A satellite image of the Lake Huron basin, showing the lake and surrounding land. The text is overlaid on a dark rectangular background.

# Lake Huron basin remote sensing: A GLRI Collaboration Project

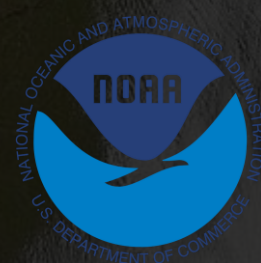
Jim Klassen, Brian Huberty, Keith Pelletier  
[jklassen@sharedgeo.org](mailto:jklassen@sharedgeo.org)

Oct 9, 2019

SOLH19

Saginaw, MI

# A Binational Great Lakes Remote Sensing Project

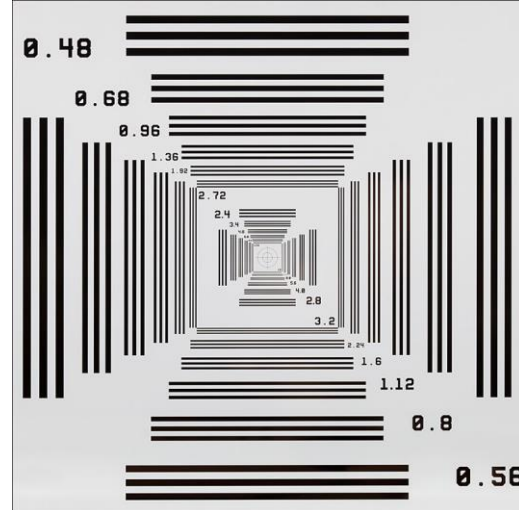


# Wetland Change





# TIME & DATE



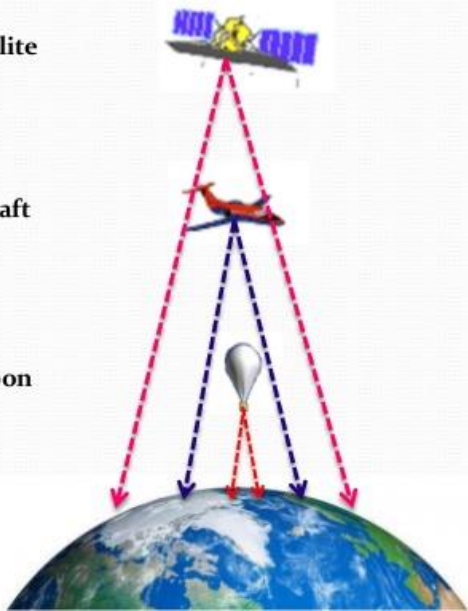
# RESOLUTION

## Sensor Height and Spatial coverage

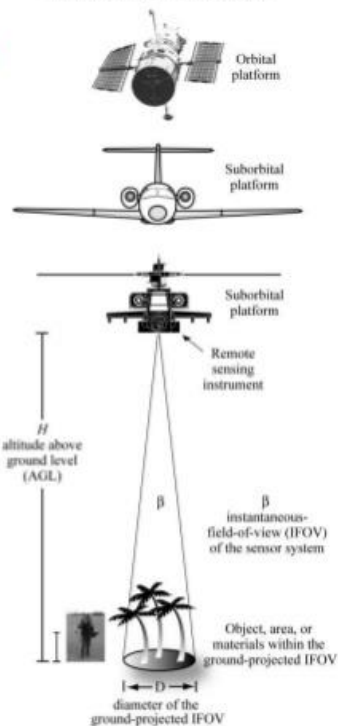
Satellite

Aircraft

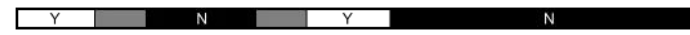
Balloon



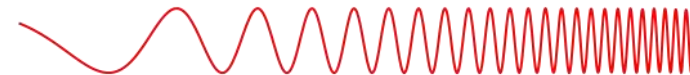
Remote Sensing Measurement



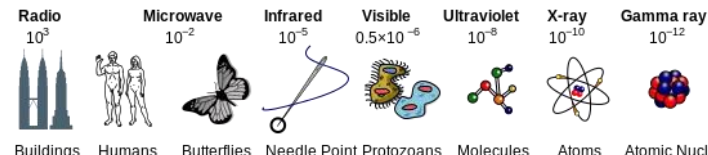
Penetrates Earth's Atmosphere?



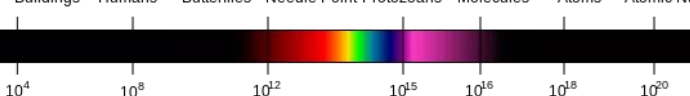
Radiation Type  
Wavelength (m)



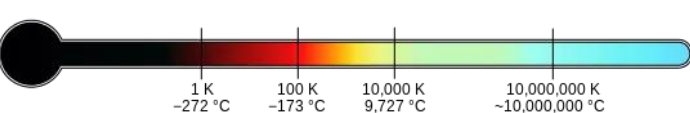
Approximate Scale  
of Wavelength



Frequency (Hz)



Temperature of  
objects at which  
this radiation is the  
most intense  
wavelength emitted



# COVERAGE

# MULTI-SENSORS

# WETLAND MEASUREMENTS – Seasonal Change

## RADAR

Water Area  
Water Levels  
Flooded Veg

## OPTICAL

Species  
Veg Canopy Ht  
Biomass

Space &  
Time

+

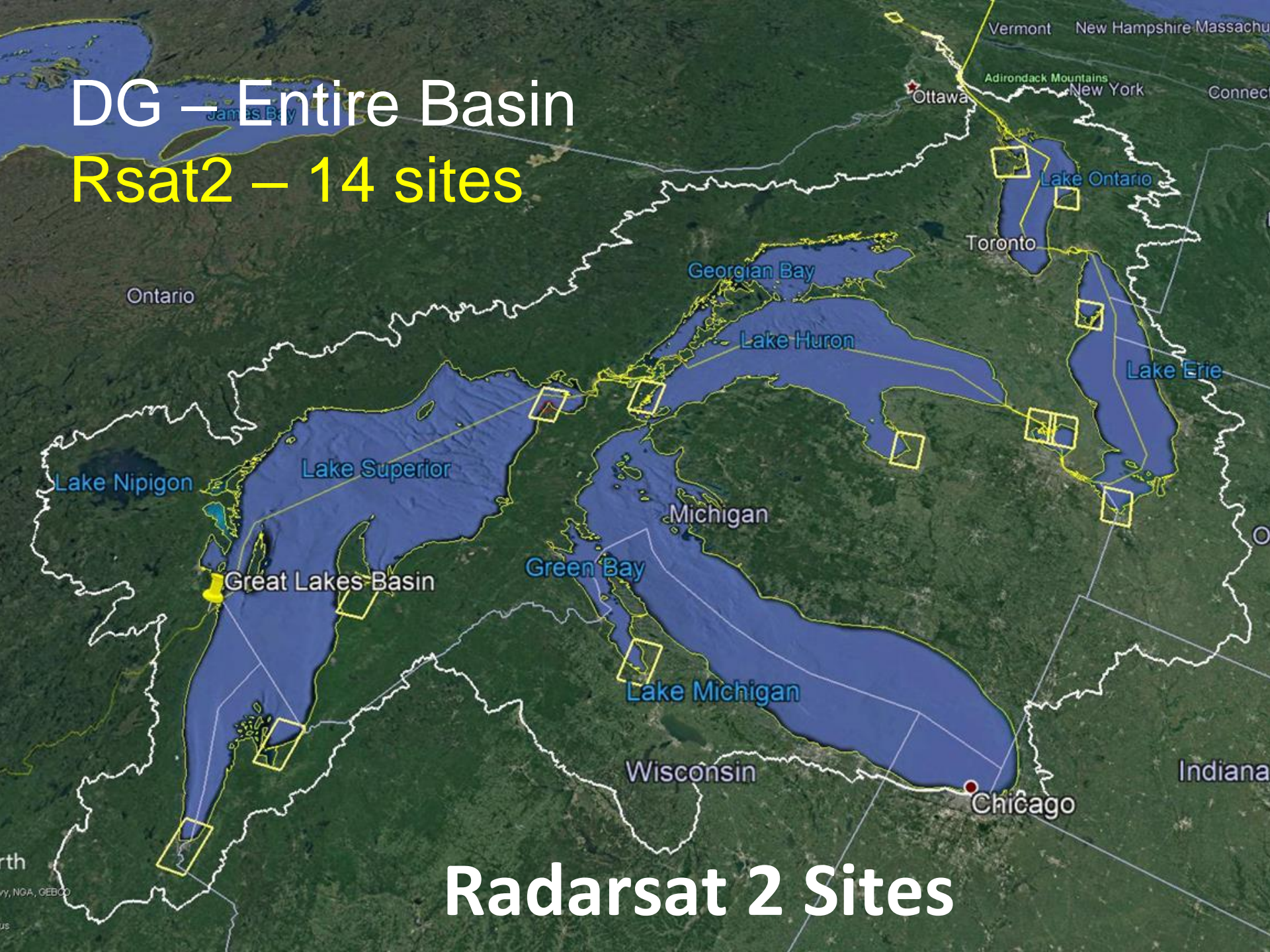
Physical  
Chemical  
Biological

=

Wetland  
Habitat

DG – Entire Basin

Rsat2 – 14 sites



Radarsat 2 Sites

# Elevation







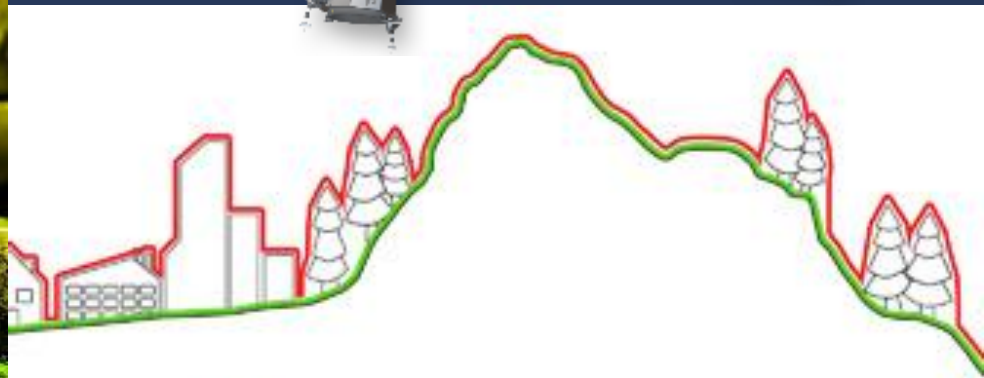




# Surface Model Generation



Entire DigitalGlobe Stereo archive  
*GE01, WV01, WV02, WV03*

2m Surface Canopy DSM



-  Digital Surface Model
-  Digital Terrain Model

# *The ArcticDEM*



**Brian Huberty**

Midwest Region, U.S. Fish & Wildlife Service

**Paul Morin**

Polar Geospatial Center, University of Minnesota

**Ian Howat & MJ Noh**

Byrd Polar, the Ohio State University

**Claire Porter & Michael Cloutier**

Polar Geospatial Center, University of Minnesota

**Michael Willis**

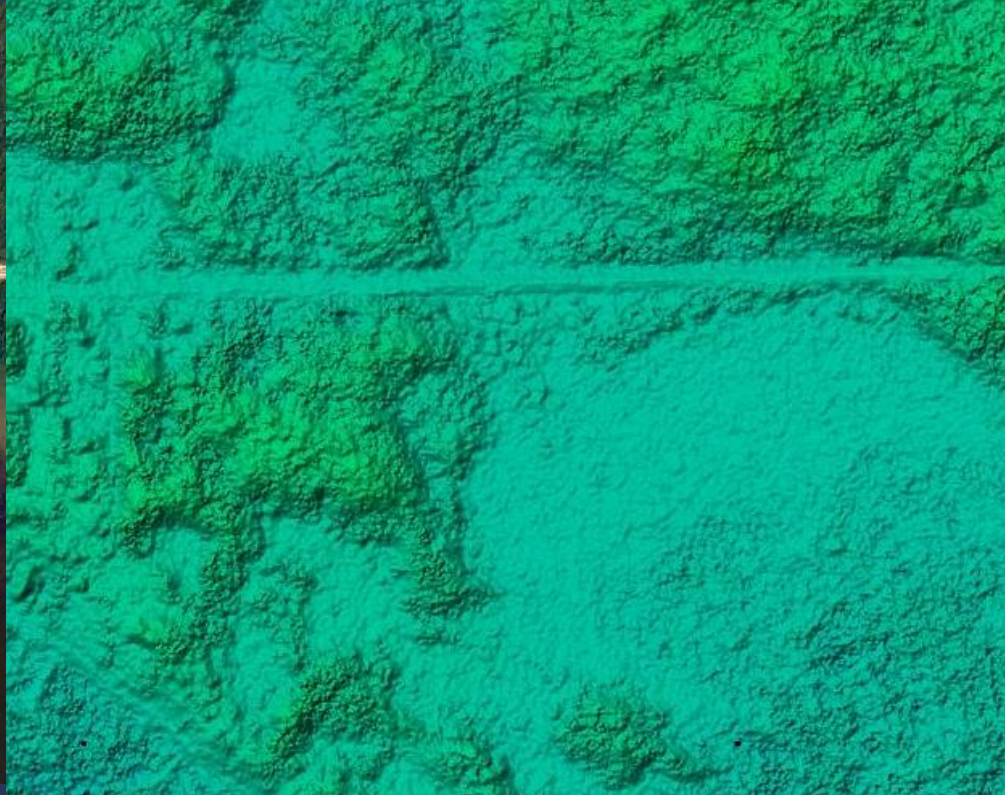
Earth and Atmospheric Sciences, Cornell University



