

# HURRICANE DAMAGE USING PIX4DMAPPER AND ENVI DEEP LEARNING

October 7&8, 2020

# Webinar agenda

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## Introductions

**L3Harris & Pix4D company and product info**

**Walk through a real-life disaster response use case**

**Demonstrate the drone mapping workflow  
of Pix4Dmapper**

**Demonstrate the imagery training & classification  
workflow of ENVI Deep Learning module**

**Questions & answers**



# Contact Information and Introductions

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**Joshua Haga**

*Tech Expert*

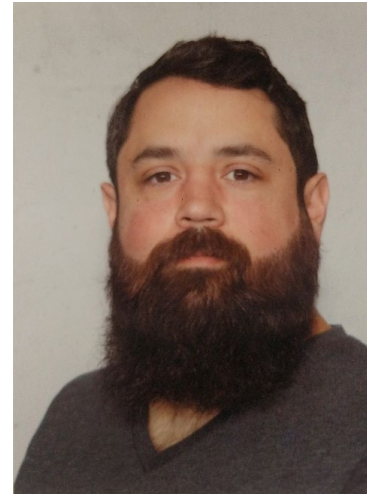
[joshua.haga@pix4d.com](mailto:joshua.haga@pix4d.com)



**Christopher Cressy**

*Managing Director, North America*

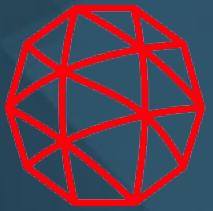
[christopher.cressy@pix4d.com](mailto:christopher.cressy@pix4d.com)



**JP Metcalf**

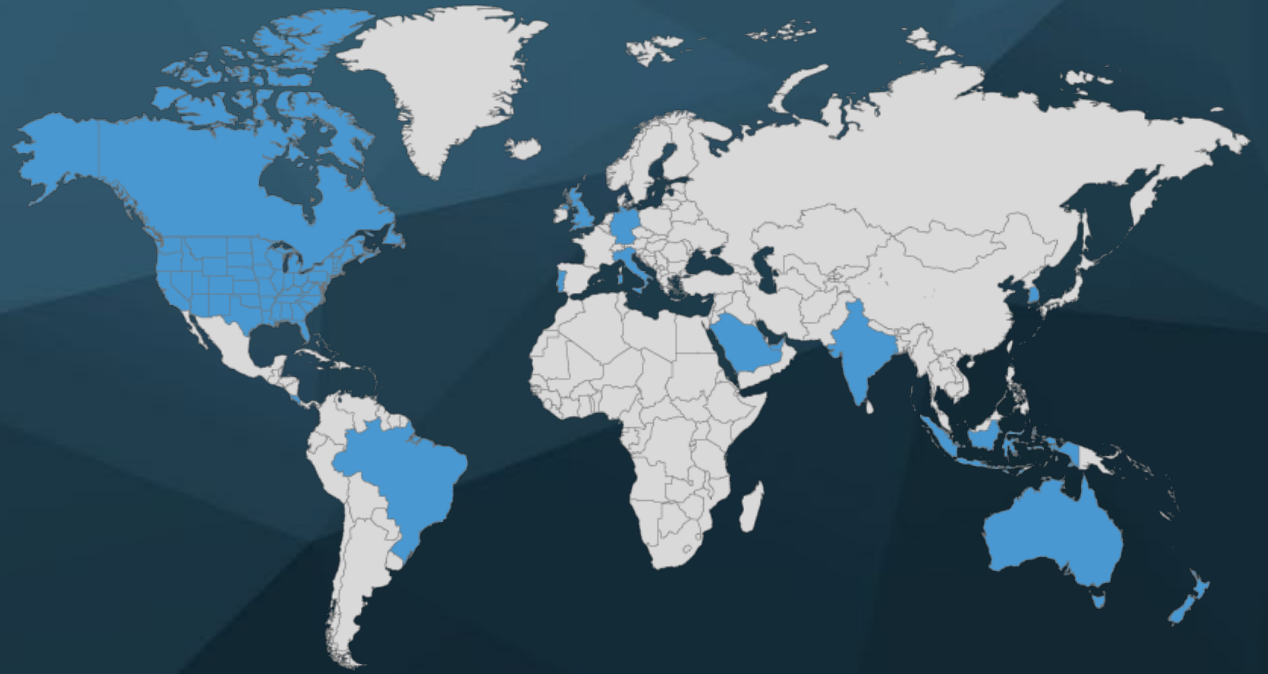
*Solutions Engineer*

[jp.metcalf@l3harris.com](mailto:jp.metcalf@l3harris.com)



# L3HARRIS

L3Harris Technologies is an agile, global aerospace and defense technology innovator, delivering end-to-end solutions that meet customers' mission-critical needs.



