

# Rapid assessment of wind impacts to urban forests



Steve Norman

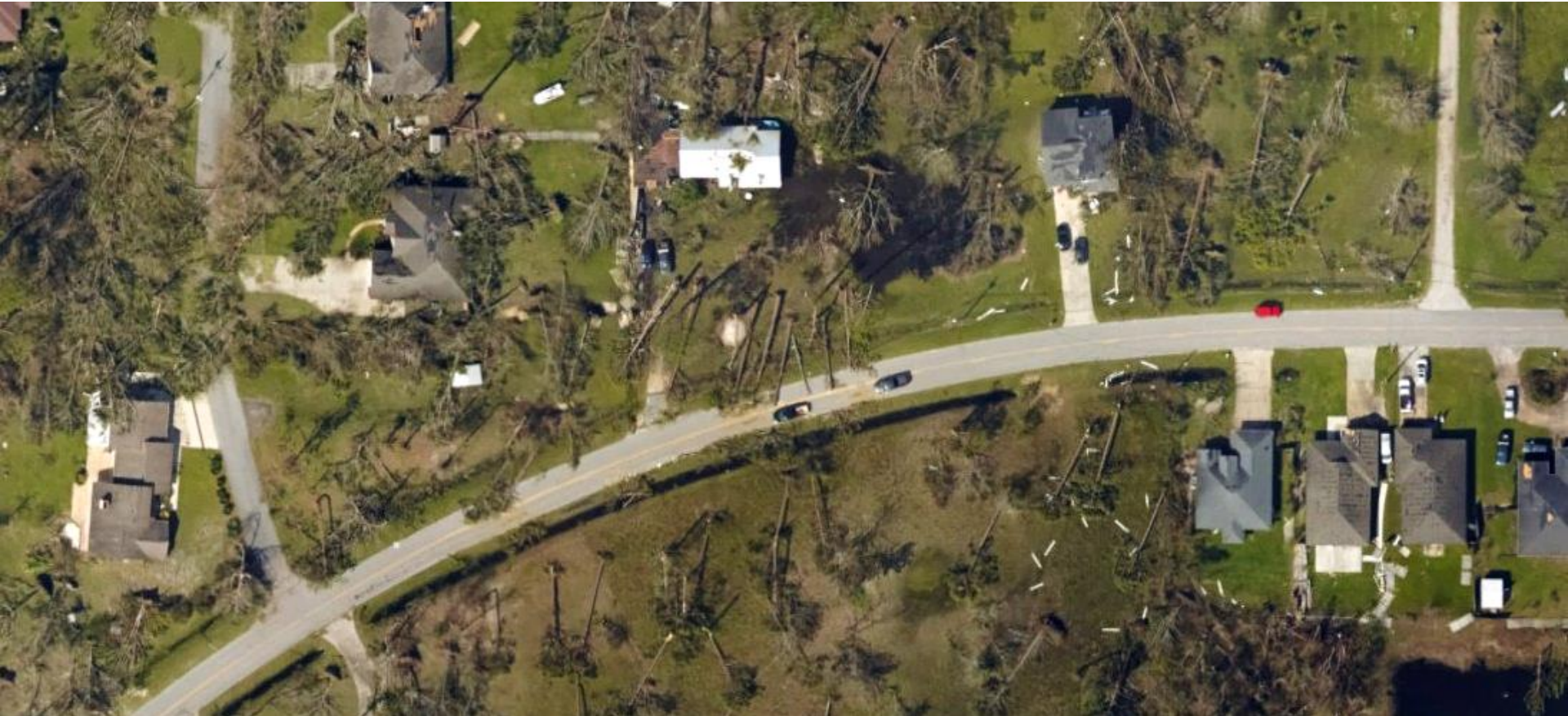
Bill Christie

USDA Forest Service Southern Research Station

*USDA Forest Service Urban Forest Connections Webinar Series*

*“Extreme Events in the Urban Forest: Assessment, Response, and Recovery”*

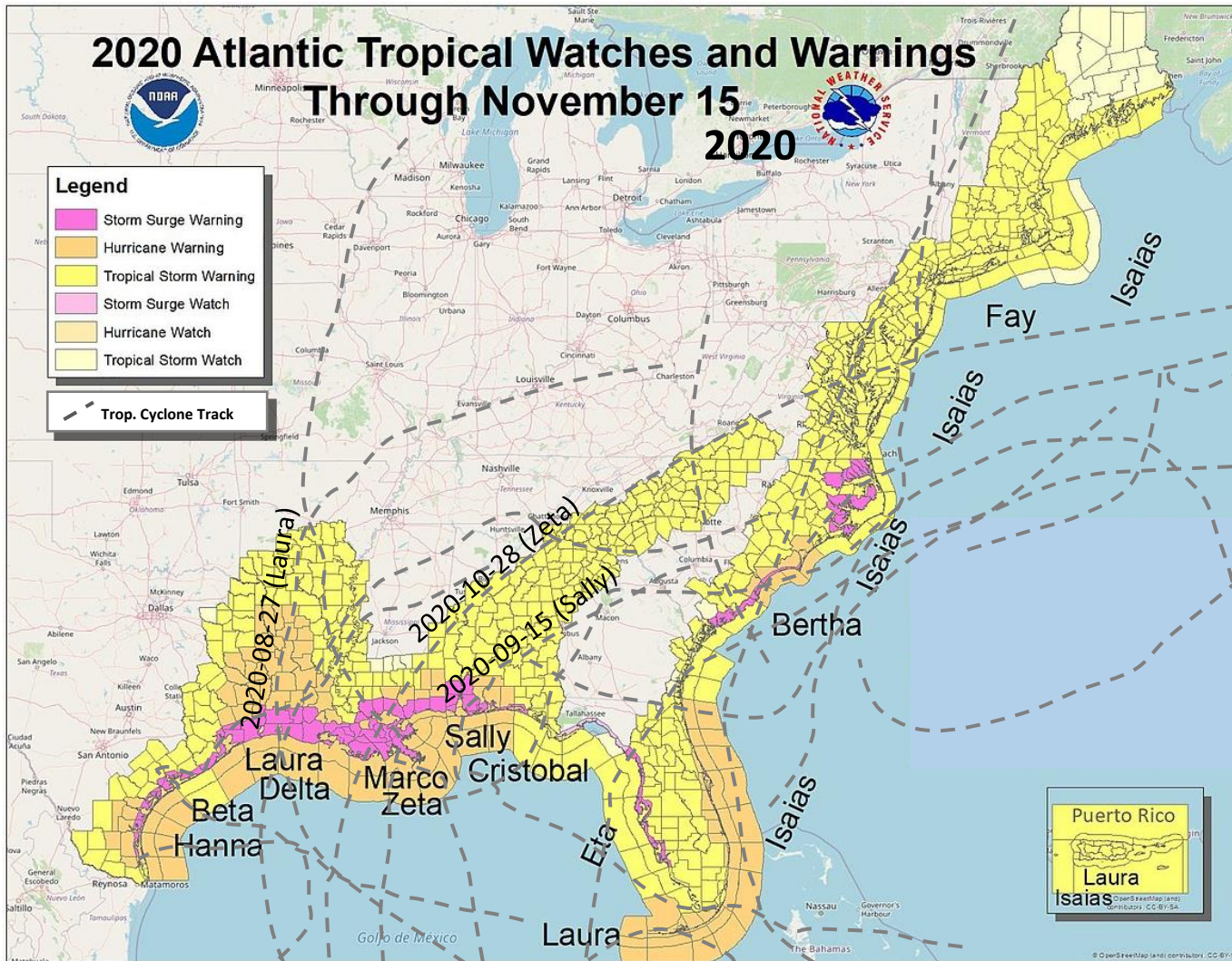
*10 February 2021*



*Source: NOAA emergency imagery, 2018 Hurricane Michael's devastation on 12<sup>th</sup> Street, Lynn Haven, FL*



# The need is clear (and growing)



H. Laura 2020-08-26

The 2020 Atlantic hurricane season was the most active on record with thirty named storms, twelve of which made landfall onto the US mainland.

**SOURCE:** Modified from NWS Corpus Christi  
<https://commons.wikimedia.org/w/index.php?curid=96207418>



## OUTLINE

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- I. What is *rapid assessment* and how can imagery help?
- II. What imagery is available?
  - Very-high-resolution aerial imagery
  - Coarser satellite imagery for change detection...and what are their tradeoffs?
- III. Implications of urban forest loss.





# I. What is *rapid assessment* and how can imagery help?

## DEFINITION

**Rapid Assessment**—The swift collection and evaluation of intelligence soon after some type of incident (*e.g.*, a hurricane, tornado, or wildfire).

## Why rapidly assess?

- To gather time-sensitive information.
- To identify areas for priority response.
- To estimate damage for emergency financial support.