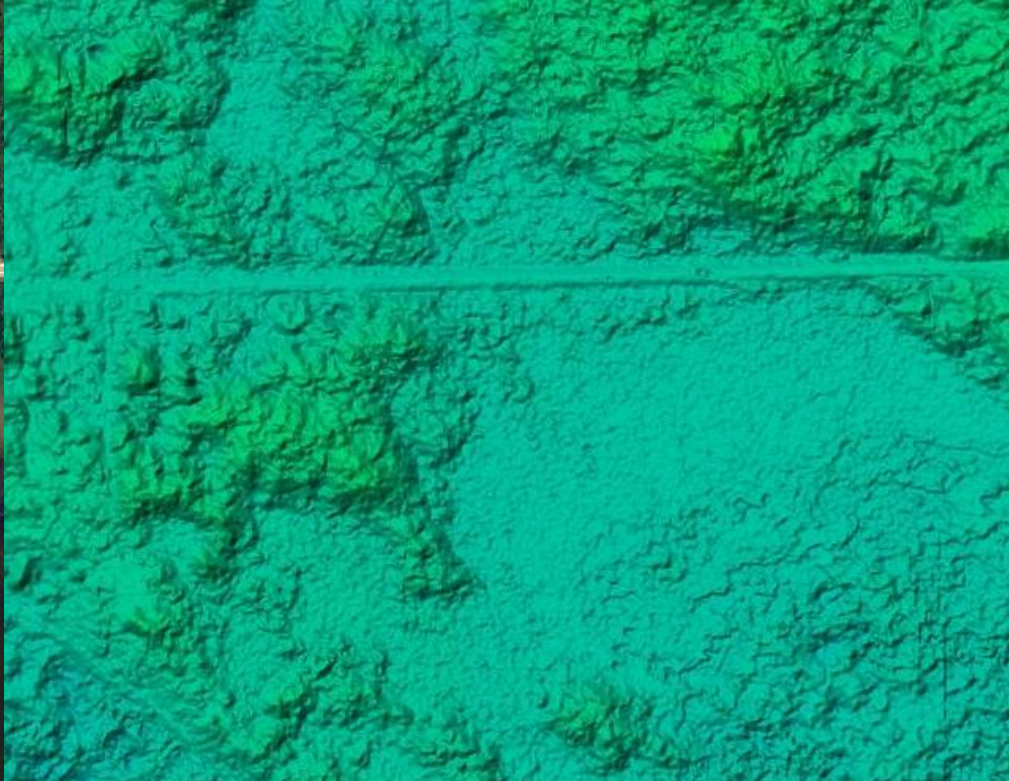
Cornell University

Ellef Ringers Island, Nunavut

# All Season Mosaic



# Summer Only DSM



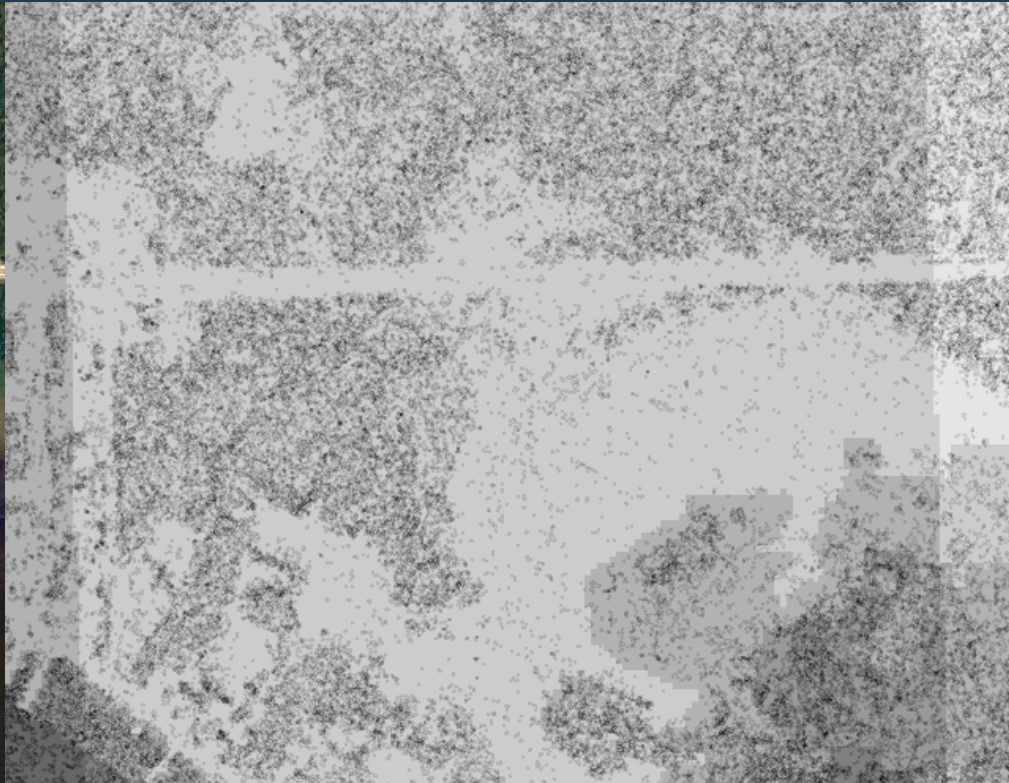
# Winter Only DSM



# All Season MAD



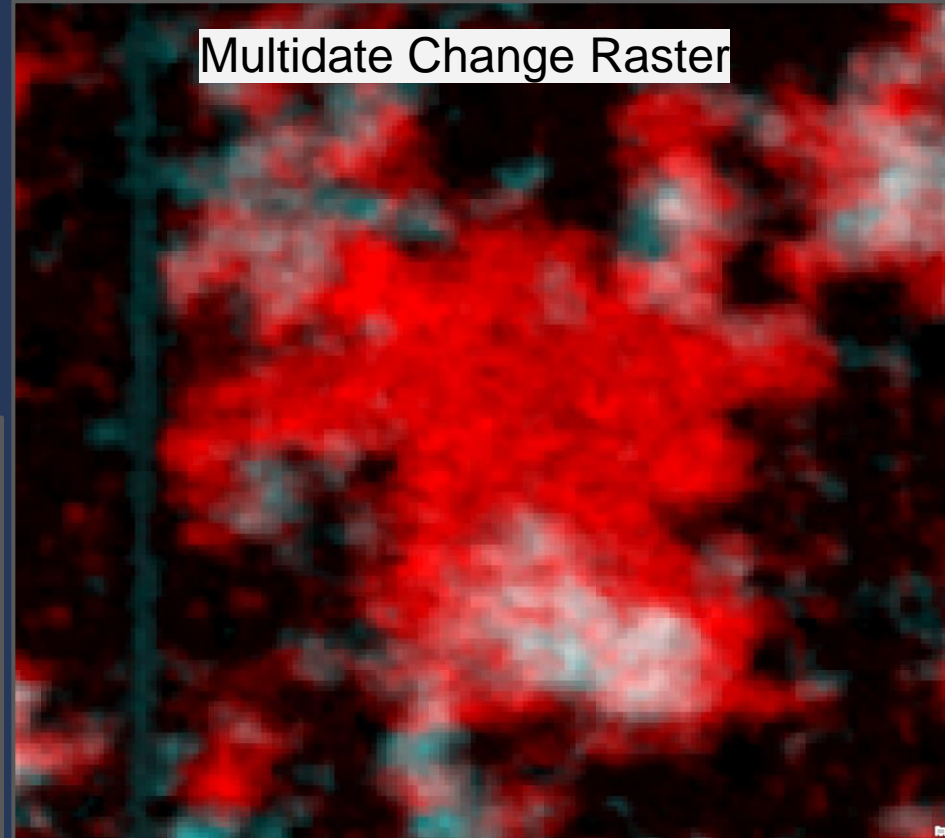
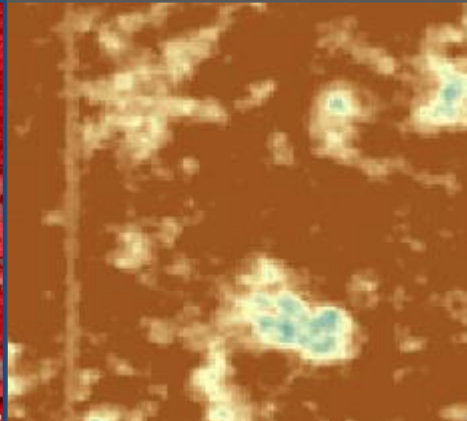
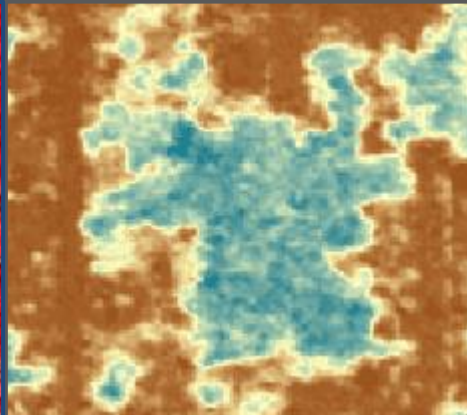
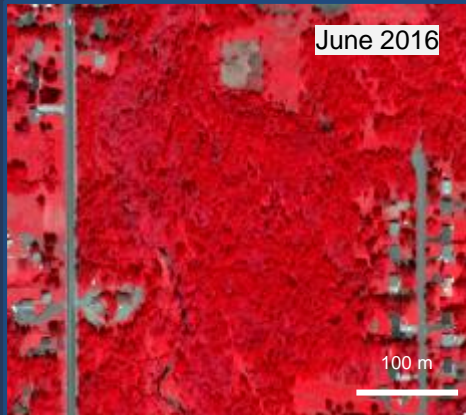
# All Season Matches