~400  
LOCATIONS



CUSTOMERS IN  
~130  
COUNTRIES



LOCATIONS IN  
~30  
COUNTRIES



~50K  
EMPLOYEES



# L3Harris Geospatial Core Products



We have more than 30 years of experience developing scientifically proven solutions using cutting-edge technology. Today, organizations across industries use our in-depth knowledge of advanced geospatial analytics, machine learning and remotely sensed data to make better decisions.

ENVI®



ENVI® SARscape®



IDL®



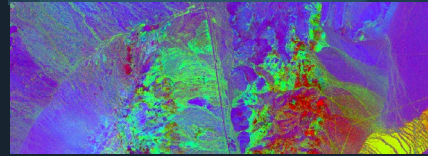
Jagwire™



Amplify™



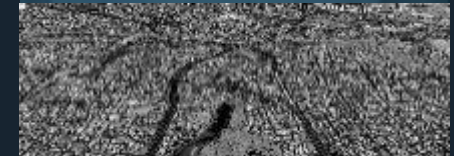
ENVI® Server



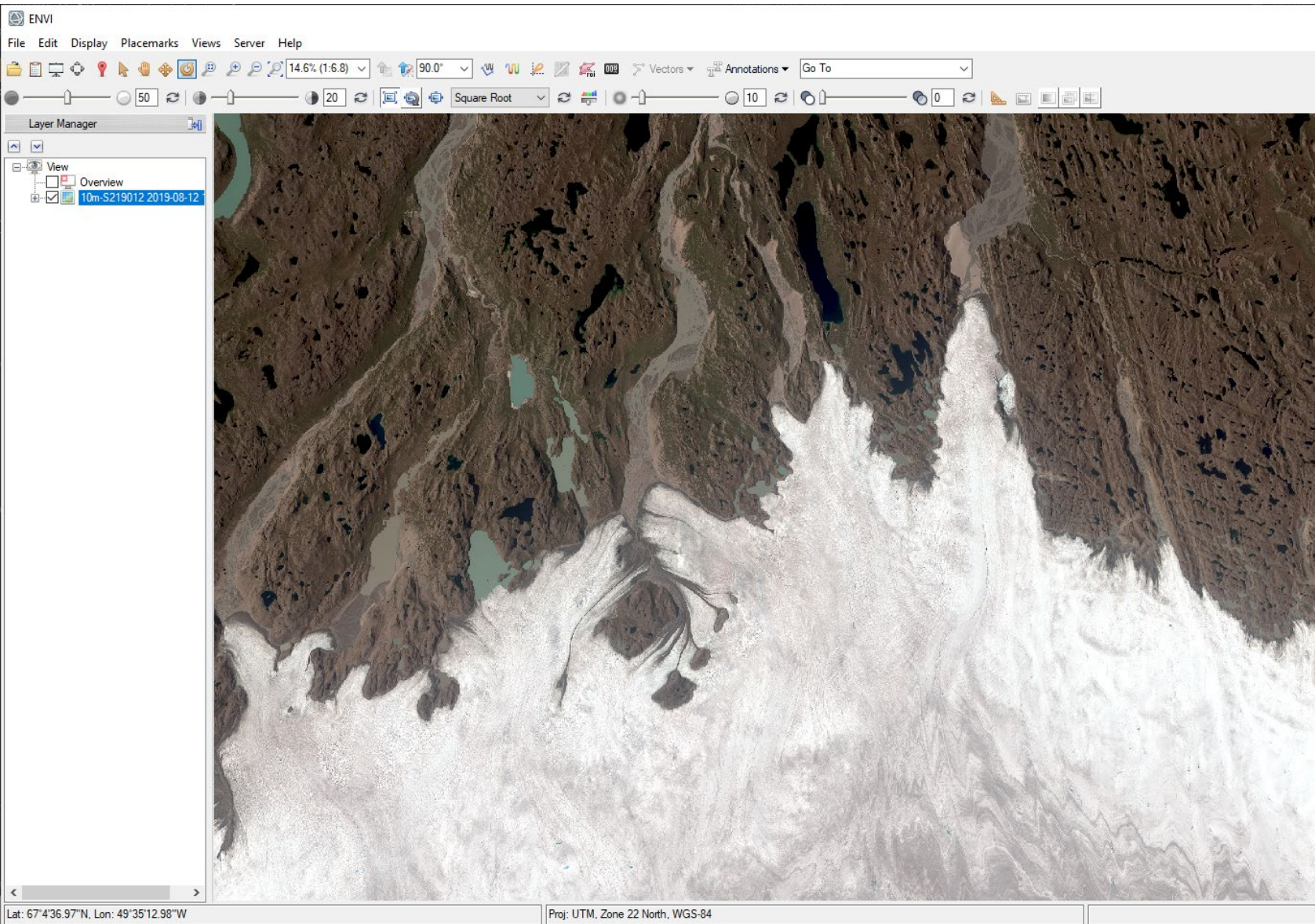
Helios®



Data & Imagery



# ENVI: The ENvironment for Visualizing Imagery



ENVI is an easy-to-use suite of tools that makes image analysis accessible to anyone.

