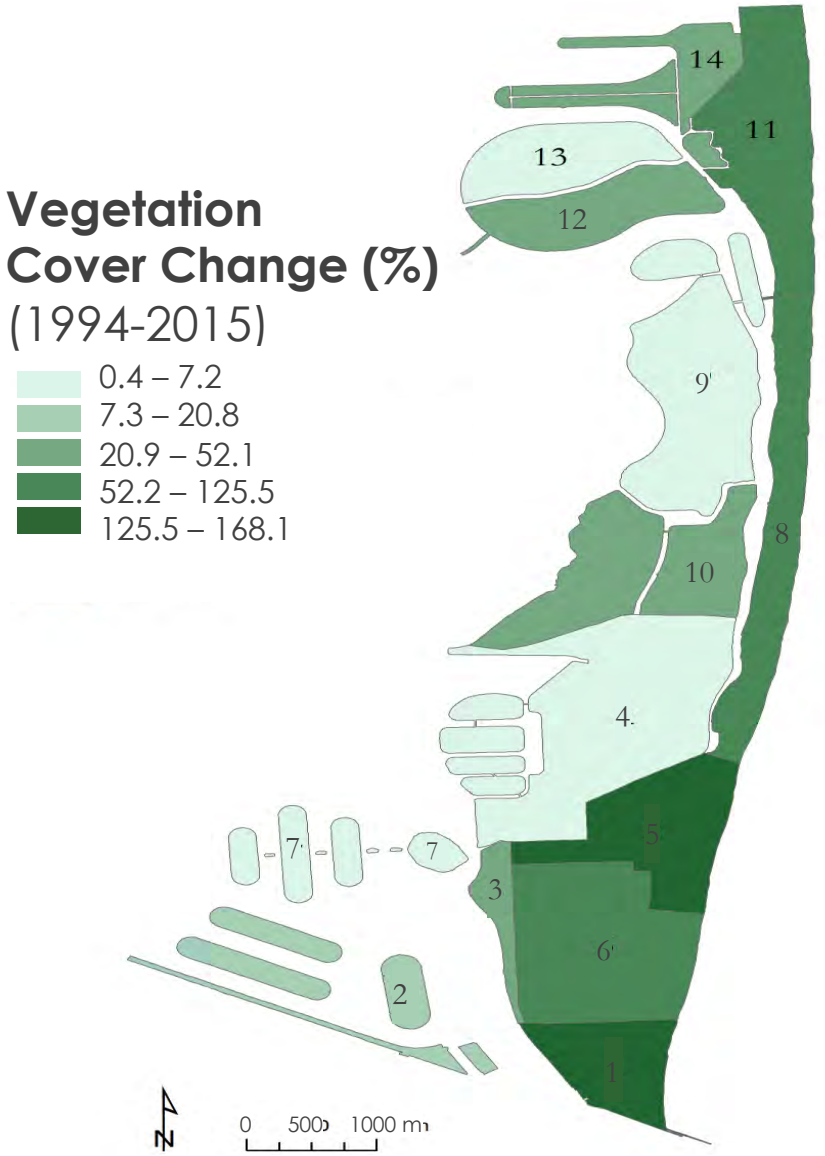
- Approximately **45%** of coastal vegetation along Miami Beach **was lost or damaged**
- An estimated **26%** of this **vegetation recovered** within 40 days of the storm's passing