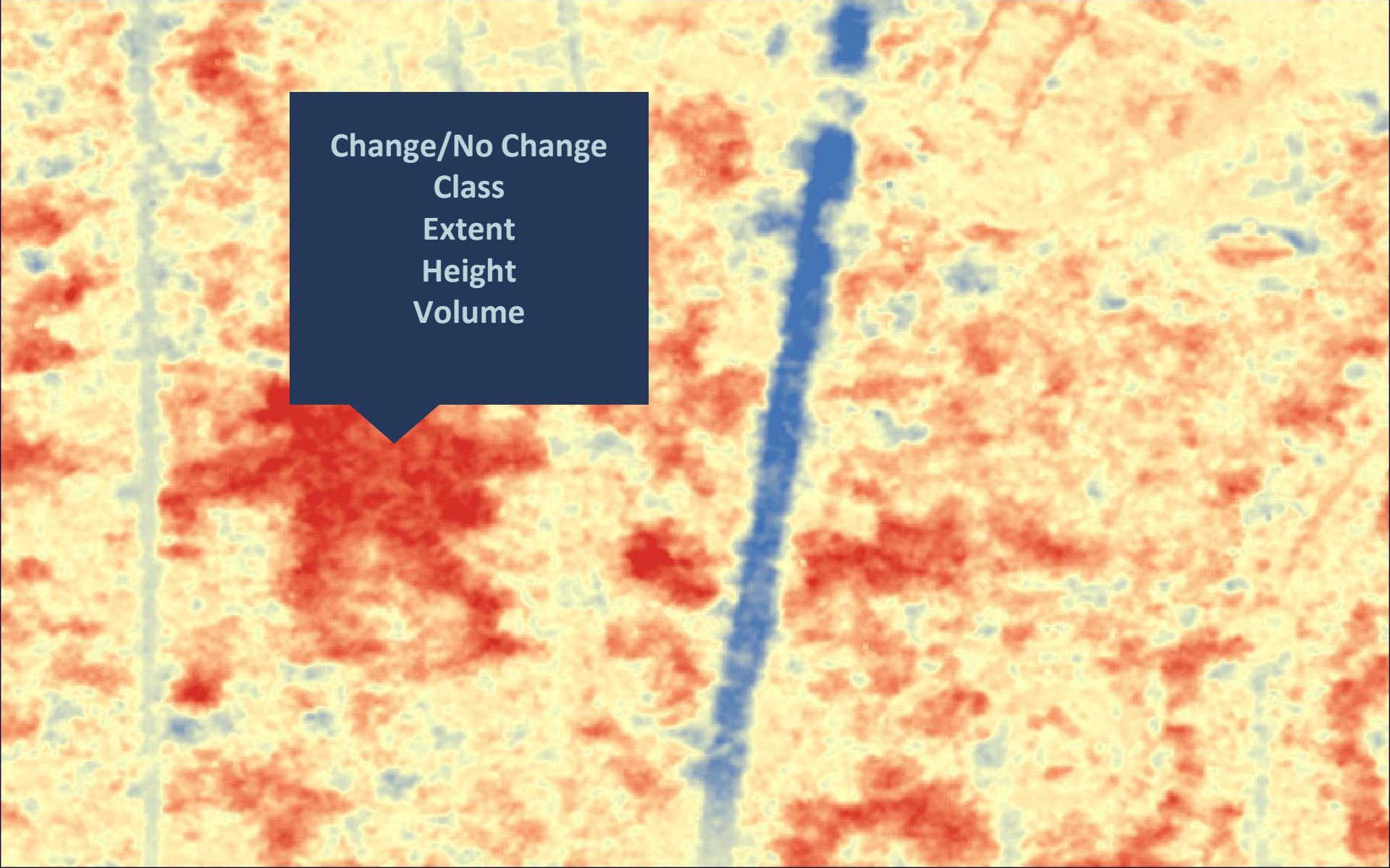


# 2016 Forest Blowdown - Duluth, MN

## Change in Stereo Surface Models



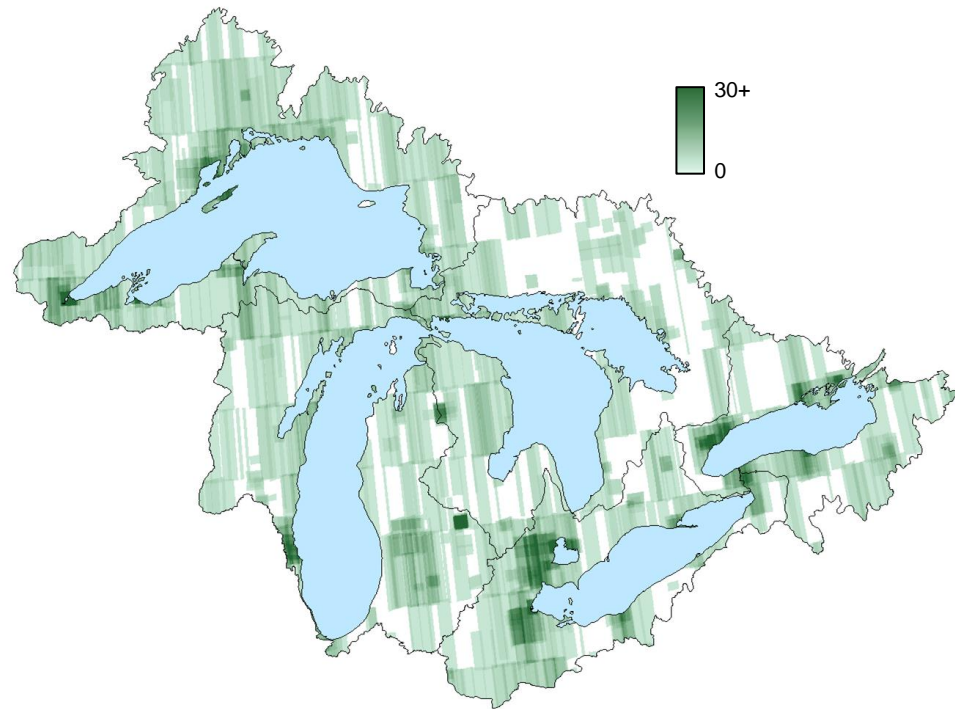
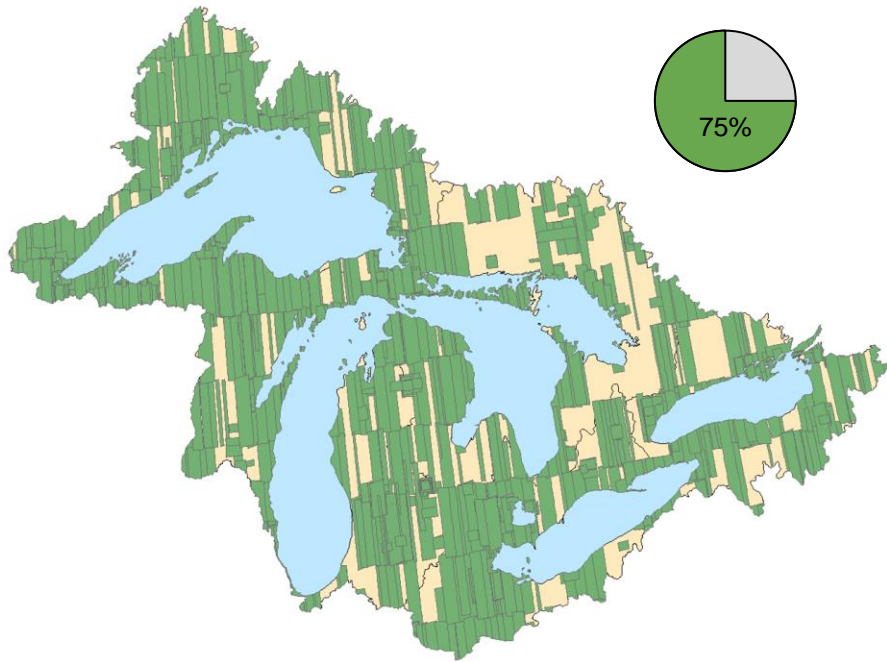
# Difference DSM



Change/No Change  
Class  
Extent  
Height  
Volume

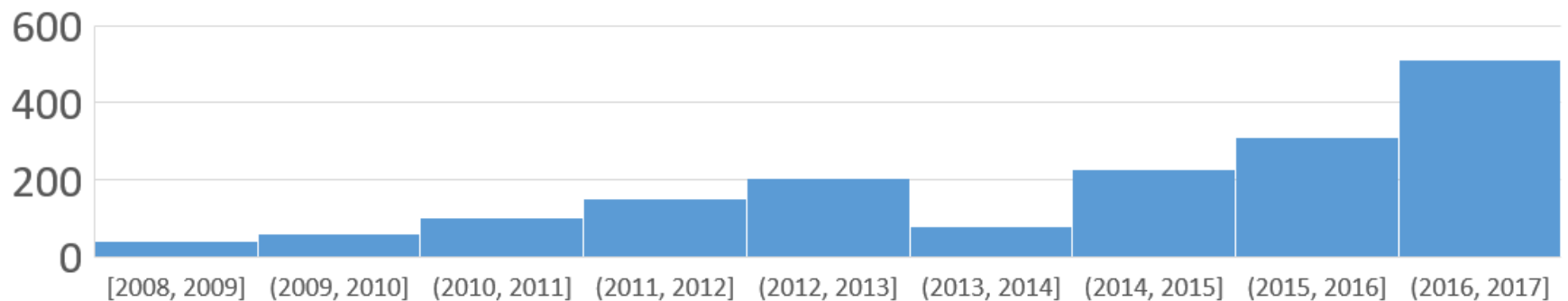


**2M DSM April  
2018**  
Note: Multiple  
Stacks



268 million acres of stereo DSMs  
 96 million acres covered out of 127 million total

GLB Stereo Strips Frequency



# Object-based Image Analysis

“...designed to exploit a particular type of dependence between

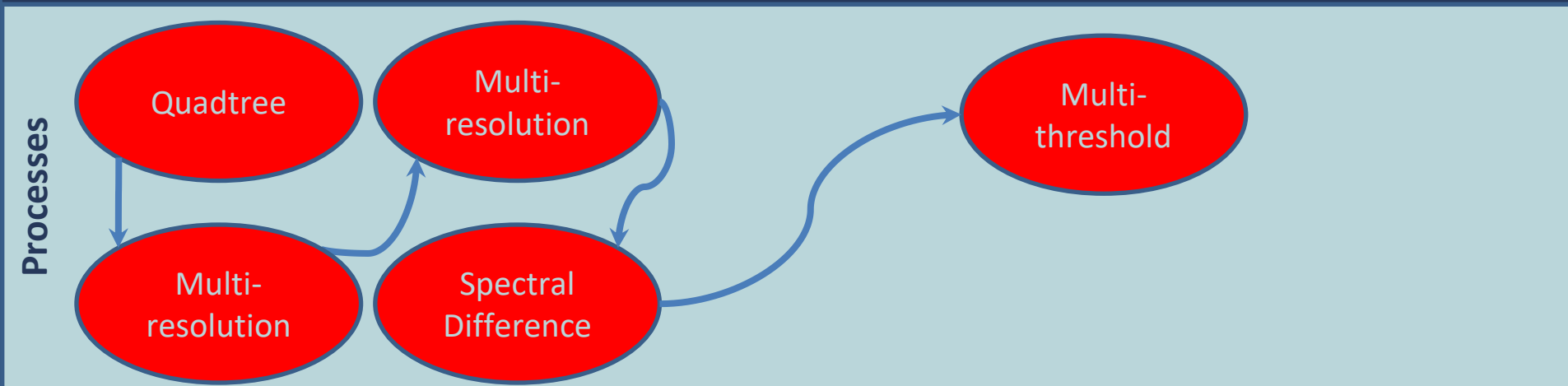
**adjacent states of nature**

that is characteristic of the data.”

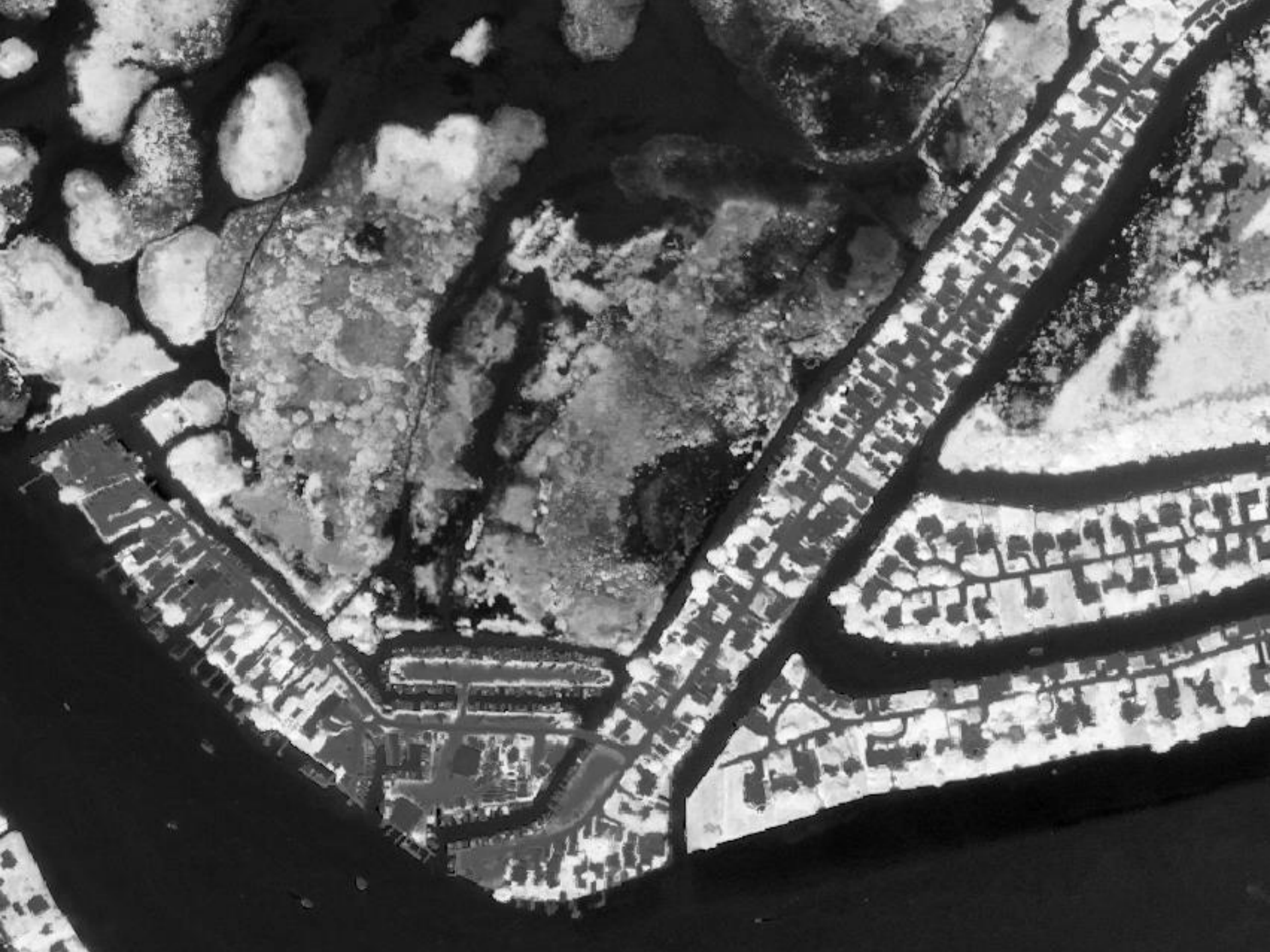
Kettig, R., & Landgrebe, D. (1976). Classification of Multispectral Image Data by Extraction and Classification of Homogeneous Objects. *IEEE Transactions on Geoscience Electronics*, 14(1), 19–26. <https://doi.org/10.1109/TGE.1976.294460>