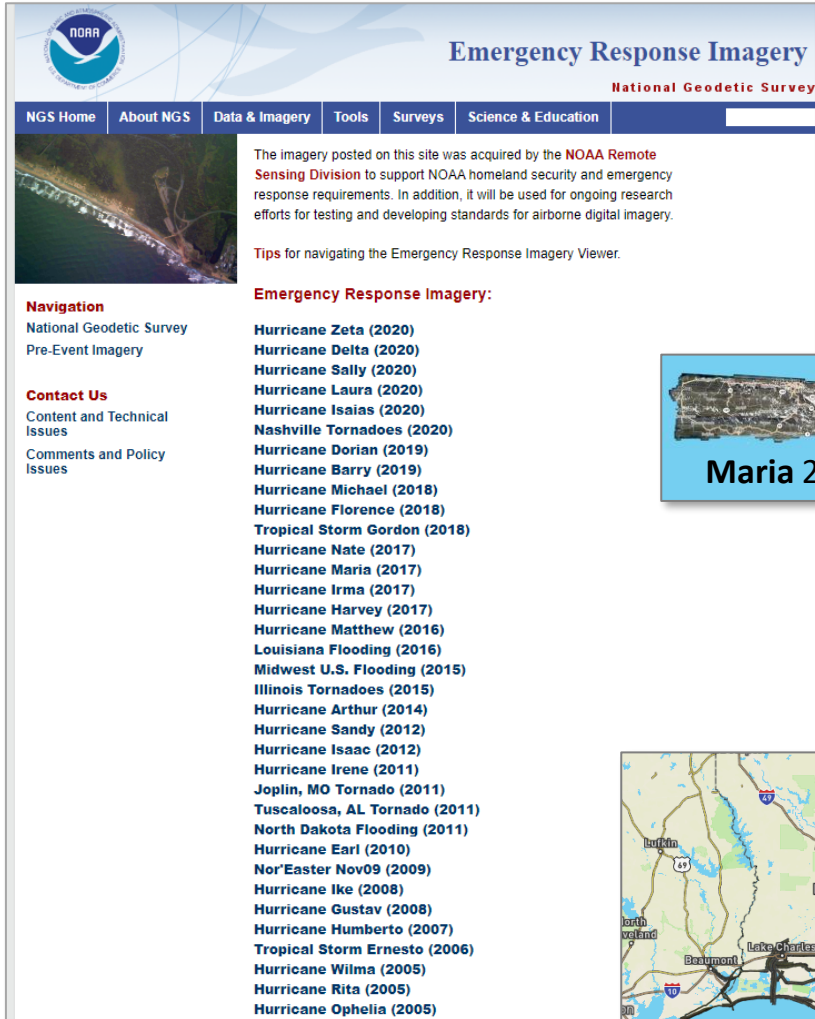
## What's the role of imagery?

- It's hard, otherwise, to assess landscape impacts.
- Recurrent analyses using imagery provides a valuable planning and monitoring strategy (*e.g.*, recovery).



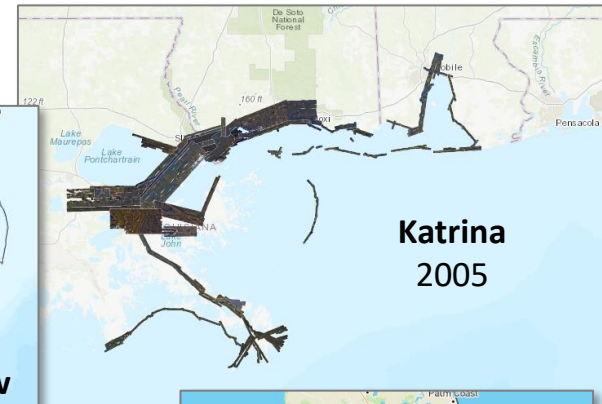
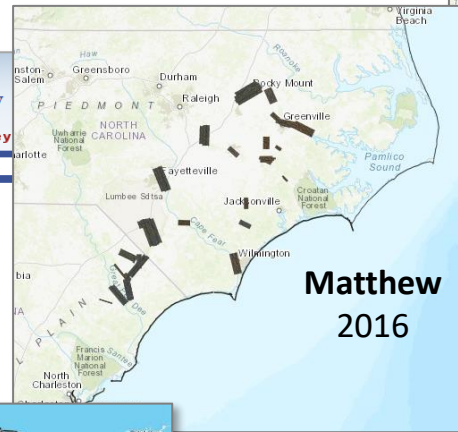
# II. What imagery is available?

## NOAA Emergency Response Imagery



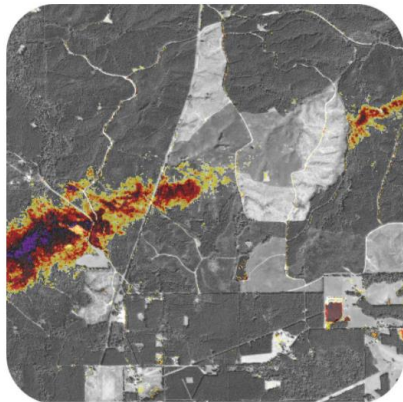
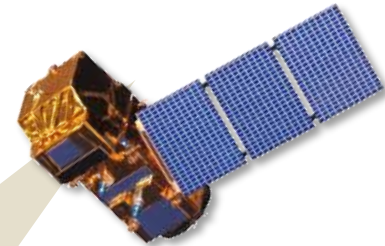
The screenshot shows the NOAA Emergency Response Imagery website. At the top left is the NOAA logo. The main heading is "Emergency Response Imagery" with the "National Geodetic Survey" logo below it. A navigation bar includes links for "NGS Home", "About NGS", "Data & Imagery", "Tools", "Surveys", and "Science & Education". A search bar is present on the right. Below the navigation bar is a small satellite image of a coastline. To the right of the image is a text block: "The imagery posted on this site was acquired by the NOAA Remote Sensing Division to support NOAA homeland security and emergency response requirements. In addition, it will be used for ongoing research efforts for testing and developing standards for airborne digital imagery." Below this is a link for "Tips for navigating the Emergency Response Imagery Viewer." A list of "Emergency Response Imagery:" follows, including events from 2005 to 2020 such as Hurricane Zeta, Delta, Sally, Laura, Isais, Nashville Tornadoes, Dorian, Barry, Michael, Florence, Tropical Storm Gordon, Nate, Maria, Irma, Harvey, Matthew, Louisiana Flooding, Midwest U.S. Flooding, Illinois Tornadoes, Arthur, Sandy, Isaac, Irene, Joplin, MO Tornado, Tuscaloosa, AL Tornado, North Dakota Flooding, Earle, Nor'Easter Nov09, Ike, Gustav, Humberto, Tropical Storm Ernesto, Wilma, Rita, and Ophelia.

<https://storms.ngs.noaa.gov/>



# II. What imagery is available?

## HiForm (High-resolution Forest mapping)



Rapidly evolving technologies are revolutionizing the way we monitor forests. These changes include the ability to monitor impacts from forest disturbances with higher spatial detail and frequency than ever before thanks to the availability of new satellites and cloud computing. Progress also depends on our ability to transfer this technology in ways that make sense to those who need it. With these applied needs in mind, this Forest Service Research and Development initiative is designed to demonstrate the forest monitoring that is now possible, to refine ways that these capabilities can be best adapted for managers, and to improve insights about eastern US forest dynamics more fundamentally.

HiForm utilizes 10 meter Sentinel-2 and 30 meter Landsat 5 and 7 to produce NDVI change products. We also research landscape applications of LIDAR and new approaches to track forest dynamics at this level of detail for longer term planning and monitoring. Our emphasis is on eastern US forests, with particular focus on the Southeast and Appalachians.

For weekly MODIS (240 meter) resolution change maps for the conterminous US, see our sister project, *ForWarn II*.

### Projects



Severe Weather



Wildland Fire



Insects and Diseases

Mapping Workflow  
Acknowledgements

About

Contact Us

Accessibility Statement  
FOIA  
Information Quality

Privacy Policy  
Plain Writing

Non-Discrimination Statement  
USA.gov

## HiForm's Google Earth Engine interface

Google Earth Engine Search places and datasets...

Layers

- State borders
- County borders
- FS Proclaimed
- Hillshade
- NDVI change-forest
- NDVI change-all lands
- NDVI change-all
- Post-date used
- Post true color
- Pre-date used
- Post true color

**NDVI Change**

- >26
- 11 to 25
- 6 to 10
- 3 to 5
- 4 to -6
- 7 to -9
- 10 to -12
- 13 to -15
- 16 to -18
- 19 to -21
- 22 to -25
- 26 to -29
- 30 to -33
- 34 to -37
- <-37