Methods – Urban Vegetation



Results – Urban Vegetation



Neighborhoods

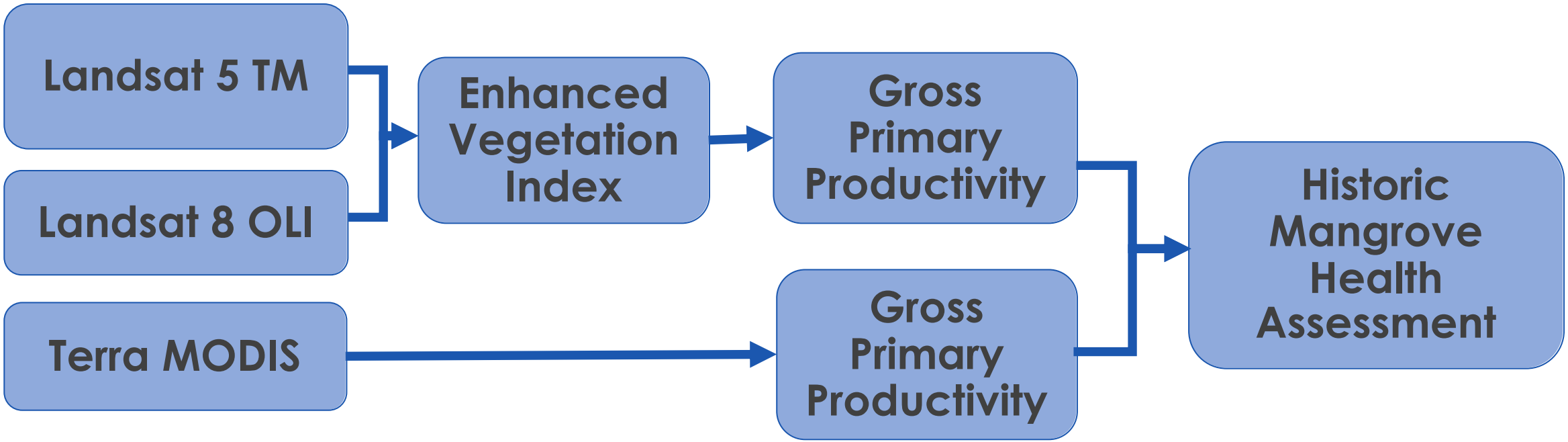
1. South Pointe
2. Star/Palm/Hibiscus
3. West Avenue & Bay Road
4. Bayshore
5. City Center
6. Flamingo/Lummus
7. South & Venetian Islands
8. Oceanfront
9. La Gorce
10. Nautilus
11. North Shore
12. Normandy Isles
13. Normandy Shores
14. Biscayne Point

Conclusions – Urban Vegetation

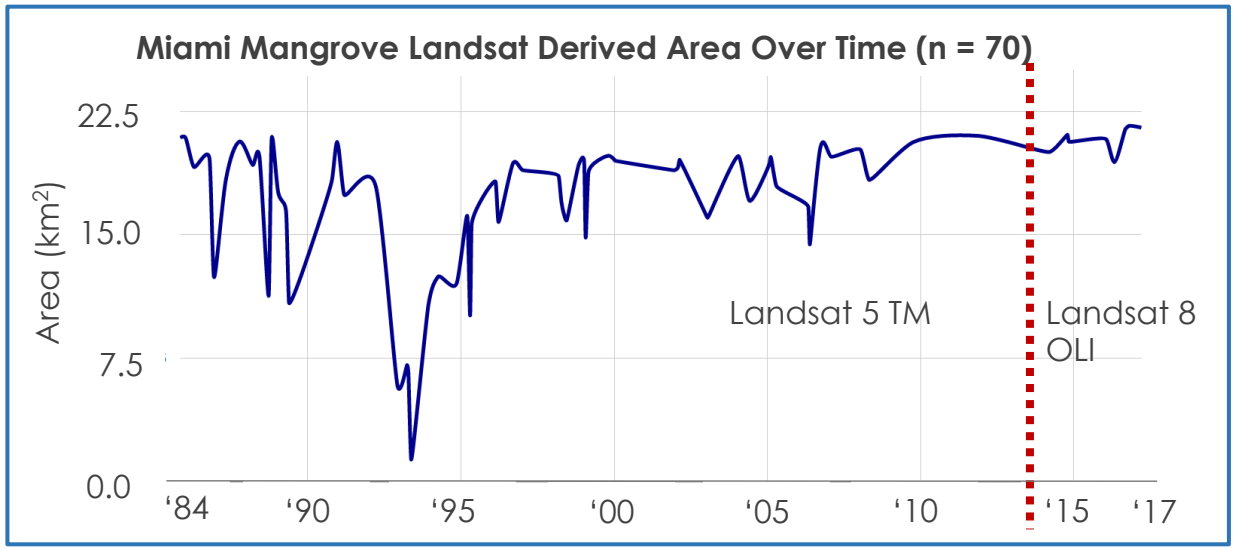
- The city of Miami Beach saw a **24% increase** in vegetation coverage between 1994 and 2015
- The city's plans to **implement and maintain green infrastructure** are having positive effects