From analysts to PHD's, ENVI is beneficial can be used for all sorts of image analysis techniques.

ENVI includes many features to make it easy to work with, including the ENVI Modeler to automate workflows without needing to program. Or, for our coders, you can use IDL to automate and extend ENVI's core functionality.



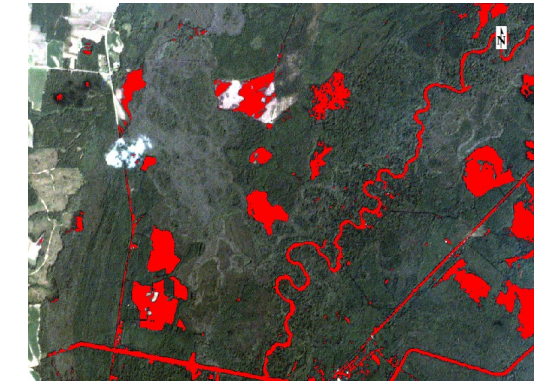
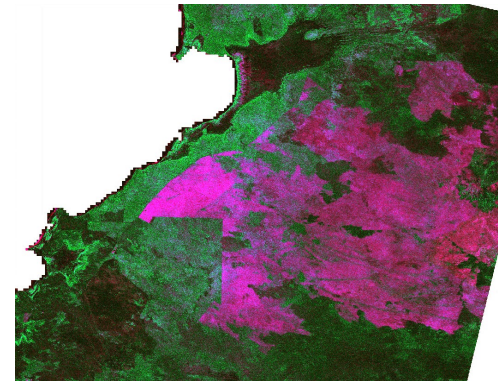
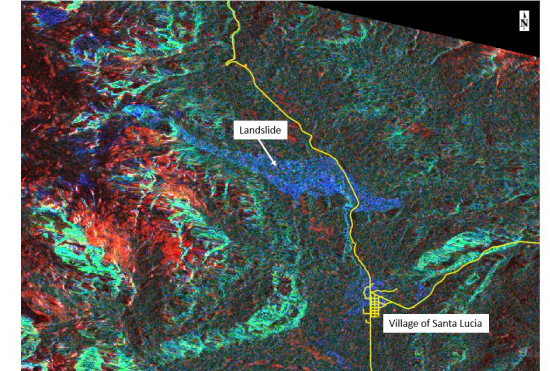
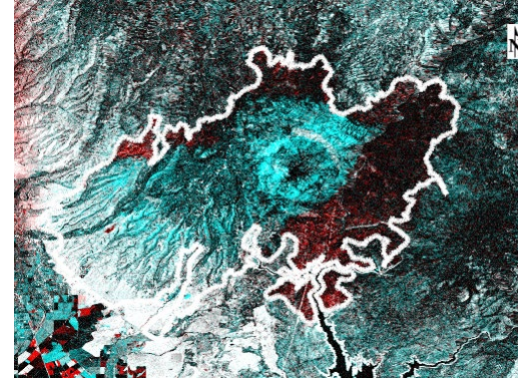
# Disaster Response



Some of the top priorities after a disaster are to:

1. Rapidly assess the extent of the damage
2. Task resources to help in the recovery effort based on where, and how severe, the damage is

Using deep learning technologies, once you have the data, you can reduce the timeline to process the scene down to hours rather than days or weeks



Examples of different natural disasters and how you can see them with remotely sensed data. Examples: Fire extent (top-left and lower-left), landslides (top-right), flooding (lower-right).