# Object-based Classification

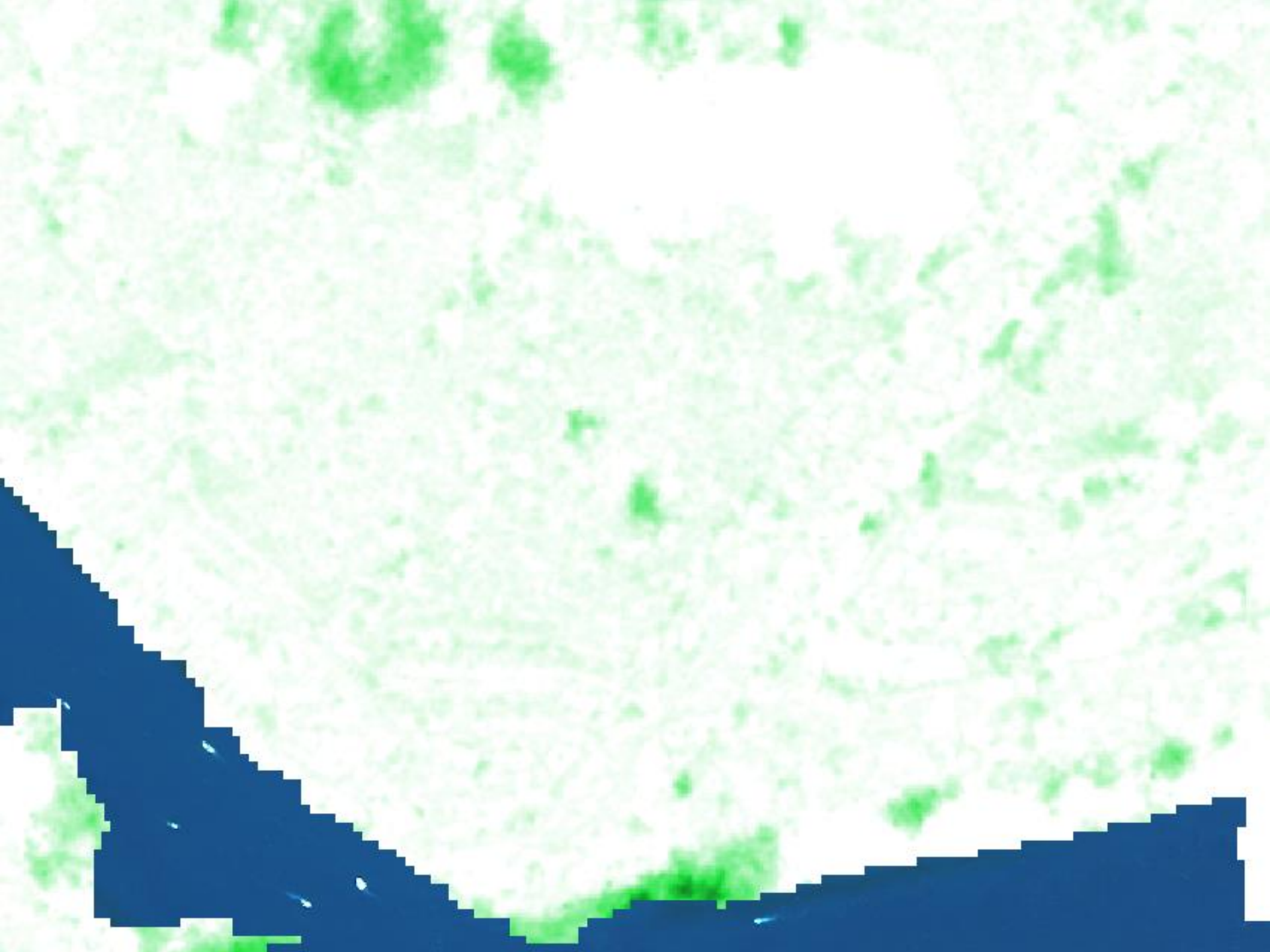
Classes	Water	Non-Vegetated	High Vegetation	Medium Vegetation	Low Vegetation
Inputs	Surface Water (MTRI)	Optical	nDSM (SharedGeo)	nDSM (SharedGeo)	nDSM (SharedGeo)
	Optical		Height (> 2m)	Height (1m < 2m)	Height (< 1m)