Open/Close Panel

HiForm.org Change Script

Choose satellite

LANDSAT/LT05/C01/T1\_SR

Valid Date Range: 1984-01-01 - 2012-05-05

Pre-Disturbance Image dates

**2010-06-02**  
**2010-06-30**

Post-Disturbance Image dates

**2011-06-02**  
**2011-06-30**

Do the change analysis

Export image to Google Drive

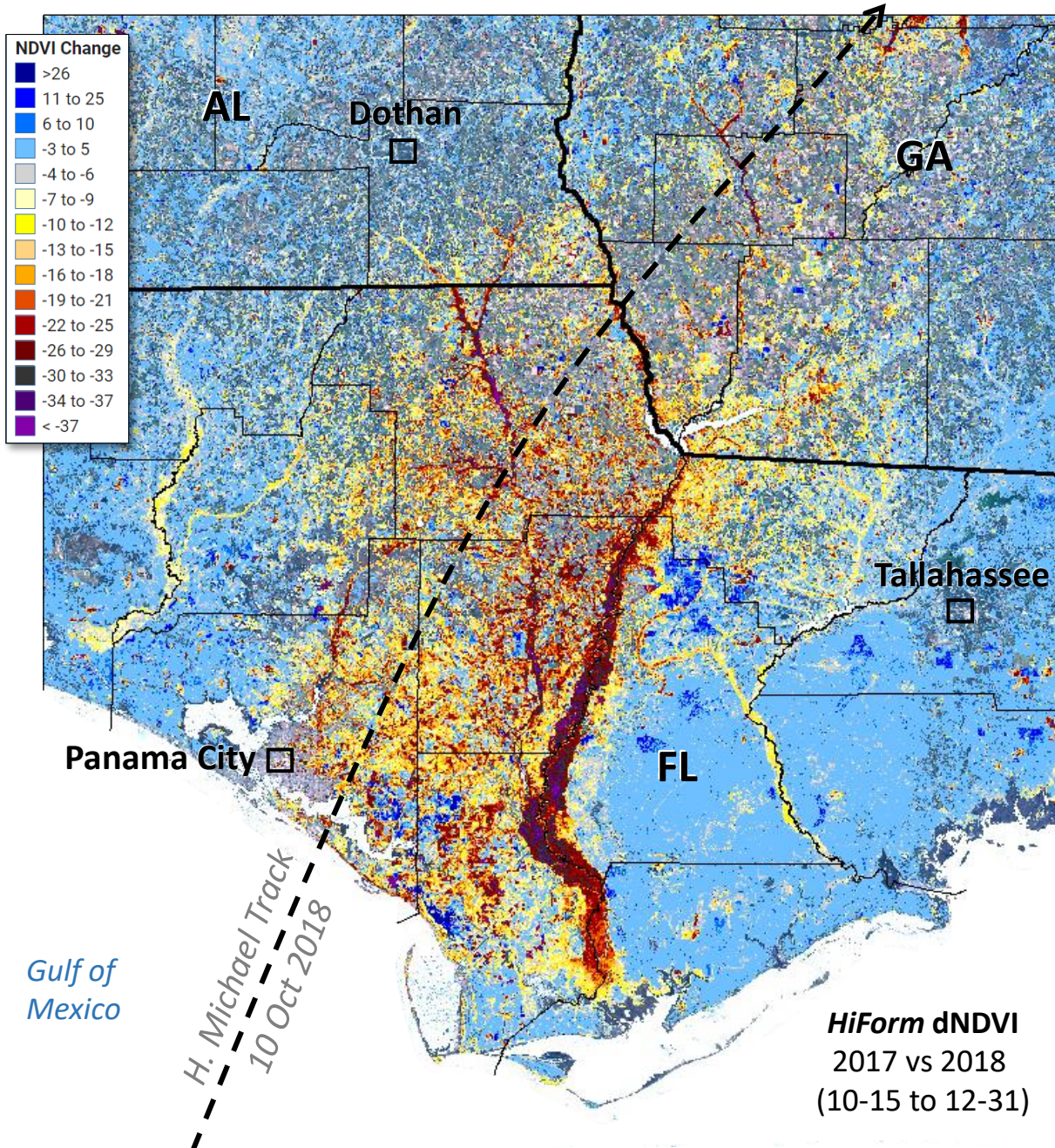
Update URL for sharing

Click on a location to see the date used

ver. 12/15/2020



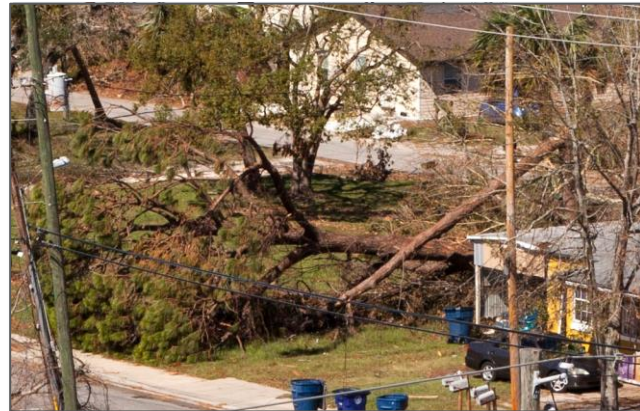
# HiForm's forest impacts from H. Michael



Alabama Forestry Commission



Florida Forest Service



Wikipedia: Patrick Bray

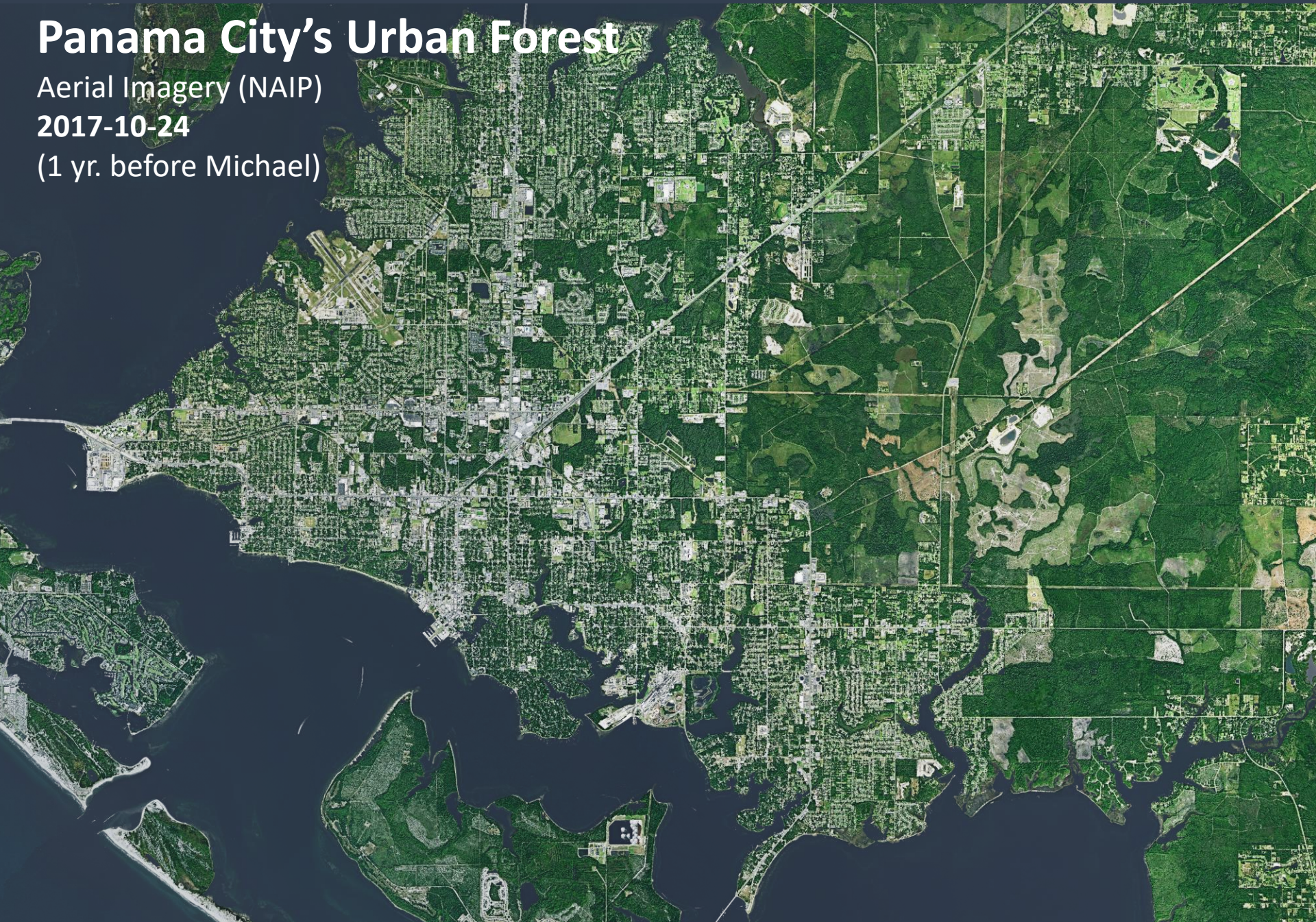


# Panama City's Urban Forest

Aerial Imagery (NAIP)

2017-10-24

(1 yr. before Michael)



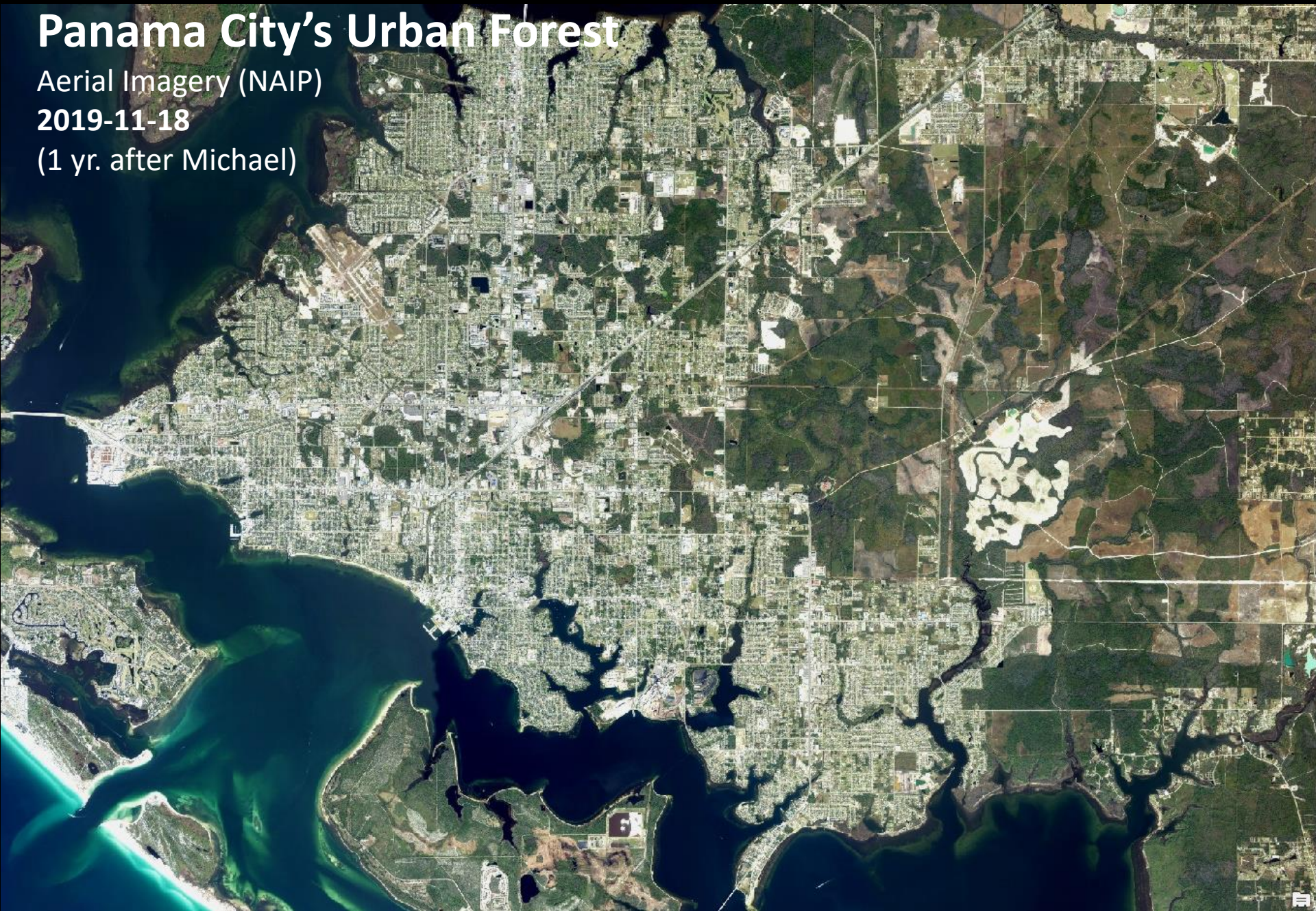


# Panama City's Urban Forest

Aerial Imagery (NAIP)