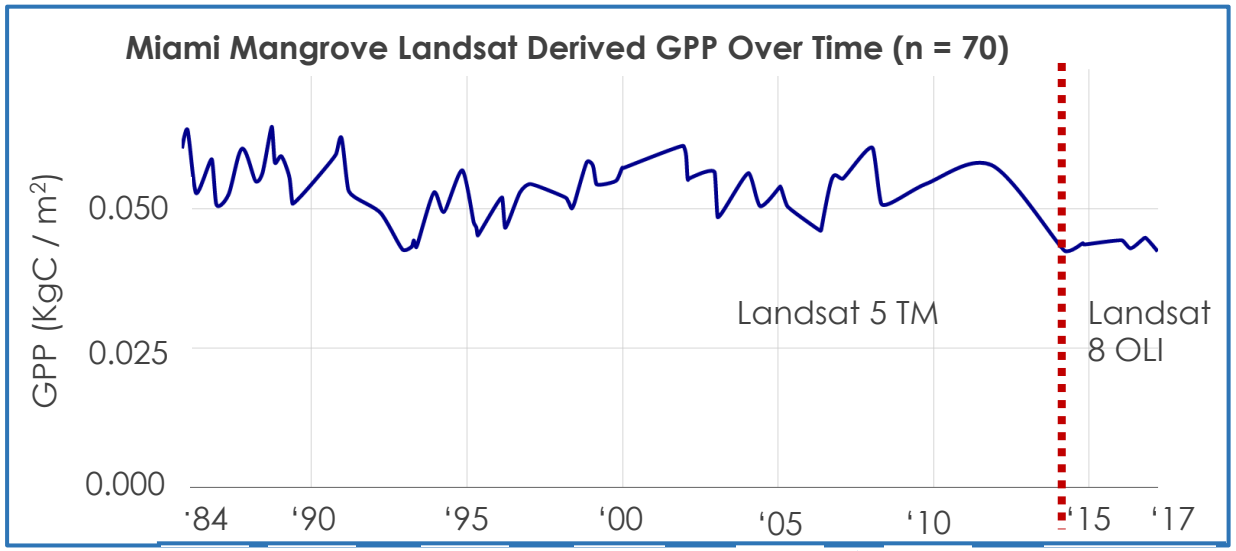


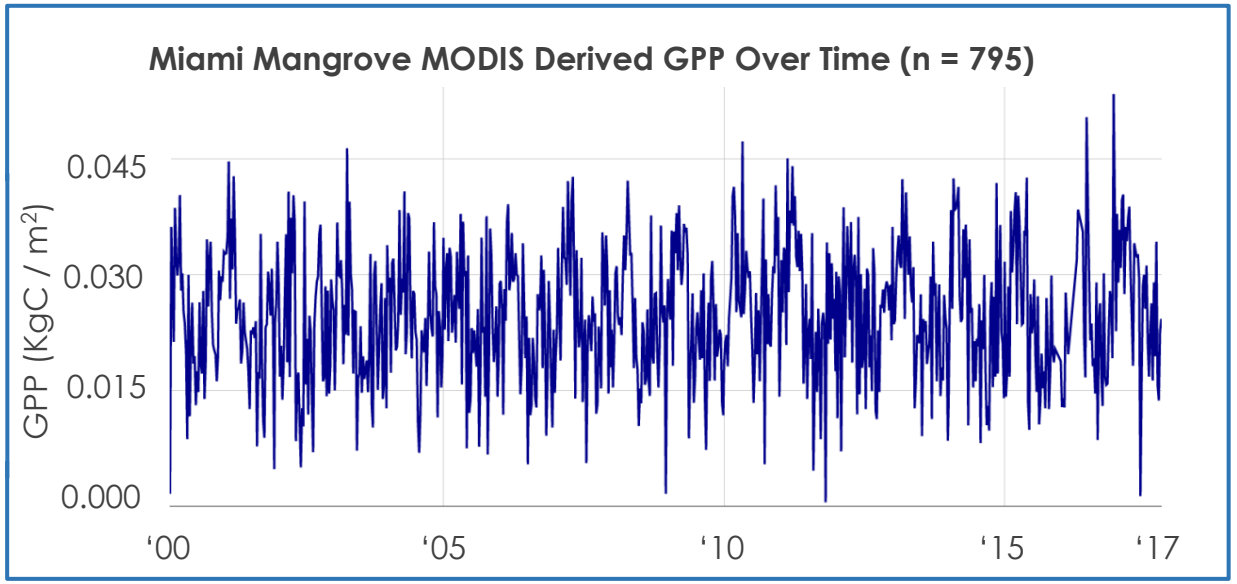
Methods – Mangrove Health



Results – Mangrove Health



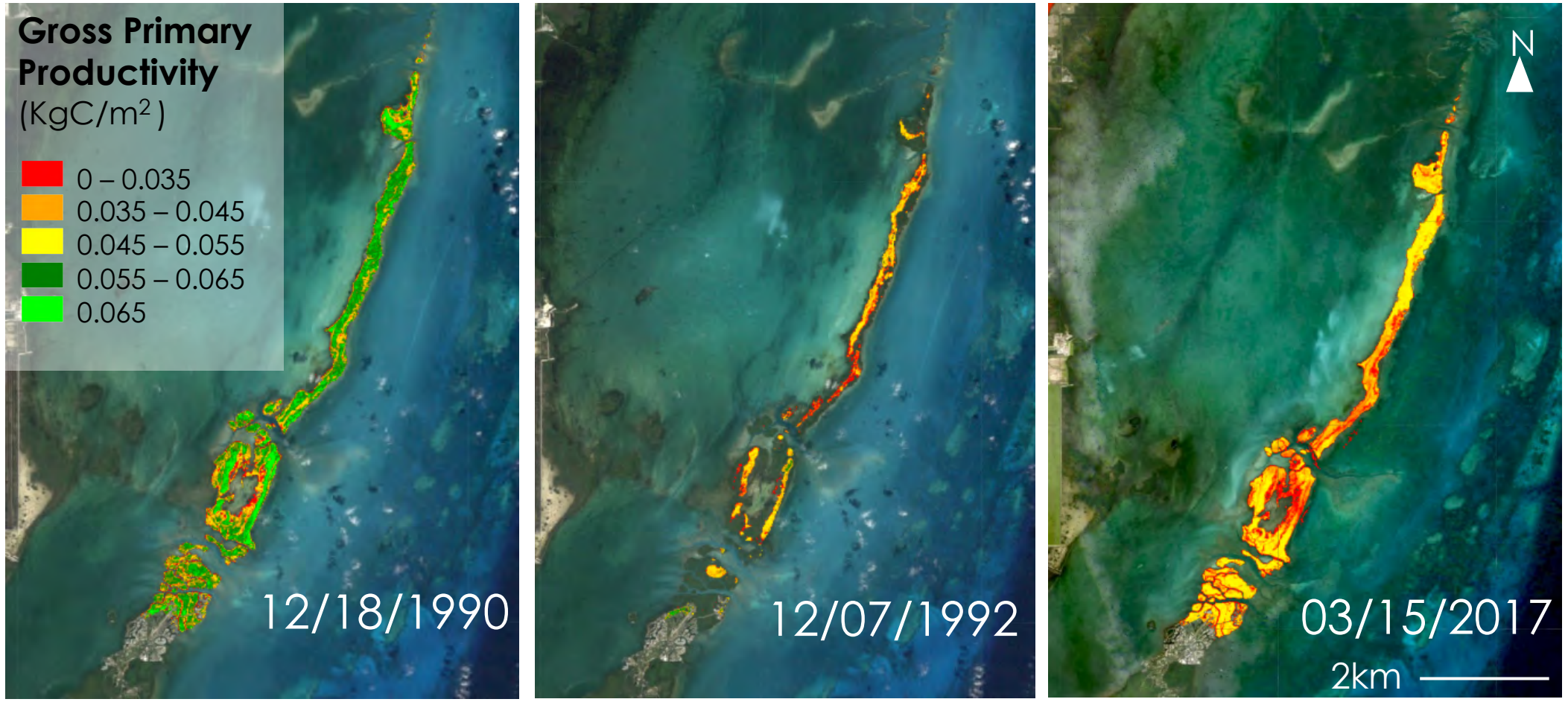




GPP=0.096926*EVI + 0.0003819

Where, EVI = 2.5 [(NIR - Red)/(1+NIR+2.4*Red)]

Results – Mangrove Health



Conclusions – Mangrove Health


Image Credit: Sevag Mehterian

- **Mangrove forests** in Biscayne National Park represent **effective**, **self-sustaining green infrastructure**