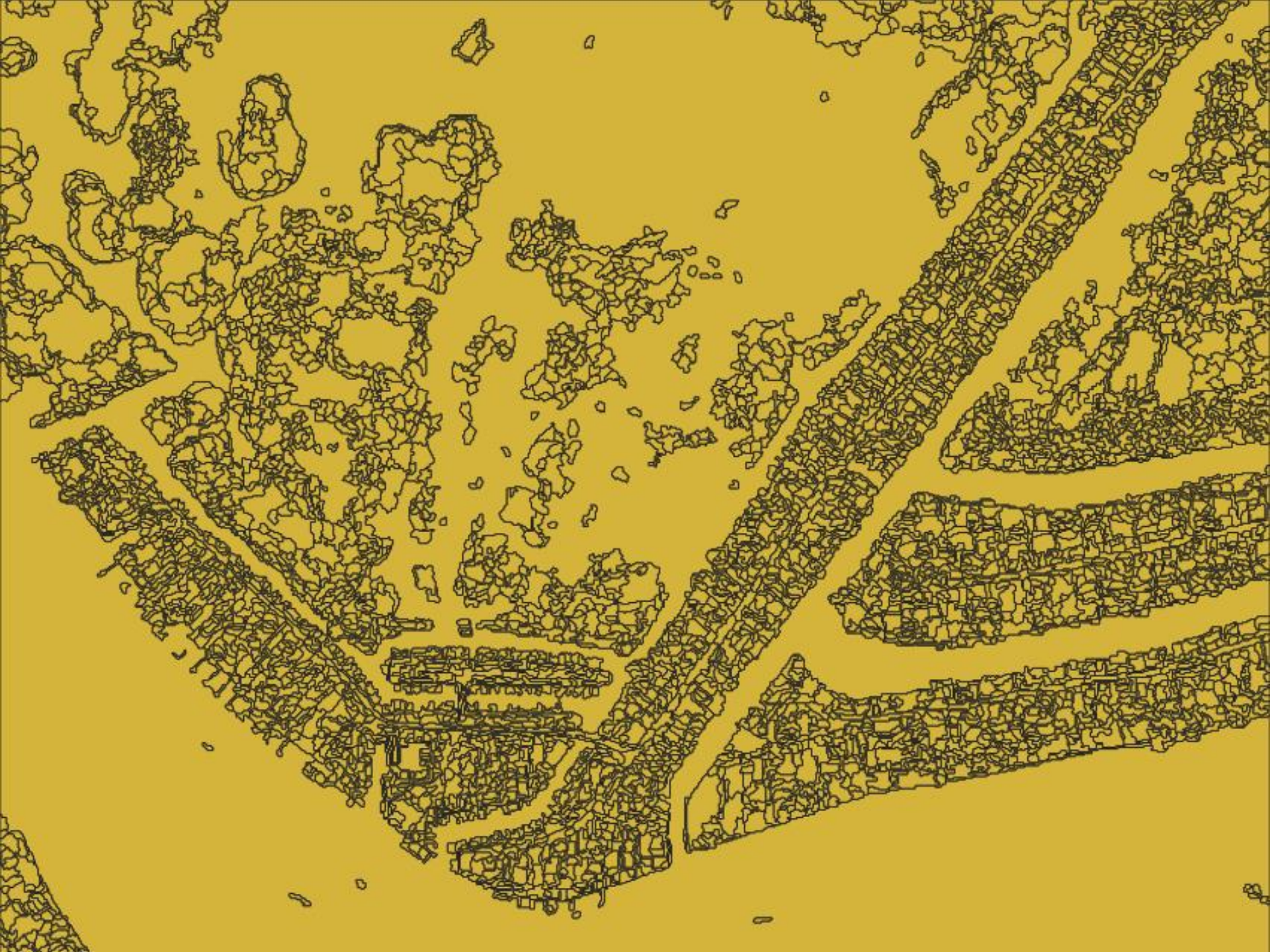


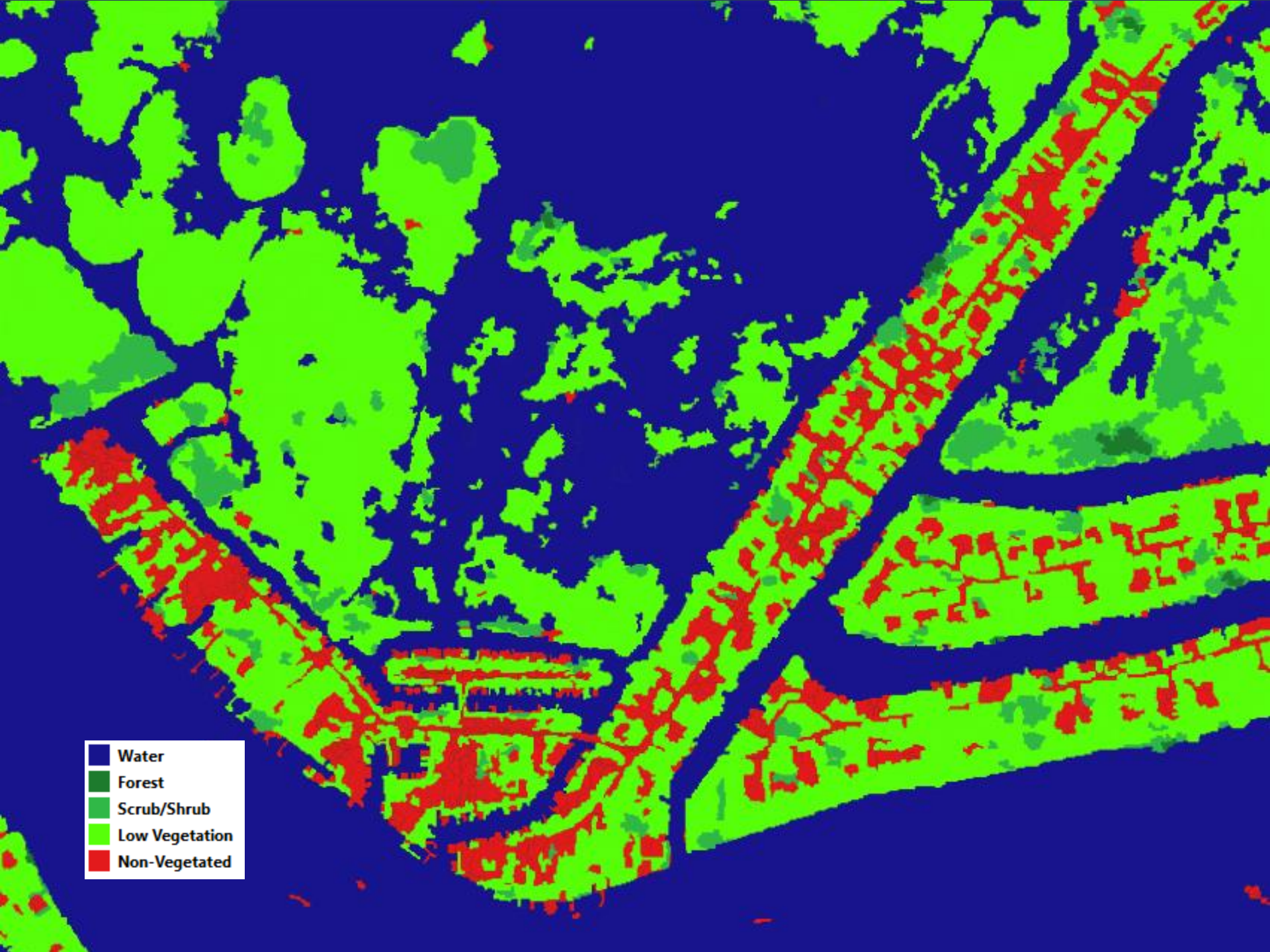




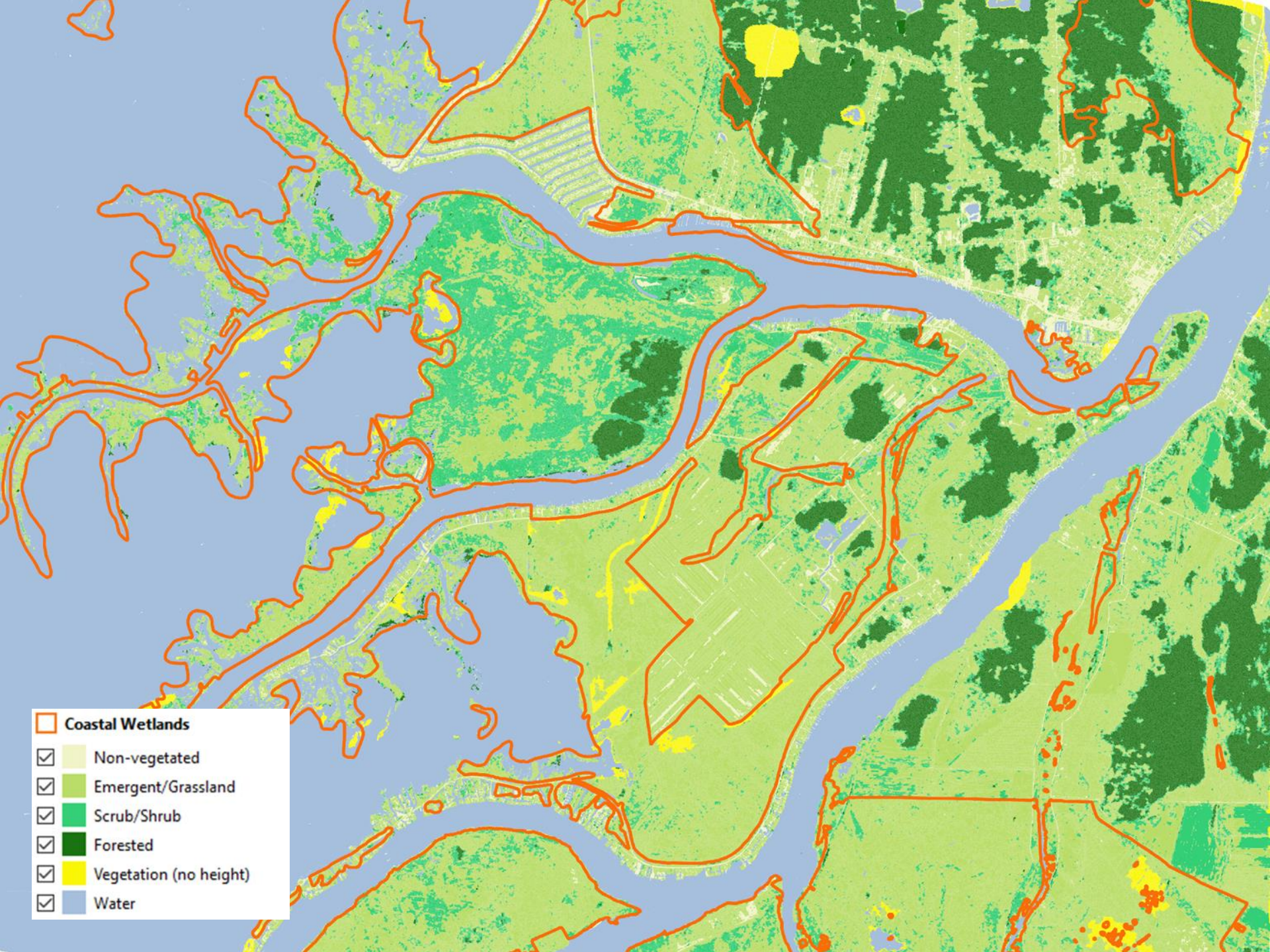




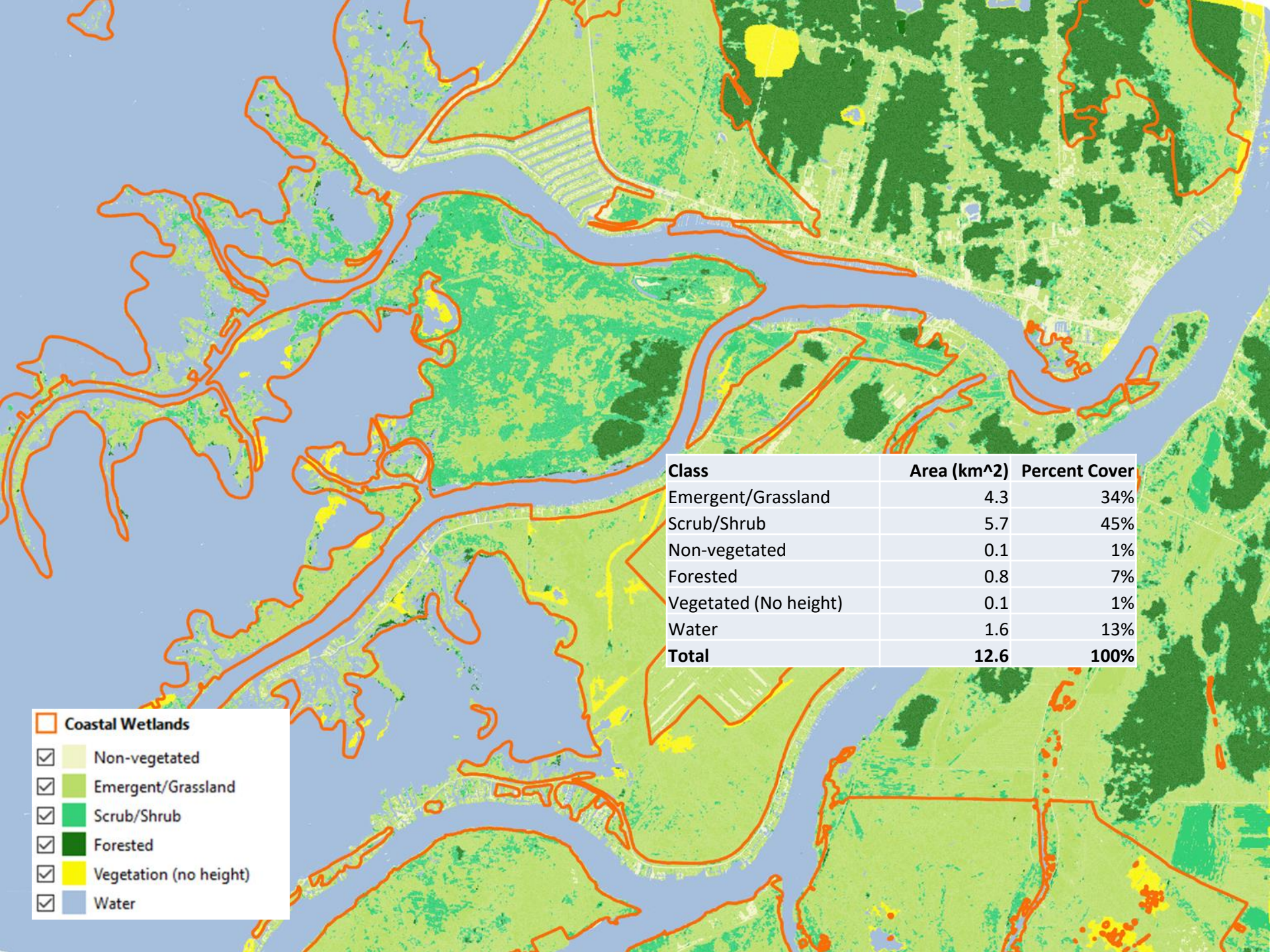








- Coastal Wetlands
- Non-vegetated
- Emergent/Grassland
- Scrub/Shrub
- Forested
- Vegetation (no height)
- Water



Class	Area (km <sup>2</sup> )	Percent Cover
Emergent/Grassland	4.3	34%
Scrub/Shrub	5.7	45%
Non-vegetated	0.1	1%
Forested	0.8	7%
Vegetated (No height)	0.1	1%
Water	1.6	13%
<b>Total</b>	<b>12.6</b>	<b>100%</b>

- Coastal Wetlands
- Non-vegetated
- Emergent/Grassland
- Scrub/Shrub
- Forested
- Vegetation (no height)
- Water

# WorldView3 June 2016



(DigitalGlobe 2016)

# WorldView3 Aug 2016



(DigitalGlobe 2016)