2019-11-18

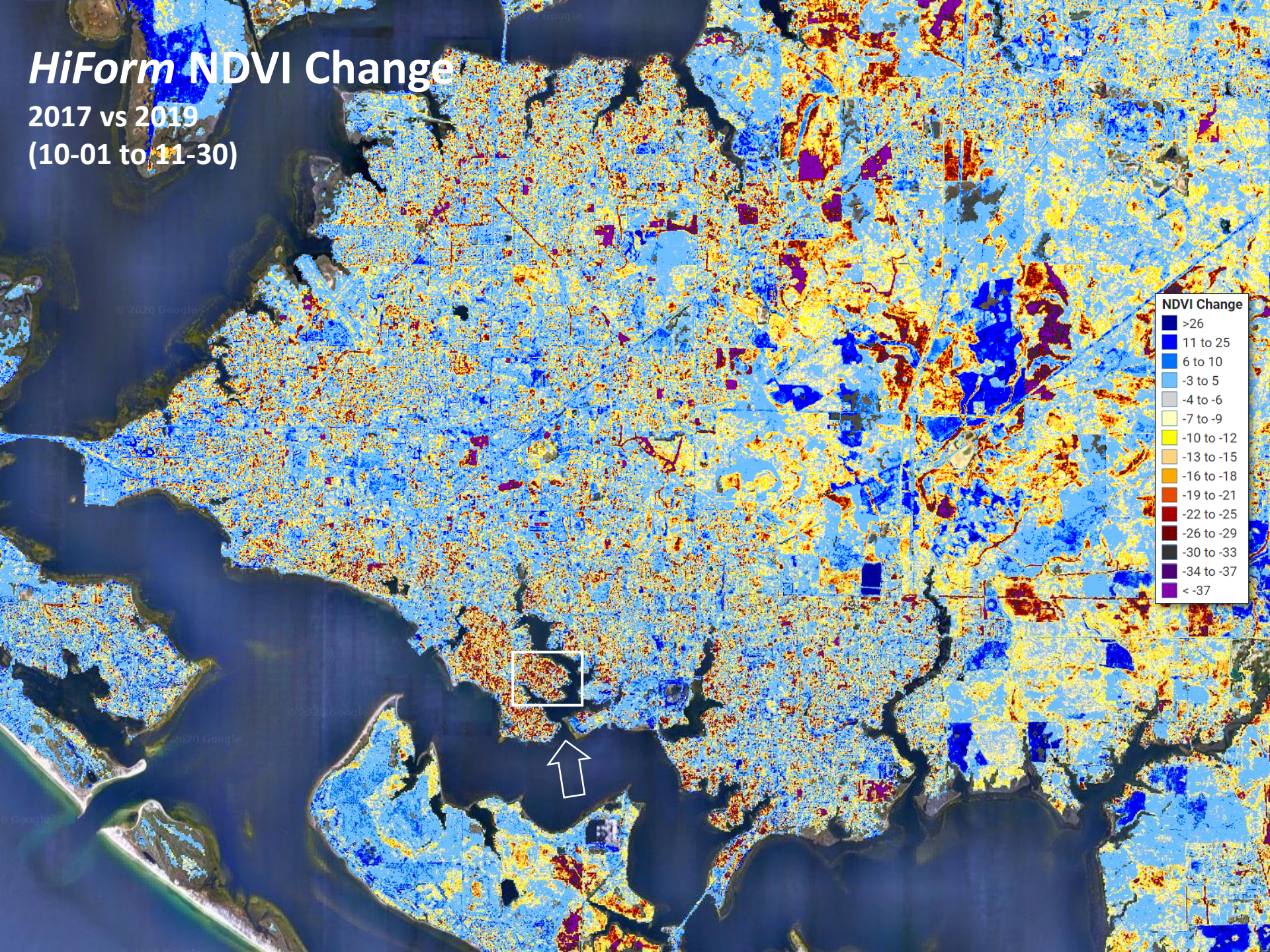
(1 yr. after Michael)





# HiForm NDVI Change

2017 vs 2019  
(10-01 to 11-30)