- They exhibit **resiliency** in both hurricane and non-hurricane years

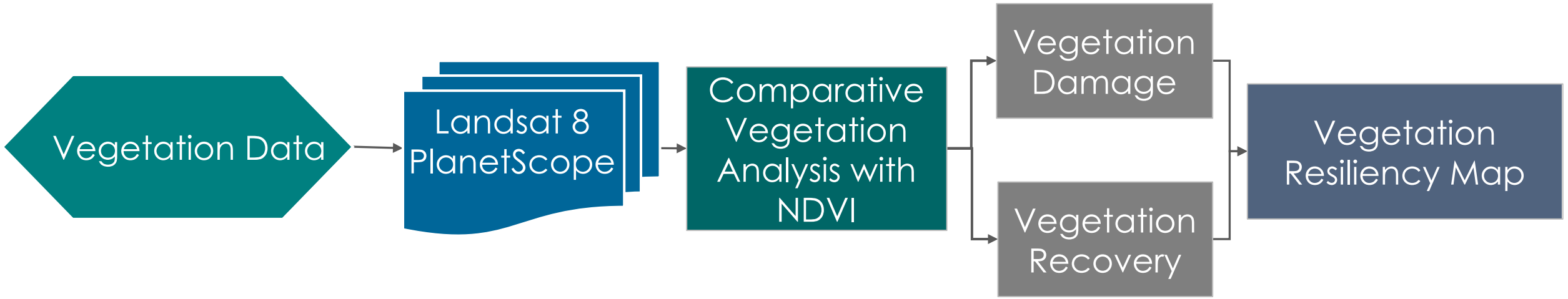
Future Work

- How do the **observed recovery rates** compare with **previous** recovery rates?
- How do **storm impacts** affect **vegetation coverage**?
- What are the **most suitable** places for the **implementation** of **green infrastructure** in Miami Beach?