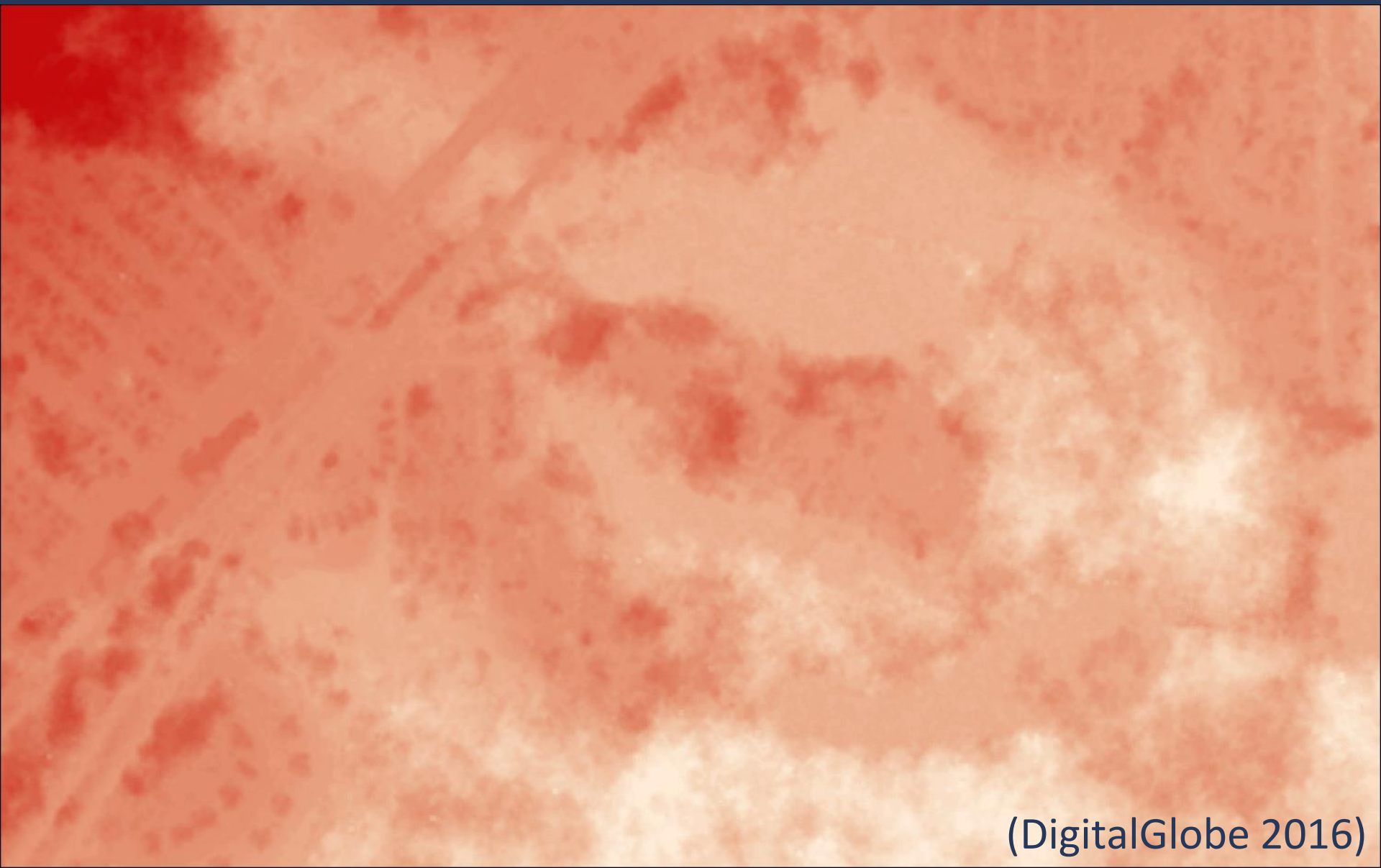
# NDVI June 2016



# NDVI Aug 2016

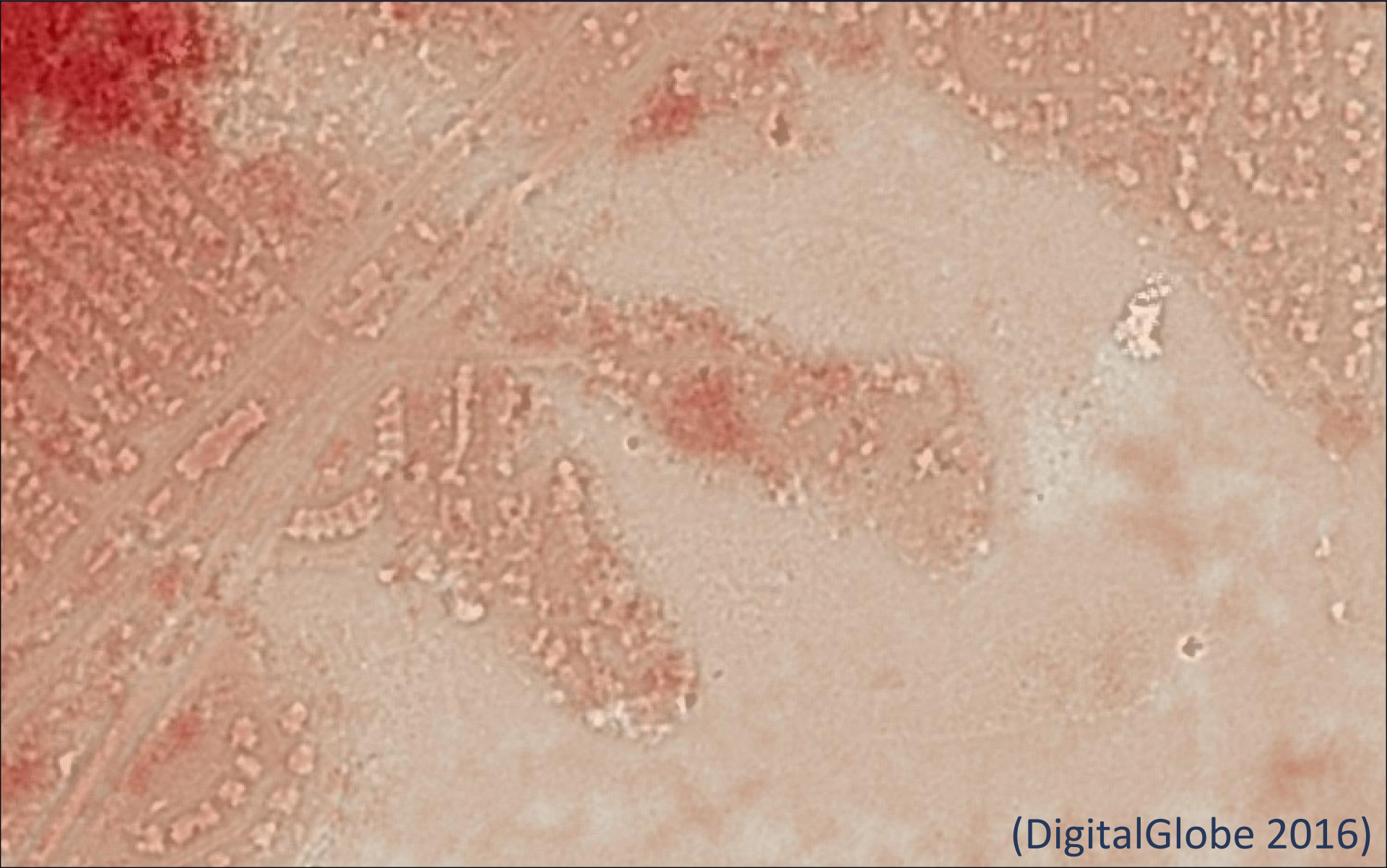


# DSM June 2016



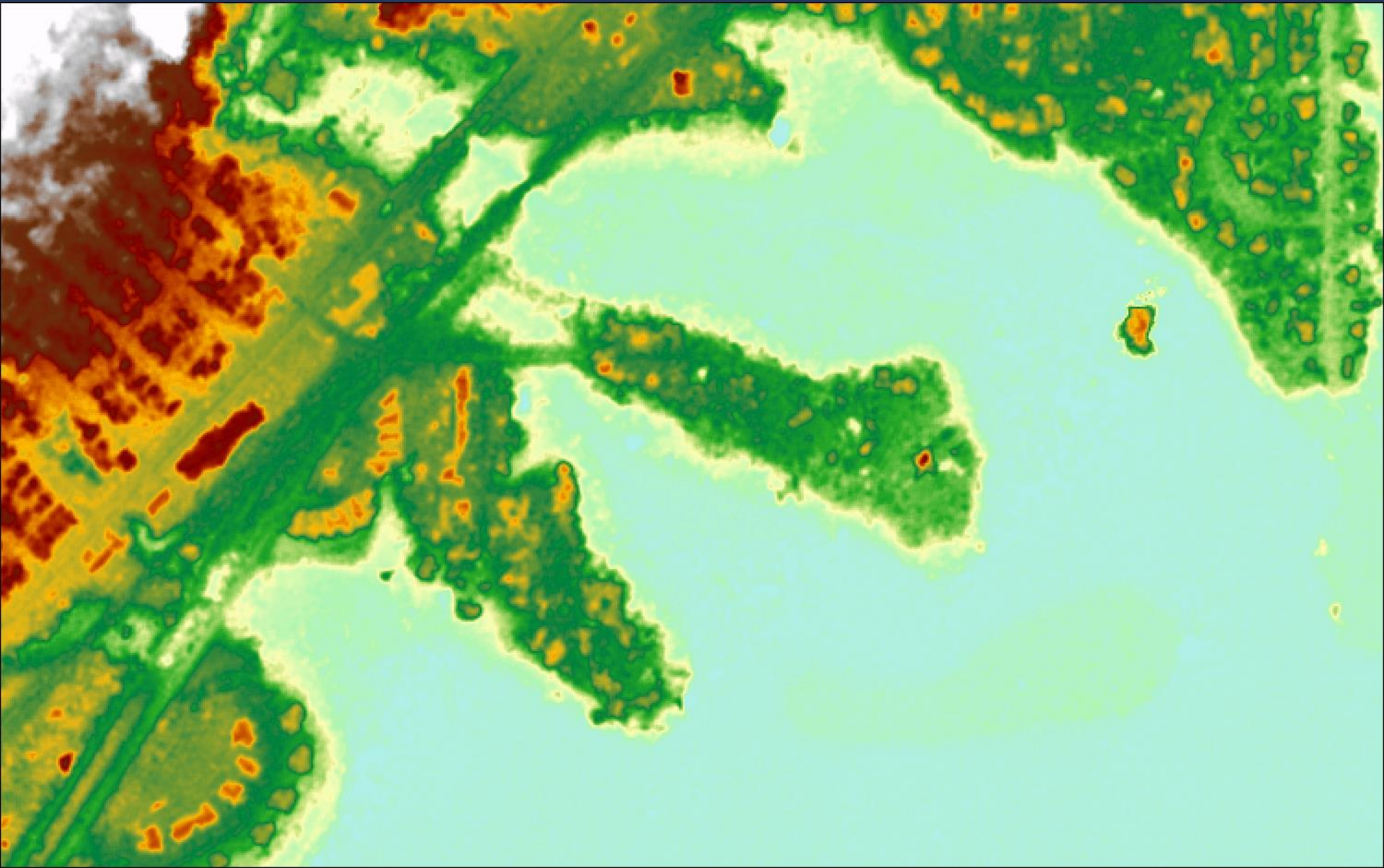
(DigitalGlobe 2016)

# DSM Aug 2016

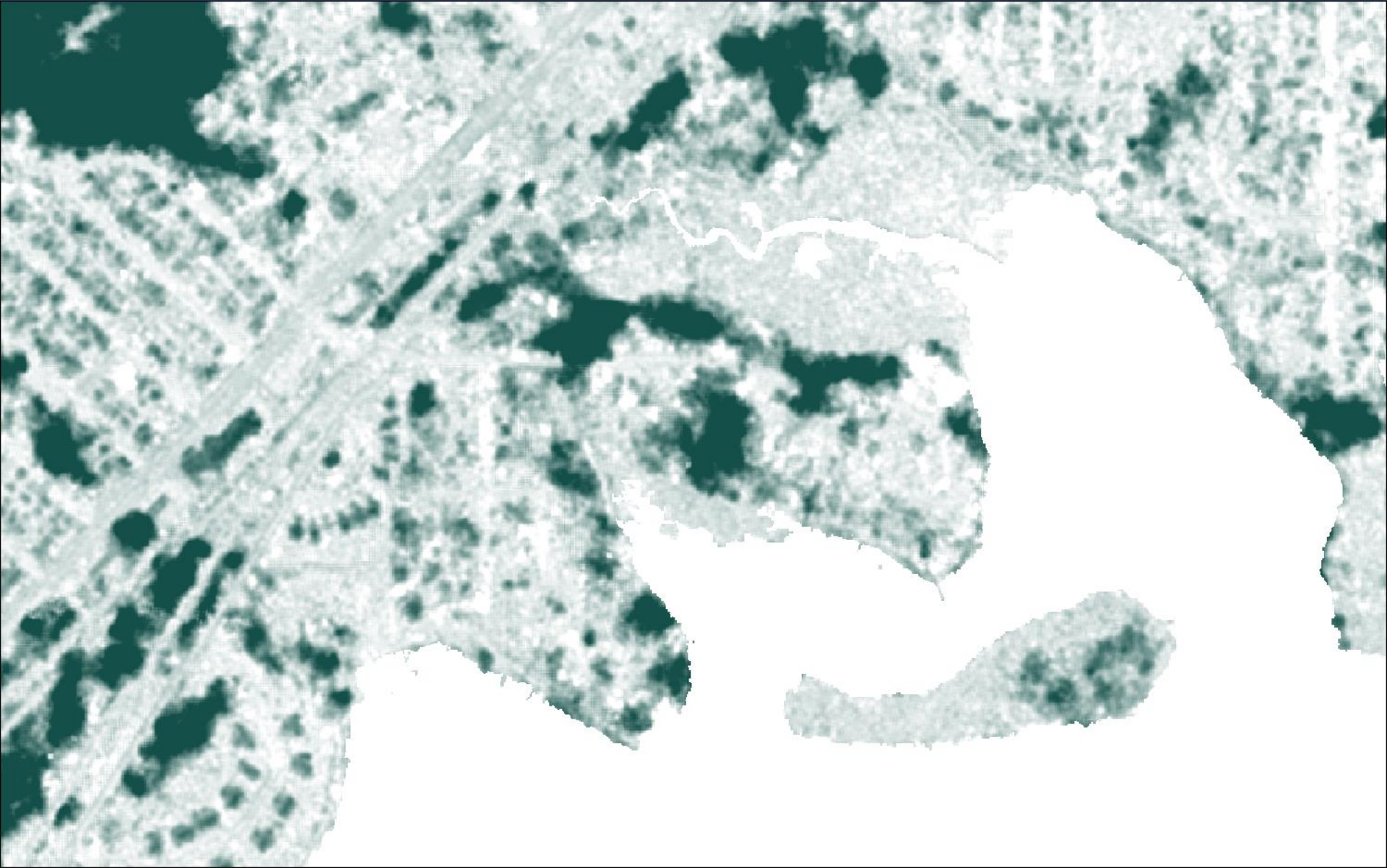


(DigitalGlobe 2016)