Panama City, FL  
2017 Aerial Imagery



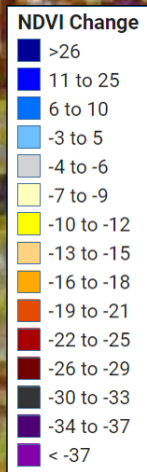


Panama City, FL  
2019 Aerial Imagery

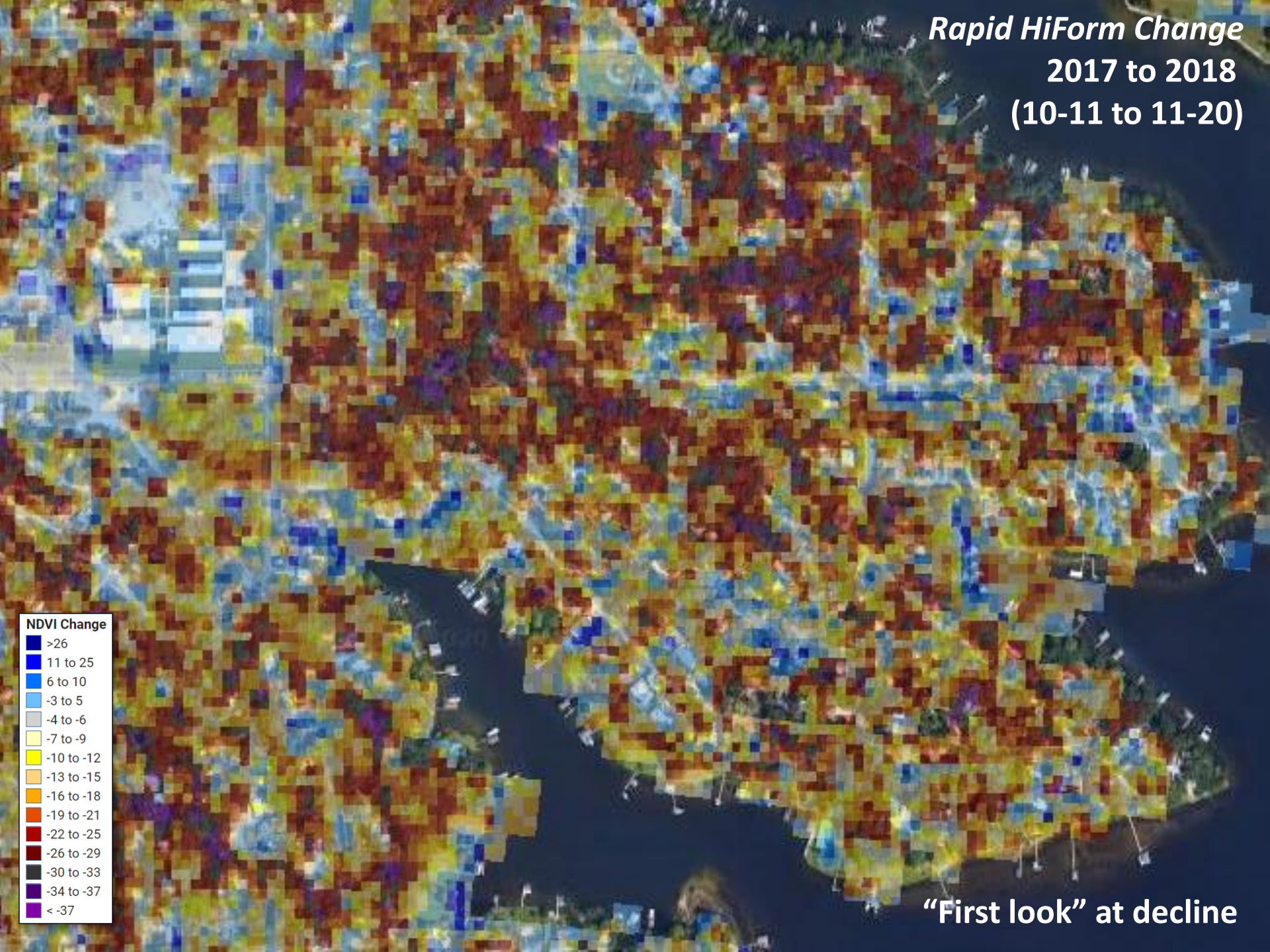




***Rapid HiForm Change***  
**2017 to 2018**  
**(10-11 to 11-20)**

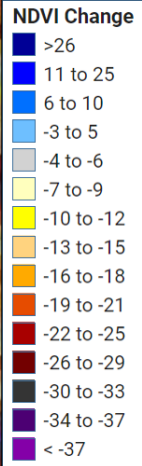


**“First look” at decline**

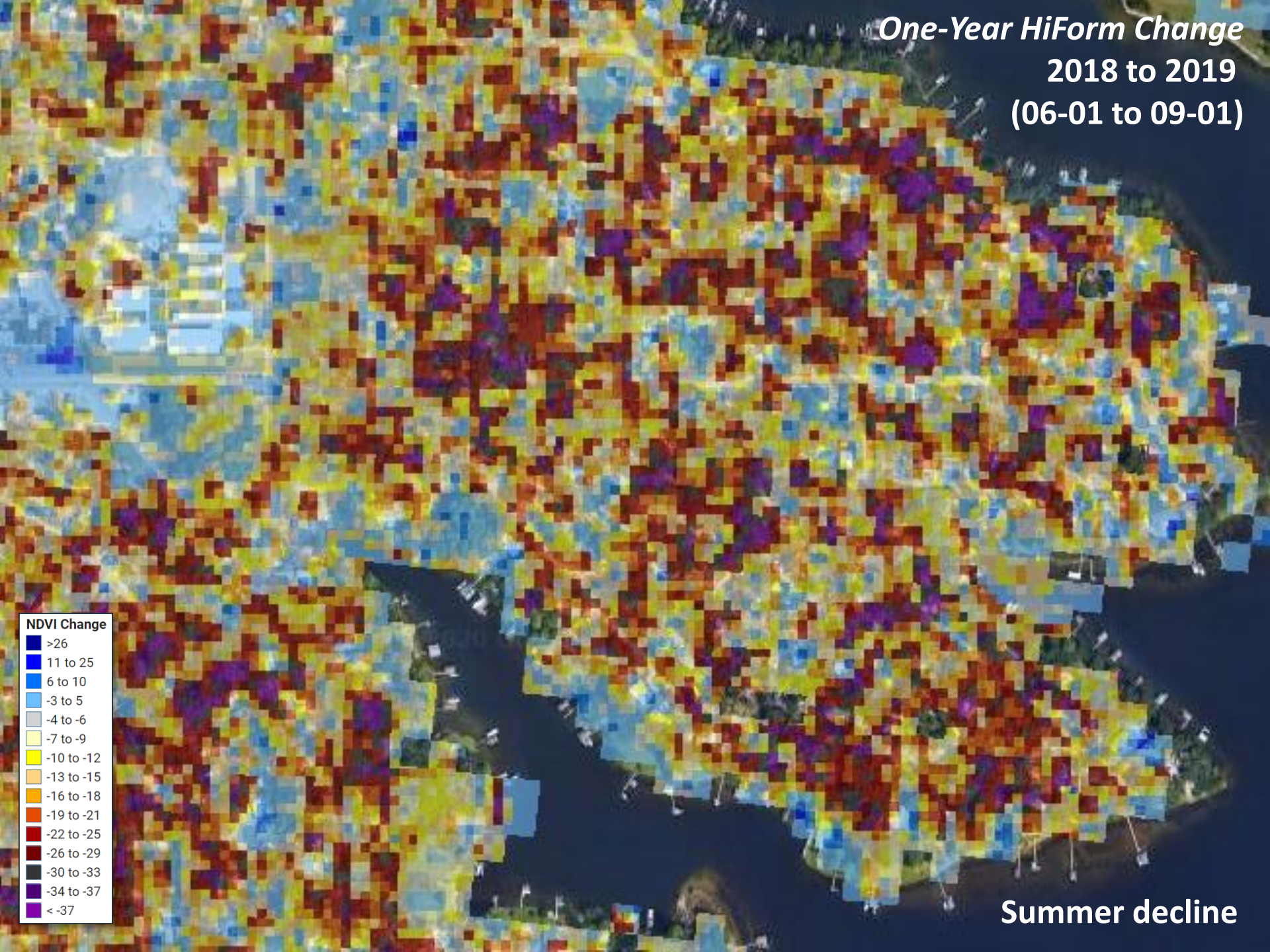




*One-Year HiForm Change*  
2018 to 2019  
(06-01 to 09-01)

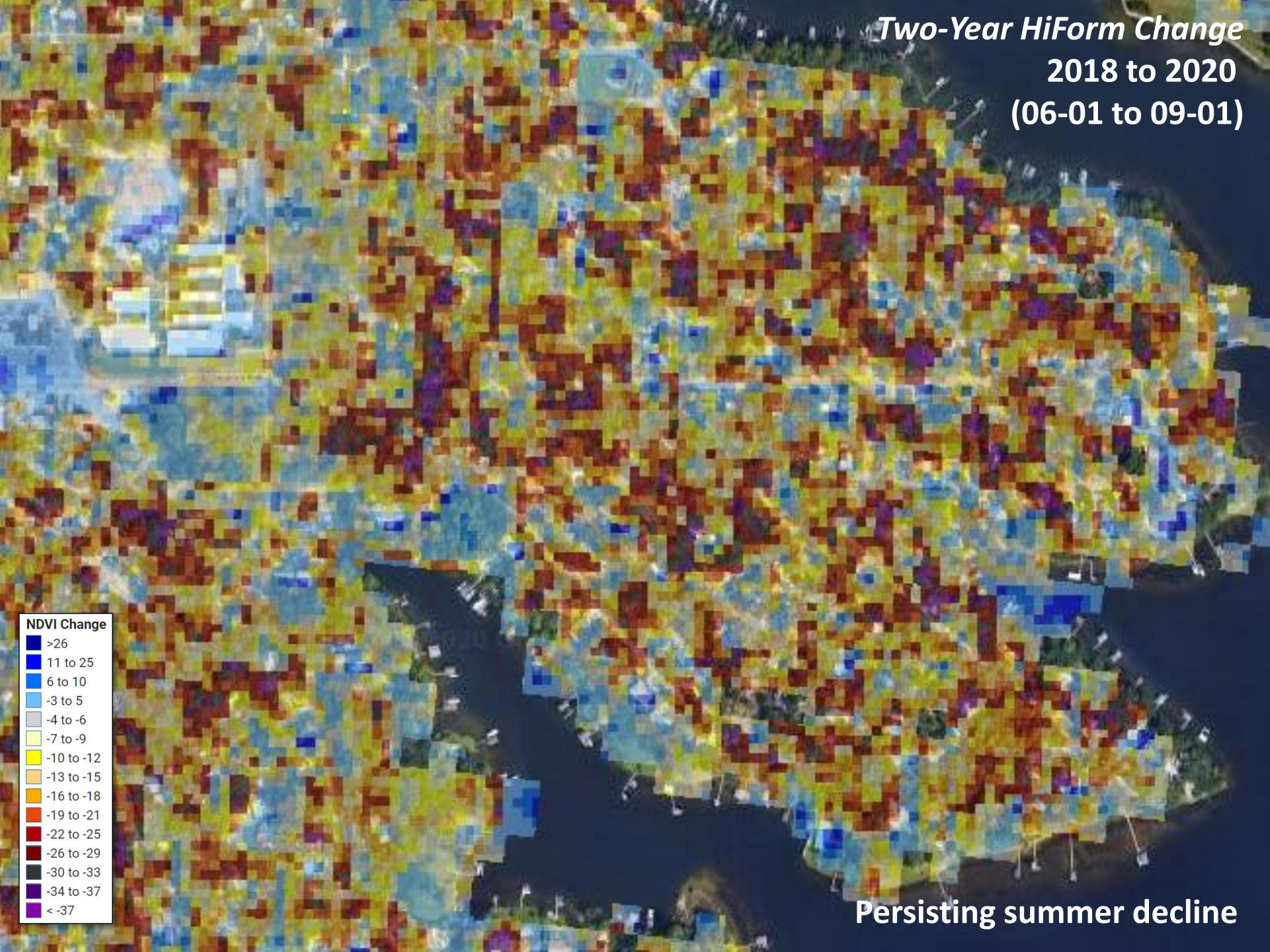


**Summer decline**





*Two-Year HiForm Change*  
2018 to 2020  
(06-01 to 09-01)



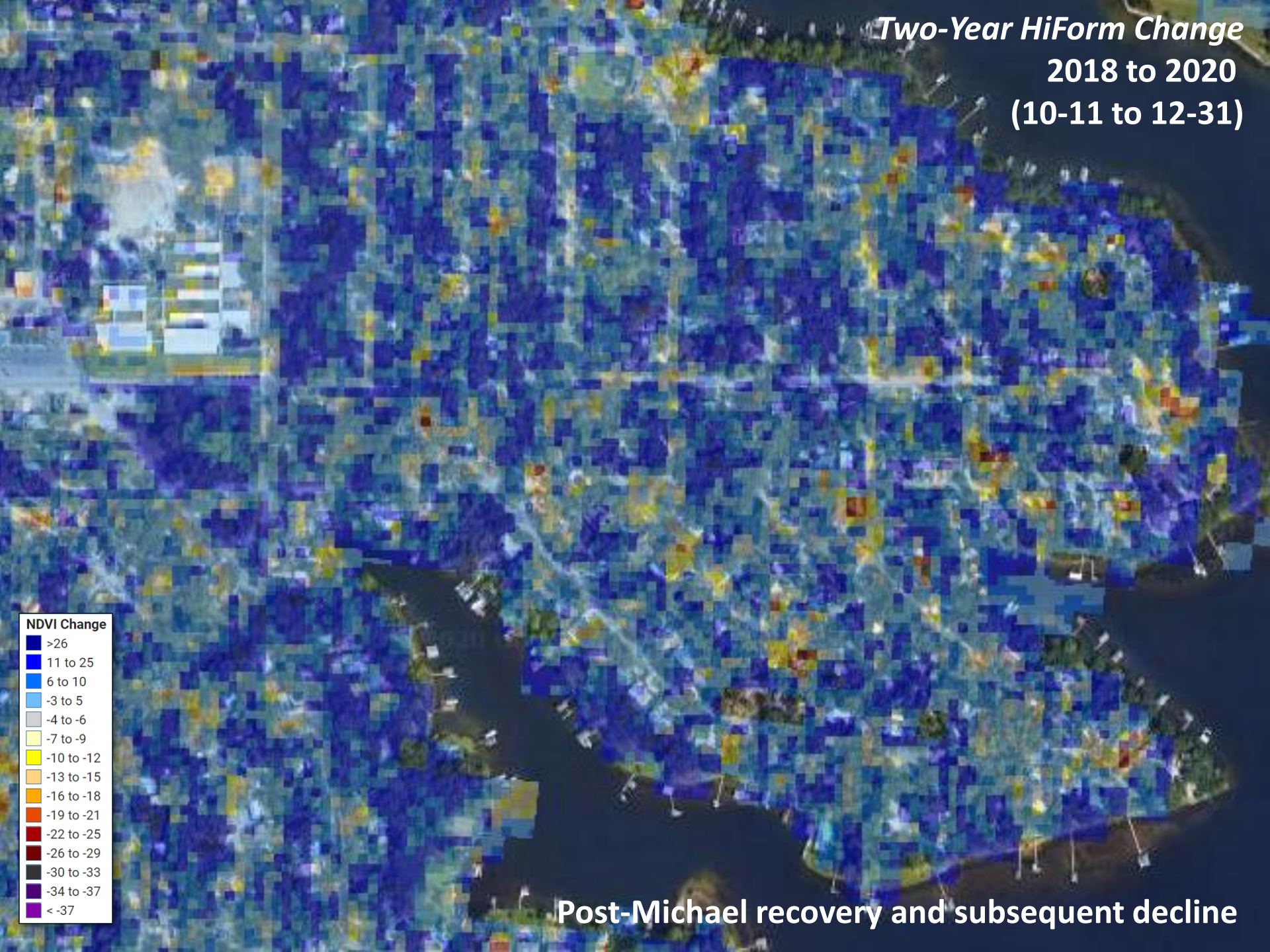
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- 30 to -33
- 34 to -37
- < -37