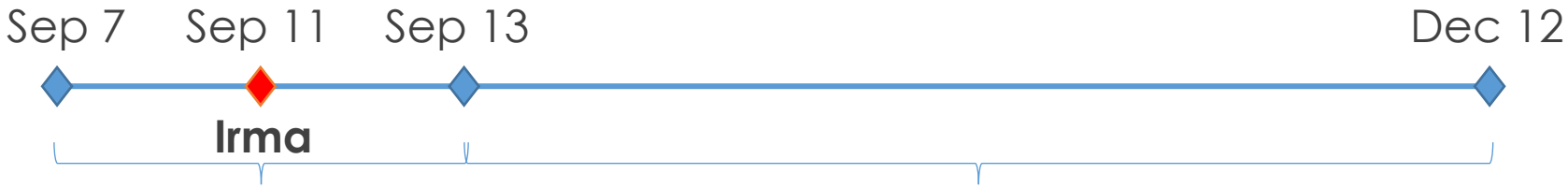
Image Credit: Sevag Mehterian

Vegetation Analysis Methods



Landsat 8 OLI

$$Damage = \frac{NDVI_{Sep\ 07} - NDVI_{Dec\ 12}}{NDVI_{Sep\ 07}}$$

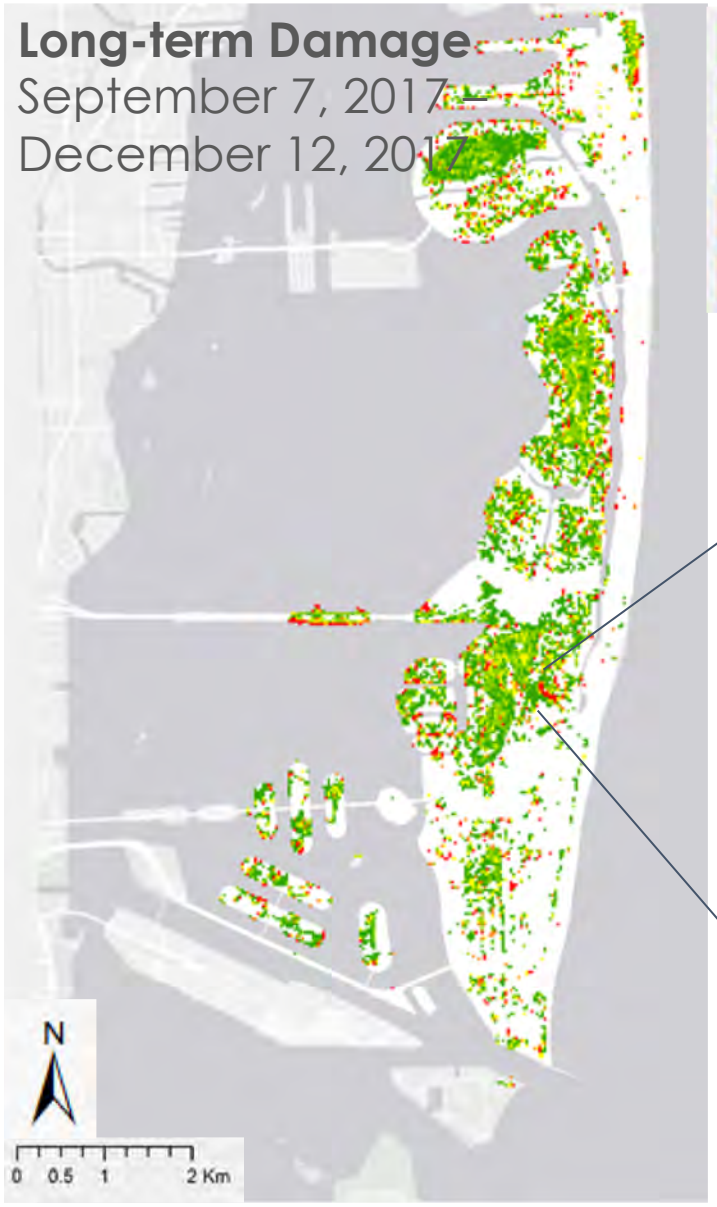


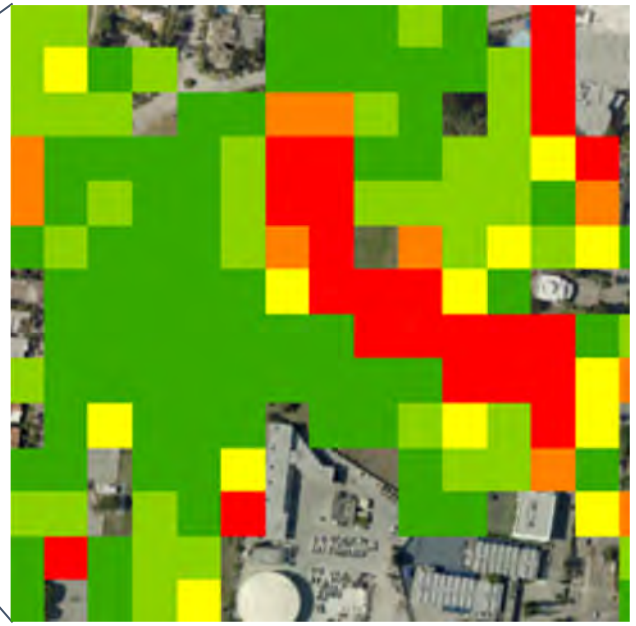
Planet

$$Damage = \frac{NDVI_{Sep\ 07} - NDVI_{Sep13}}{NDVI_{Sep\ 07}}$$

$$Recovery = \frac{NDVI_{Dec\ 12} - NDVI_{Sep13}}{NDVI_{Sep\ 07} - NDVI_{Sep13}}$$