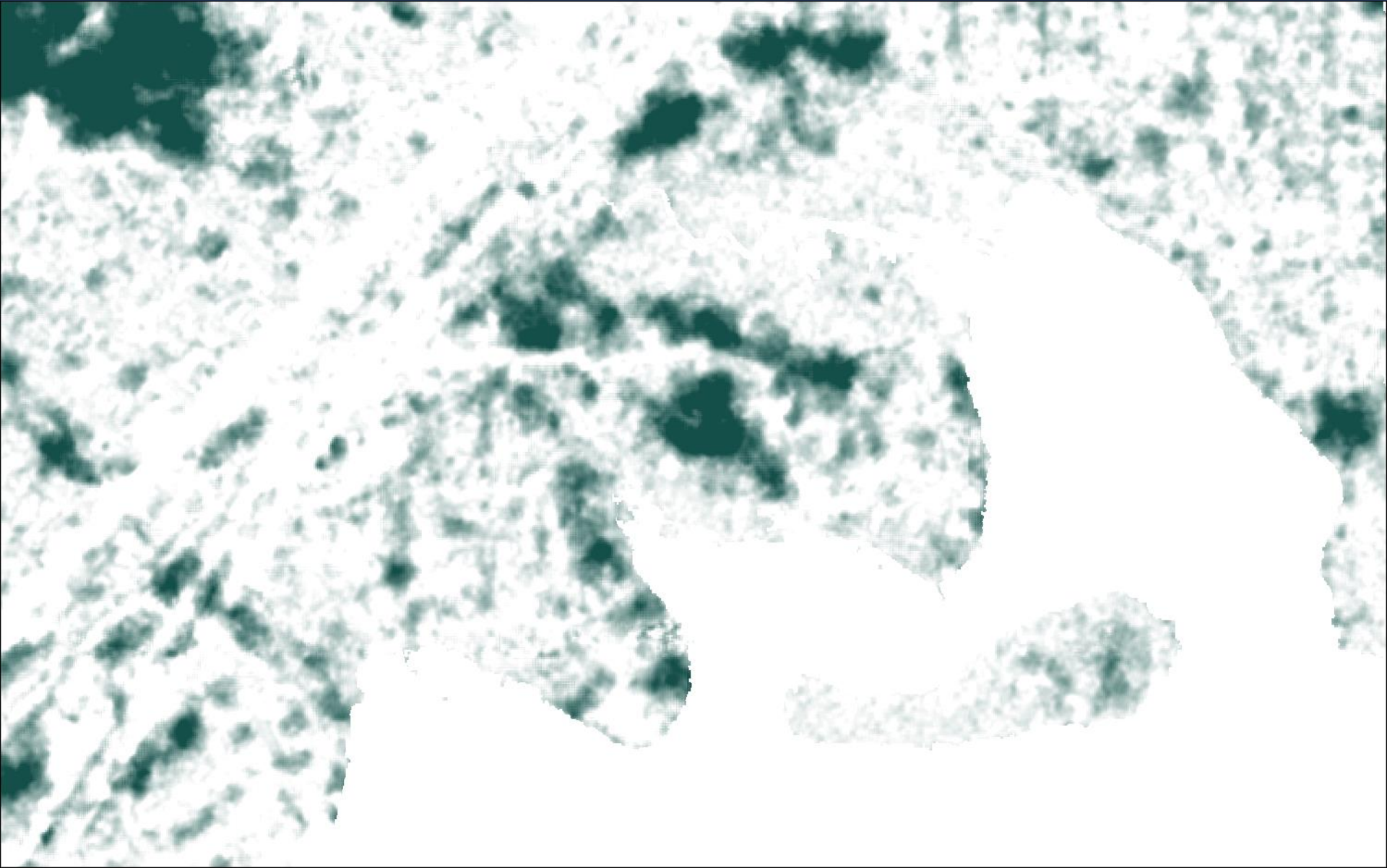
# DSM Jan 2017



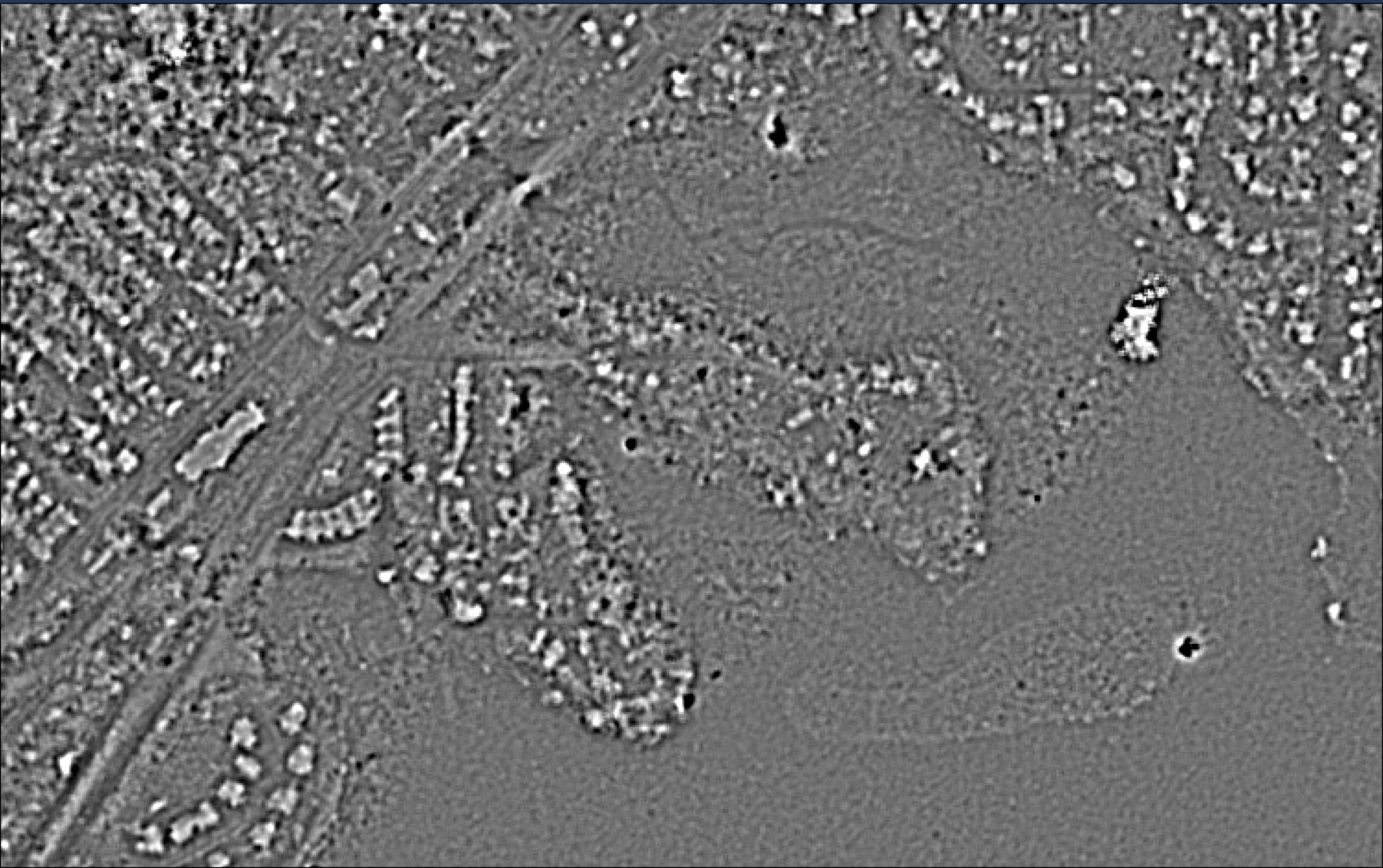
# Normalized DSM June 2016



# Normalized DSM Aug 2016

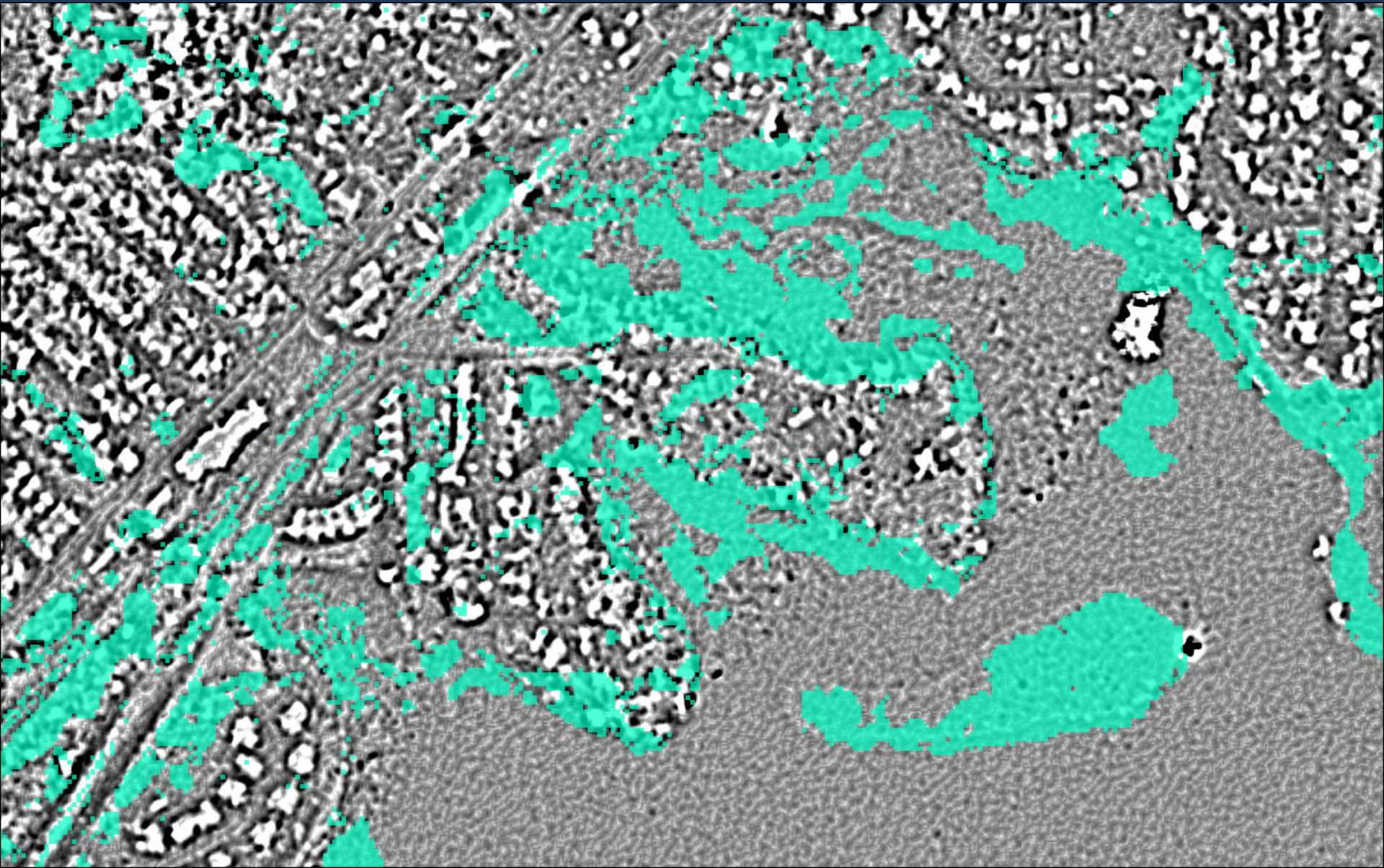


# Topo Position Index

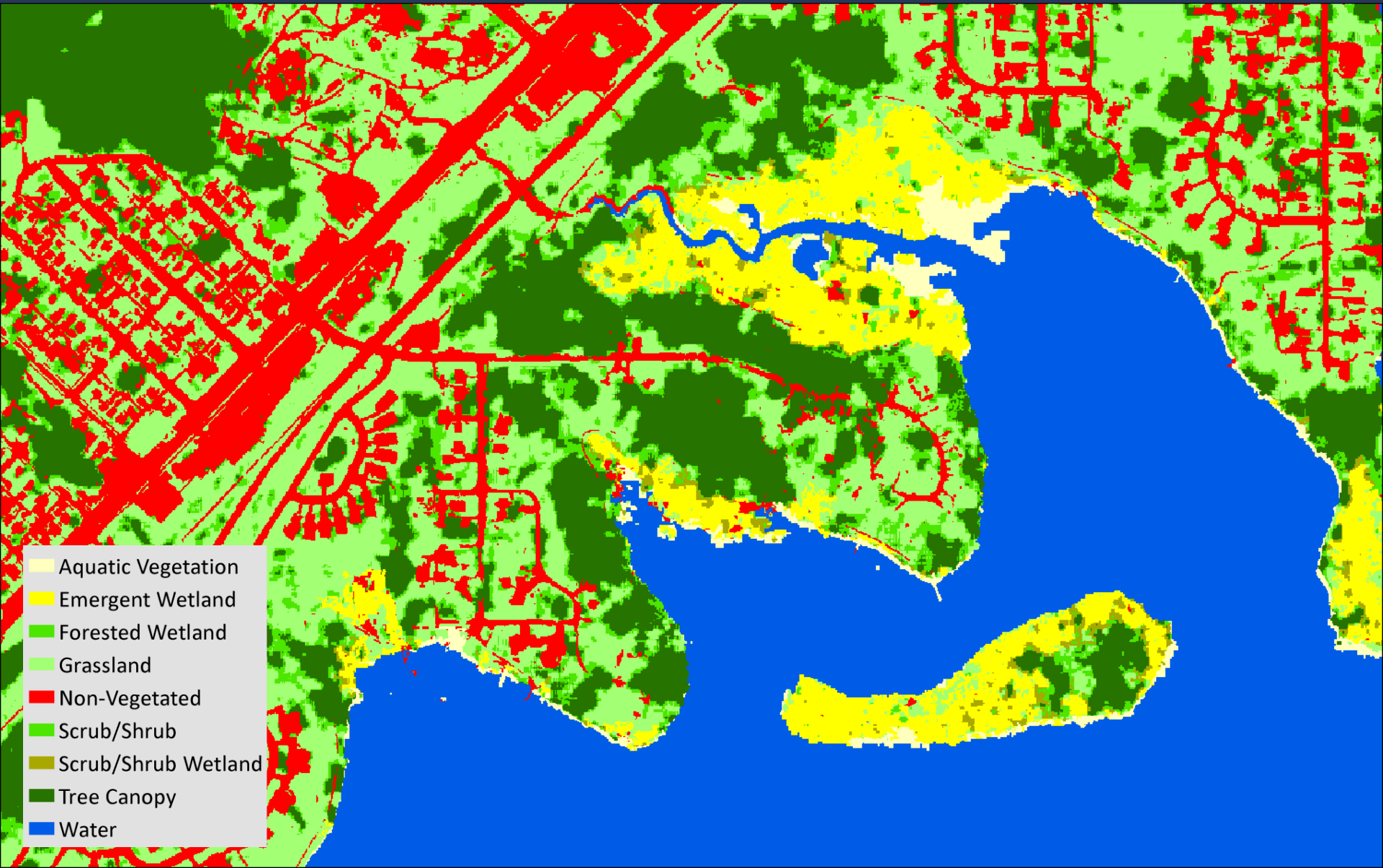




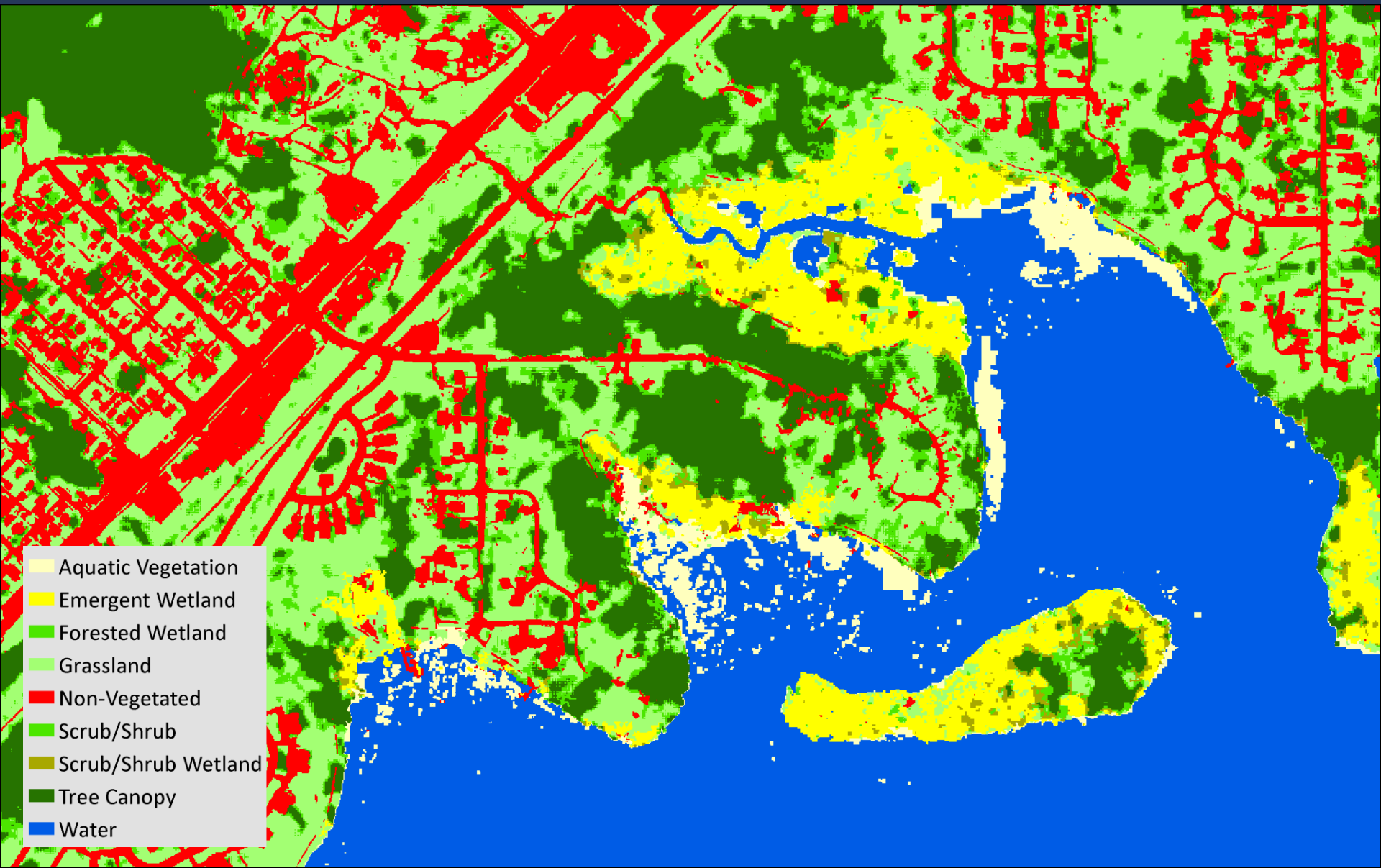
# MTRI Wetlands



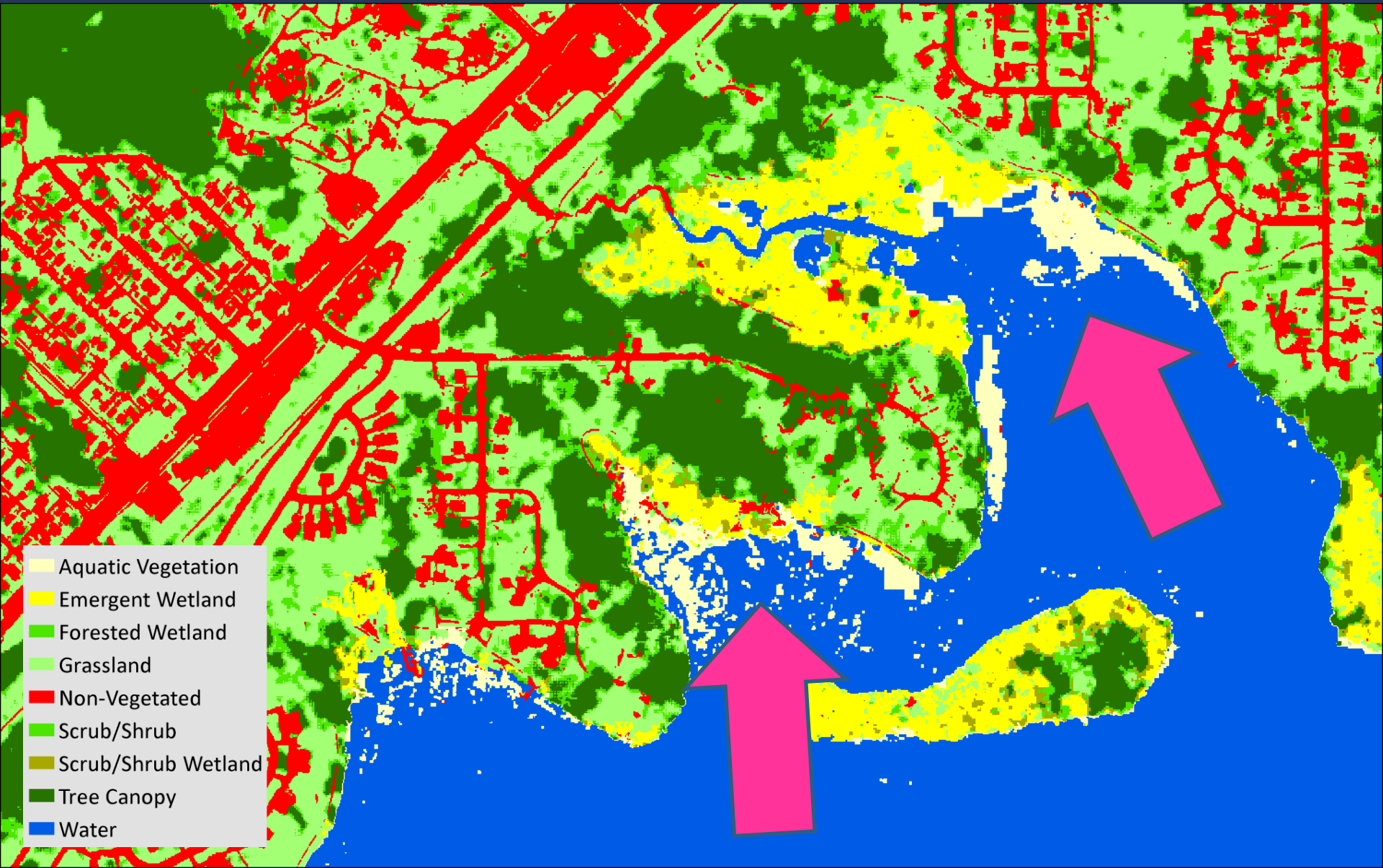