**Persisting summer decline**



*Two-Year HiForm Change*  
2018 to 2020  
(10-11 to 12-31)



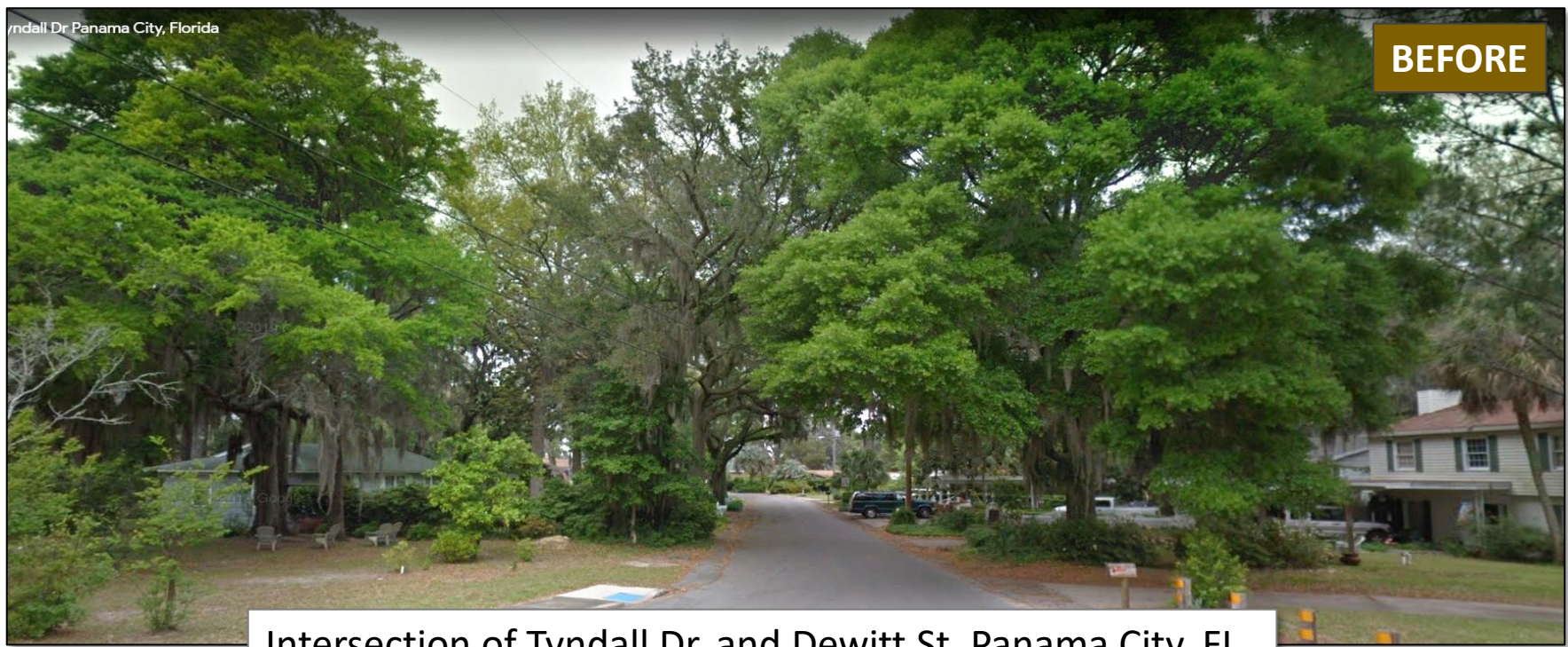
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- 22 to -25
- 26 to -29
- 30 to -33
- 34 to -37
- < -37

**Post-Michael recovery and subsequent decline**

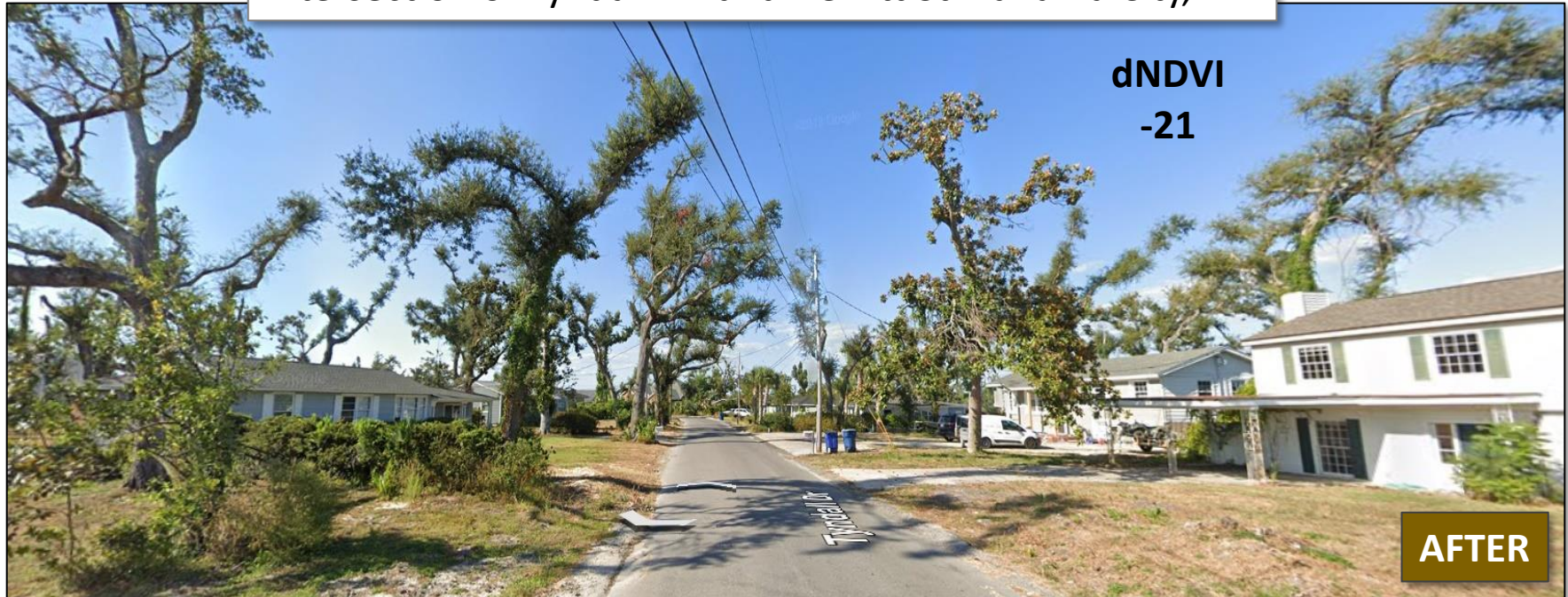


**BEFORE**



Intersection of Tyndall Dr. and Dewitt St. Panama City, FL

**dNDVI  
-21**



**AFTER**



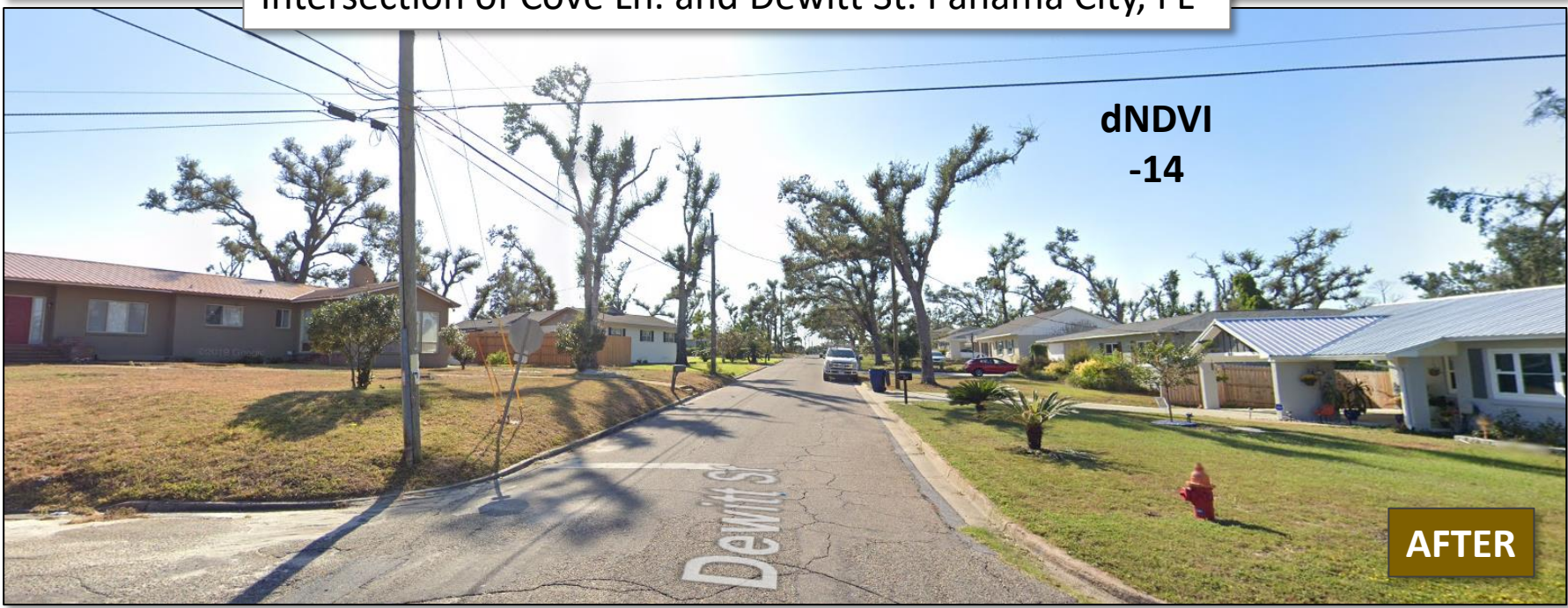
Credit: Google Earth Street view

**BEFORE**



Intersection of Cove Ln. and Dewitt St. Panama City, FL

**dNDVI  
-14**



**AFTER**



# Options for time-sensitive urban forest damage assessment

## SUMMARY



**Restrictions:** None.

**Limitations:** Clouds often delay acquisition; the greater need to interpret coarse imagery.

**Rapid uses:** Landscape to regional assessment of the storm's "footprint" and relative impacts; easy updates.



**Restrictions:** Agency-managed (*e.g.*, NOAA).

**Limitations:** Not always available after an event; limited coverage; clouds can delay acquisition; large file processing time and costs.