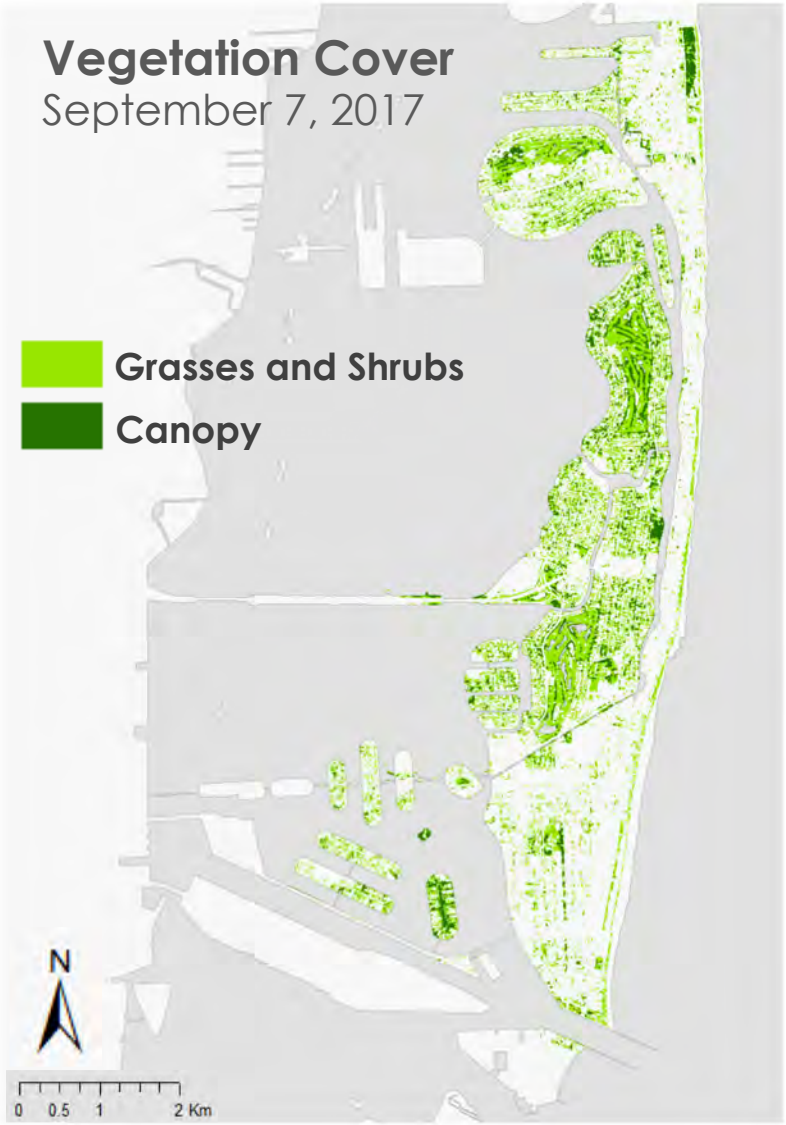
Landsat 8 Results



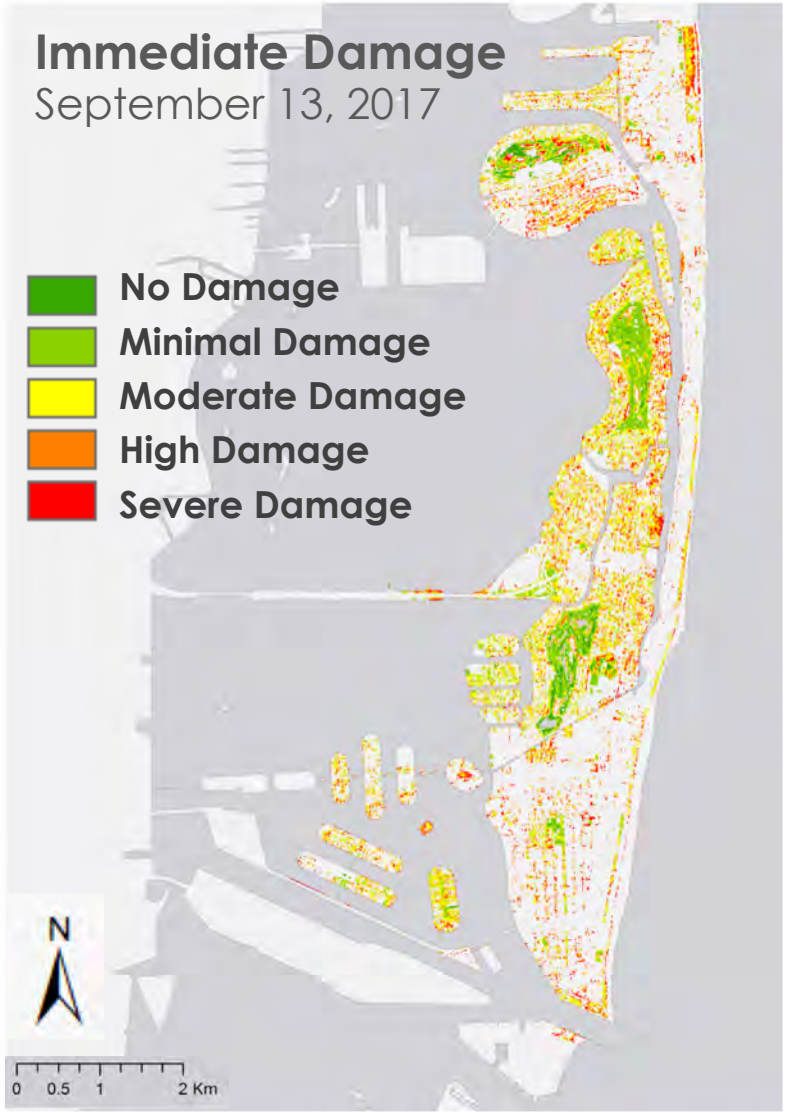




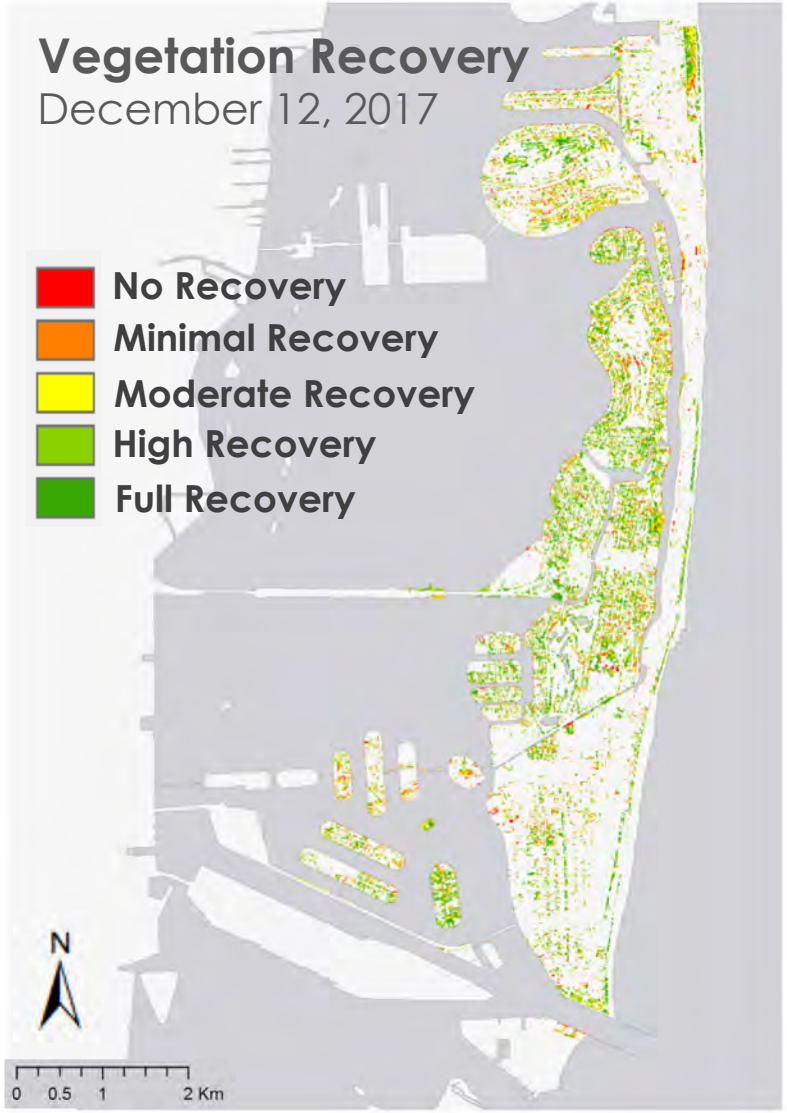
Results



Vegetation cover makes up **30%** of the land



74% of vegetation experienced **moderate to severe damage**



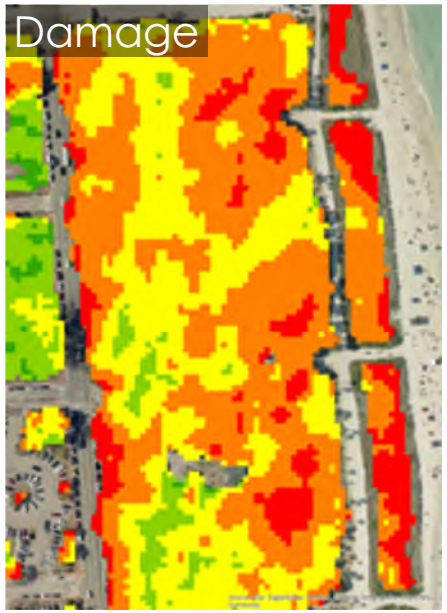
80% of damage was more than **50% recovered**

Results

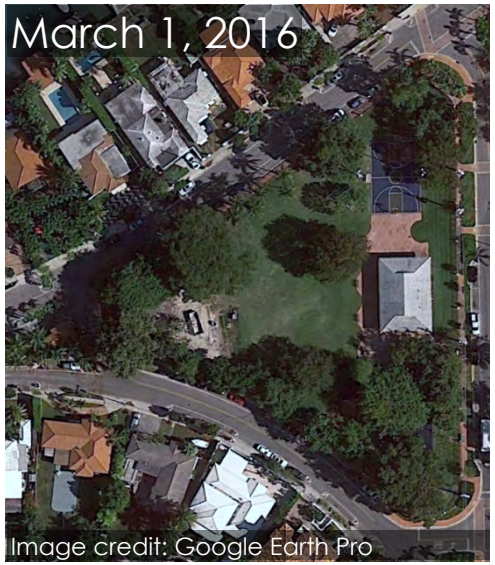