# June 2016 Land Cover



# Aug 2016 Land Cover



# Land Cover Change

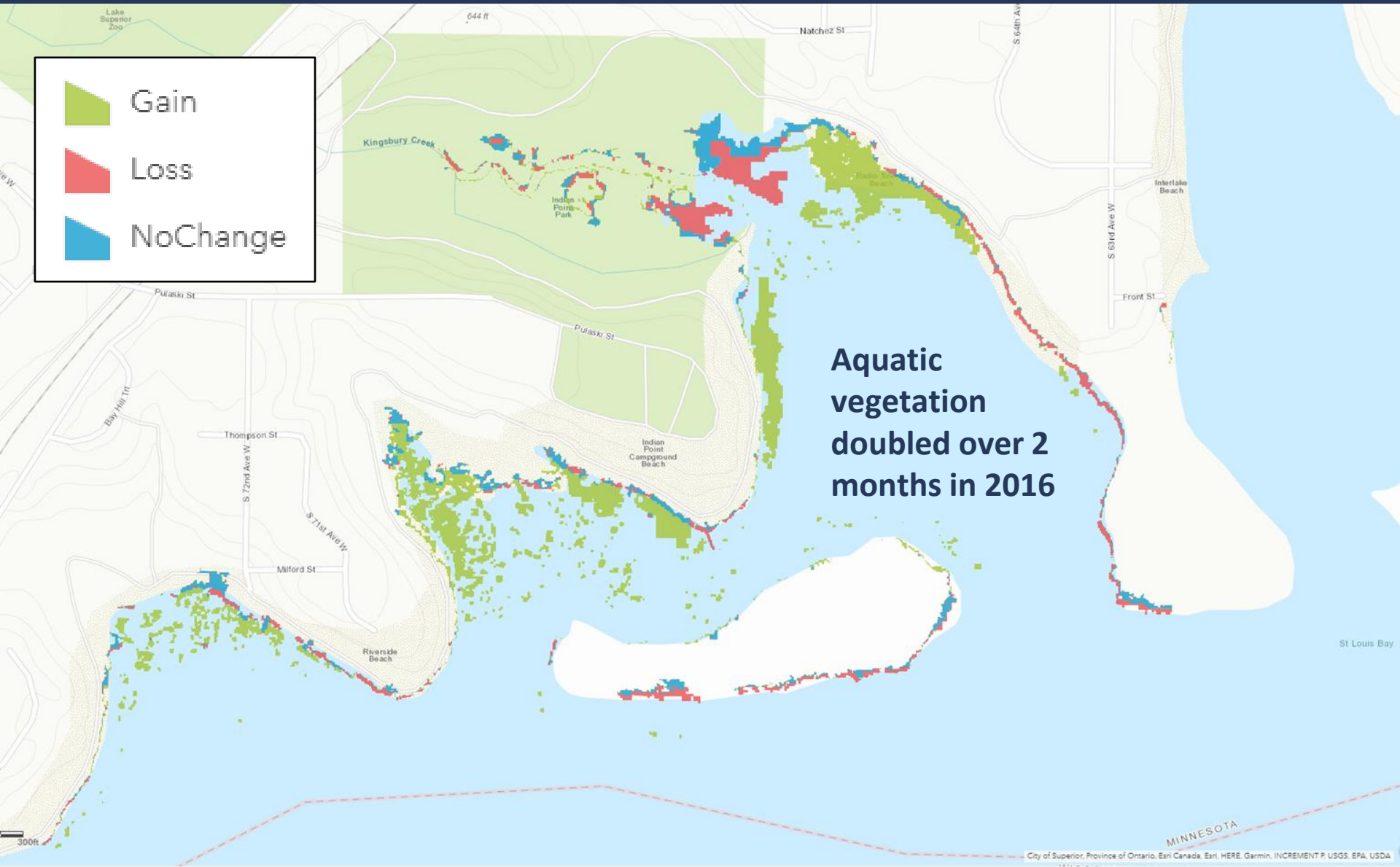
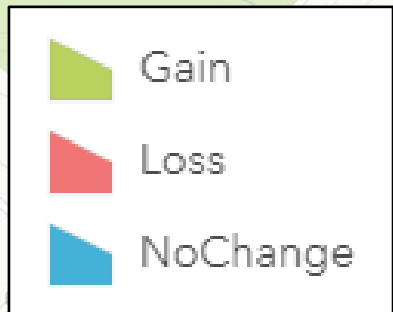


# Land Cover Change

**1% Increase in aquatic vegetation**

**Doubled the total area**

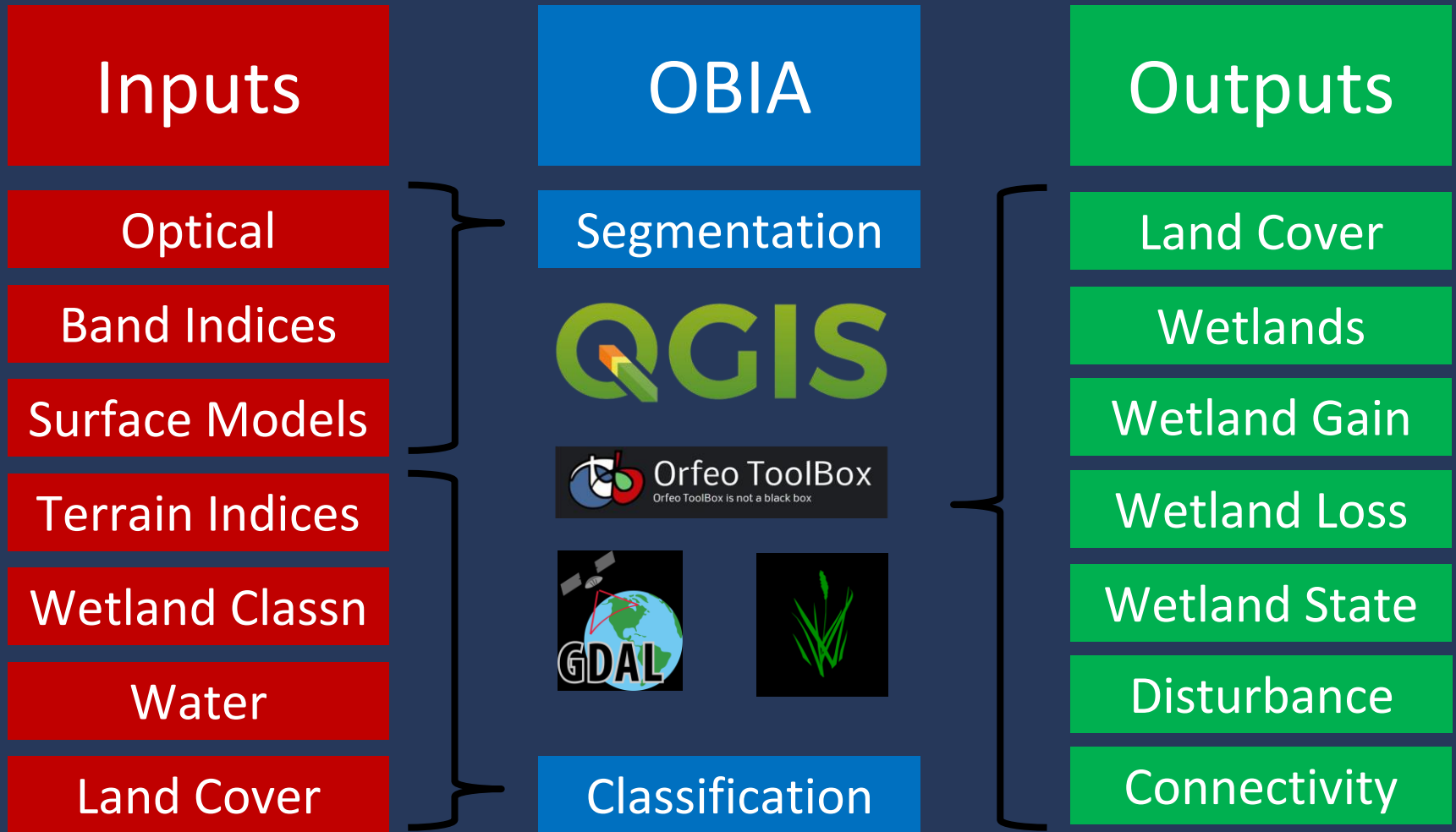
# Land Cover Change



# Free and Open Source



# Open Source







# SUMMARY