**Rapid uses:** Detailed insights to compare with prior imagery.

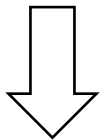
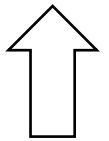


**Restrictions:** Low height (<400 ft.) limits coverage; line-of-sight; not < 5mi. airports; not over people; additional jurisdictional restrictions; special response constraints; operator licenses/authorizations.

**Limitations:** Acquisition and processing time and costs; troublesome mosaic artifacts; biased neighborhood coverage.

**Rapid uses:** Highly detailed site to neighborhood insights.

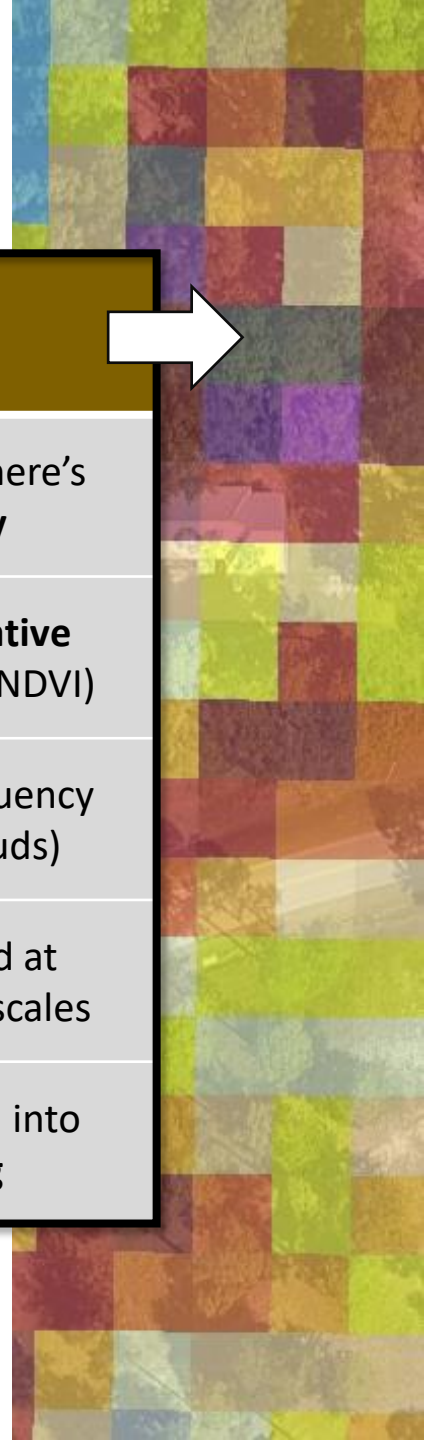
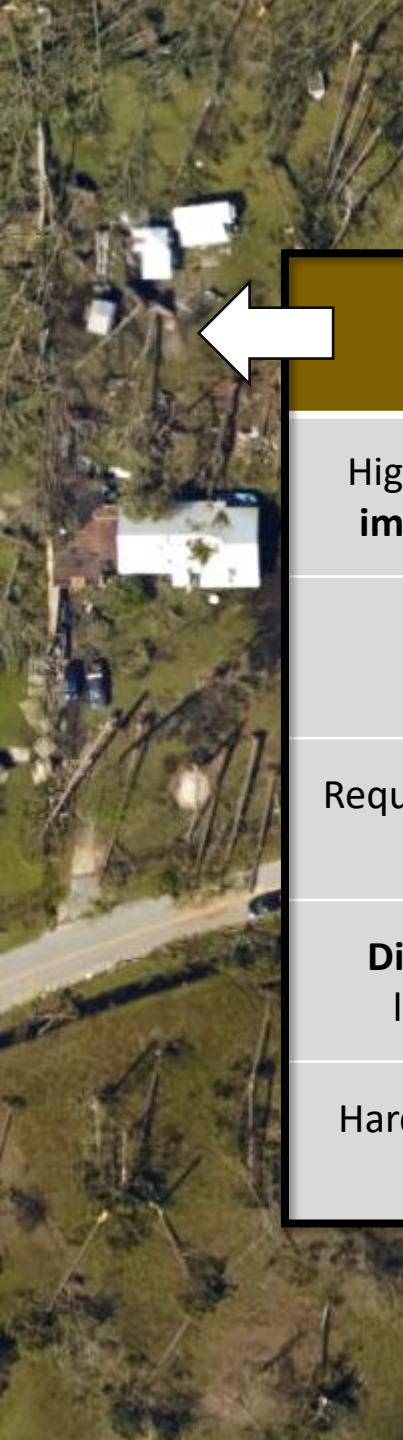
COARSE  
and  
BROAD



FINE  
and  
LOCAL



# Assessment Tradeoffs

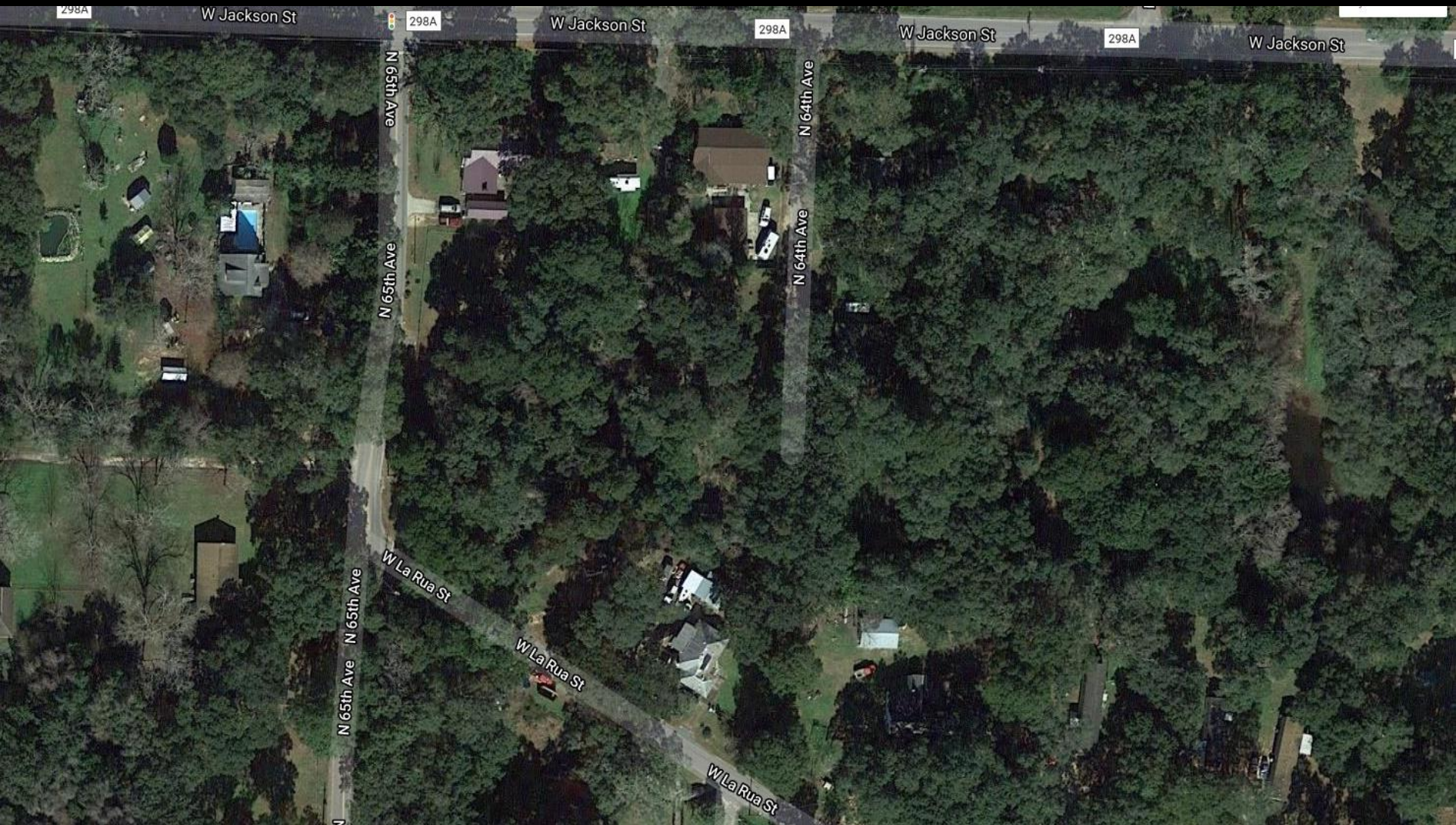


Very-High-Resolution Aerial Event Imagery	Systematic Satellite Imagery
High detail conveys very <b>specific impacts</b> but not all that matter	Lower resolution means there's much more <b>ambiguity</b>
Requires interpretation and feature mapping	Change detection is a <b>relative measure</b> of change ( <i>e.g.</i> , dNDVI)
Requires a <b>special costly flight</b> that can be delayed by clouds	Has <b>regular</b> pass-over frequency (this helps overcome clouds)
<b>Difficult</b> and <b>costly</b> to <b>process</b> large areas if even available	Can be <b>efficiently</b> applied at neighborhood to regional scales
Hard to <b>standardize</b> observations for long term monitoring	More readily incorporated into <b>long term monitoring</b>