North Shore Park



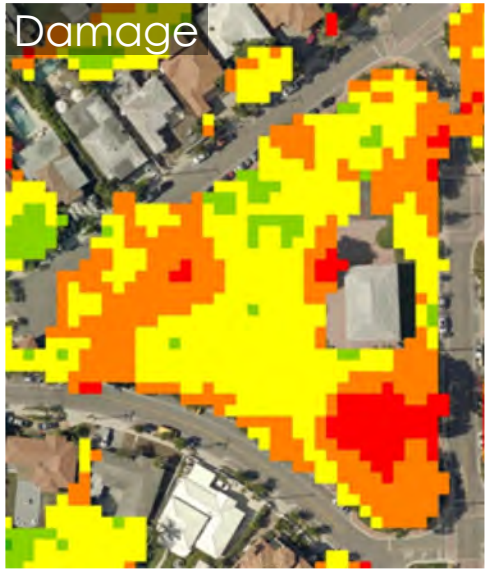




Still Water Park







- No Damage
- Minimal Damage
- Moderate Damage
- High Damage
- Severe Damage

Conclusions – Vegetation Analysis


Image credit: Miami Beach Public Works Department

- Immediately following Hurricane Irma, our analysis showed that **vegetation experienced severe damage.**
- Our results will help our project partners to identify areas and species that demonstrated the **highest rate of resiliency.**

Acknowledgements

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City of Miami Beach, Public Works Department

Bruce Mowry
City of Miami Beach, Public Works Department

Photographs Provided by

Sevag Mehterian (GravelMonkey14)



Image Credit: Sevag Mehterian

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