*Can we get the best of both approaches with private imagery?  
Can event data and satellite imagery work together?*



# Tradeoffs illustrated – 2020's Hurricane Sally



***Pensacola Pre-Sally aerial imagery (Digital Globe)  
Made landfall 15 Sep 2020***



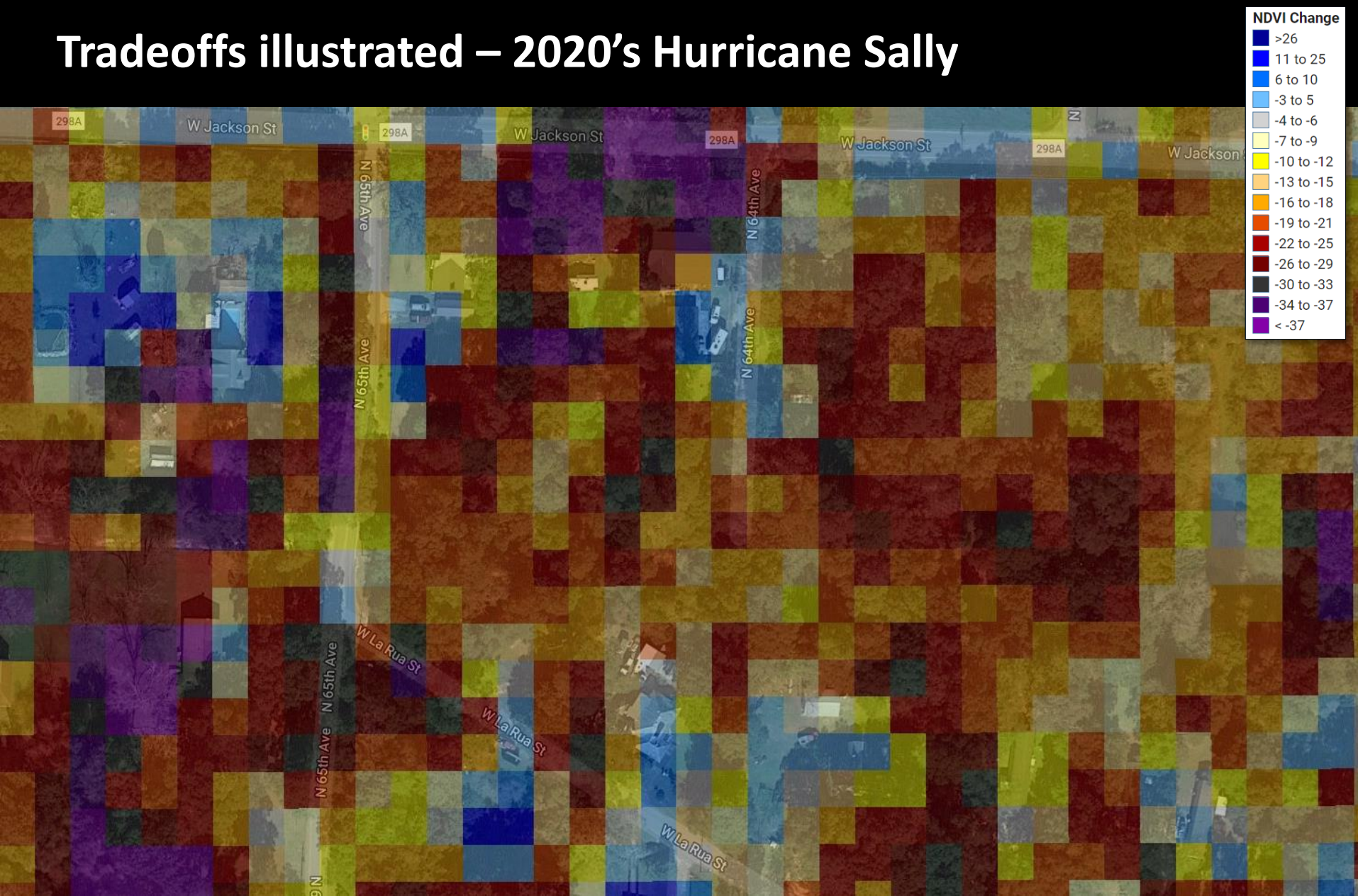
# Tradeoffs illustrated – 2020's Hurricane Sally



*Pensacola Immediate post-Sally aerial imagery (NOAA)  
Made landfall 15 Sep 2020*



# Tradeoffs illustrated – 2020's Hurricane Sally



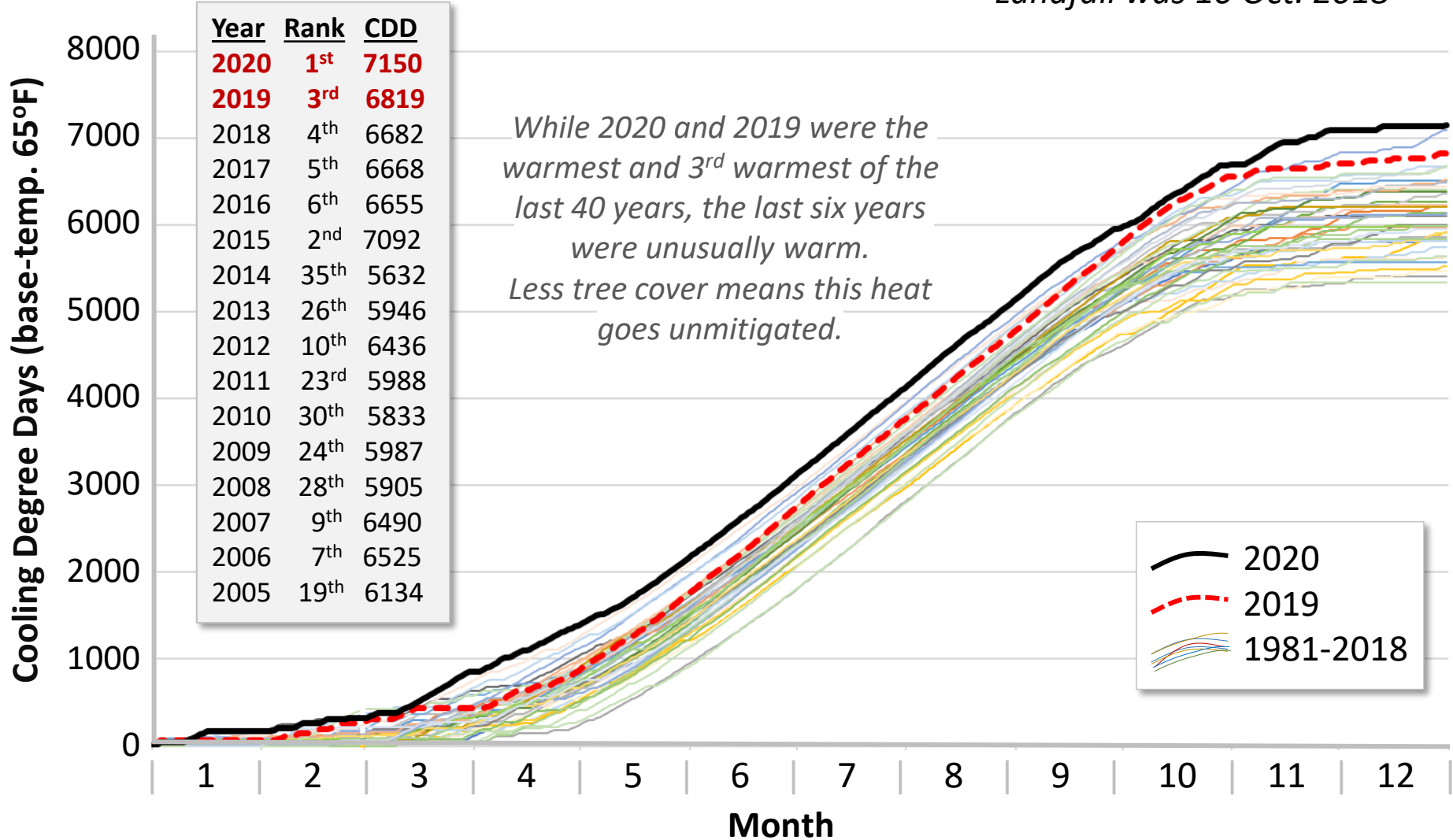
HiForm S2-SR: 2019 vs 2020 (09-25 to 10-01)



### III. Some implications of urban forest loss

Did the massive loss of the Panama City tree canopy after Michael affect temperatures?

*Landfall was 10 Oct. 2018*



Source: 4km PRISM data, 1981-2020; Climate Engine





## SUMMARY

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- I. Mapping technology and data are rapidly evolving, but **assessment** still takes work.
- II. Both very **high-resolution emergency aerial imagery** *and* **satellite change imagery** can help, building on the **strengths** and **tradeoffs** of each.
- III. These ***near-real-time*** and ***long-term*** tools for monitoring the urban forest must compliment **field-based** approaches.





## Useful bookmarks

**NOAA Emergency Response Imagery**

<https://storms.ngs.noaa.gov/>

**Digital Globe** open data for disaster response

<https://www.maxar.com/open-data>

**HiForm:** High Resolution Forest Mapping

<https://hiform.org>

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*Thank you!*



Extreme wind comprises a major and growing hazard for urban forests of the eastern United States as losses from tornadoes and hurricanes mount. After an event, rapid assessments can improve response by efficiently mapping areas of likely damage, but assessment is considerably more challenging in densely developed areas with complex cover types than for the broader forest landscape. This presentation compares two approaches that are in current use: (1) very-high resolution emergency aerial imagery and (2) a 10m Sentinel-2 satellite change detection product called *HiForm*. We discuss their strengths and weaknesses for a range of short and long-term urban forest mapping and monitoring needs.