# L3Harris Geospatial is an Authorized Pix4D Reseller



Partnership began in 2020

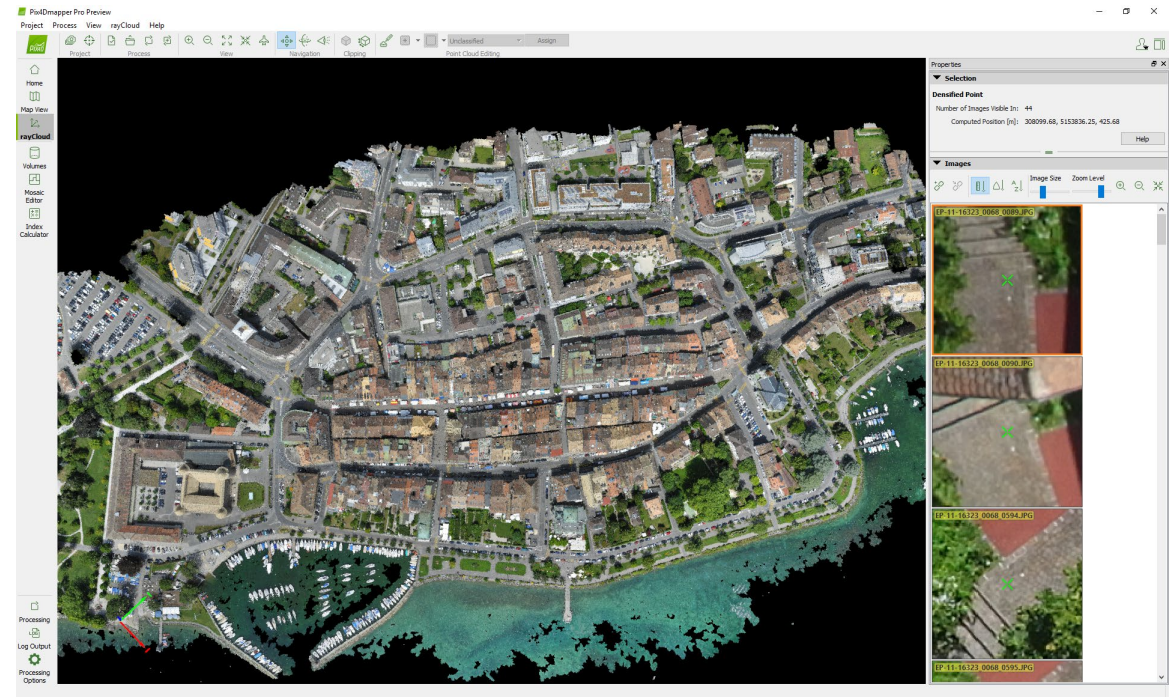
*The remote sensing image processing of ENVI...*

*With the Pix4D photogrammetry suite for drone mapping*

Focus is the user who needs the bundled software mix

Contact your L3Harris Geospatial sales representative or distributor to buy Pix4D with ENVI

Email: [geospatialinfo@L3Harris.com](mailto:geospatialinfo@L3Harris.com)





# Pix4D Overview And Workflow with ENVI

Christopher Cressy  
Josh Haga  
Pix4D

# About Pix4D



**2011** Pix4D founded in Switzerland  
**200+** global employees  
**55,000+** active users  
**570,000 km<sup>2</sup>** mapped in 2019



DENVER  
U.S.A.



LAUSANNE  
SWITZERLAND



BERLIN  
GERMANY



SHANGHAI  
CHINA



MADRID  
SPAIN



TOKYO  
JAPAN





# What is Photogrammetry?



*Measure from Images*

Photogrammetry can digitize the world, purely from images



# Brief History of Photogrammetry

1480 Leonardo Da Vinci - Perspective

1858 Albrecht Meydenbauer

- Architectural Photogrammetry

1910 Carl Zeiss

- Aerial Photogrammetry

1960s Computer Vision

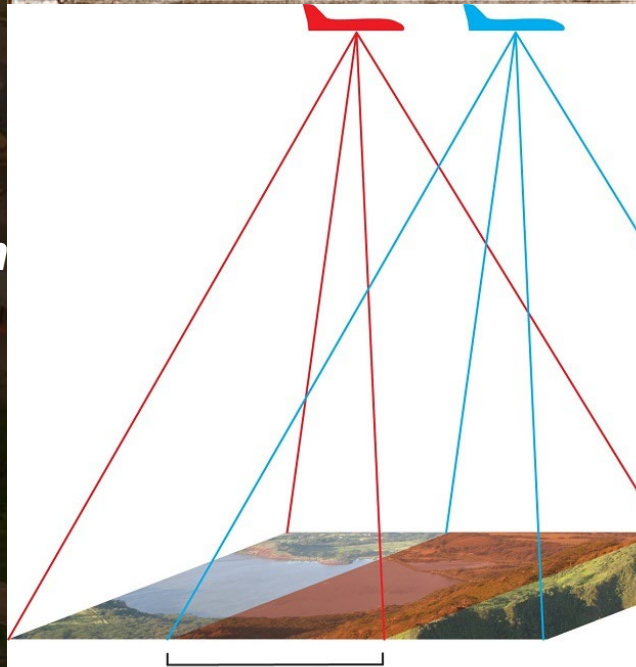
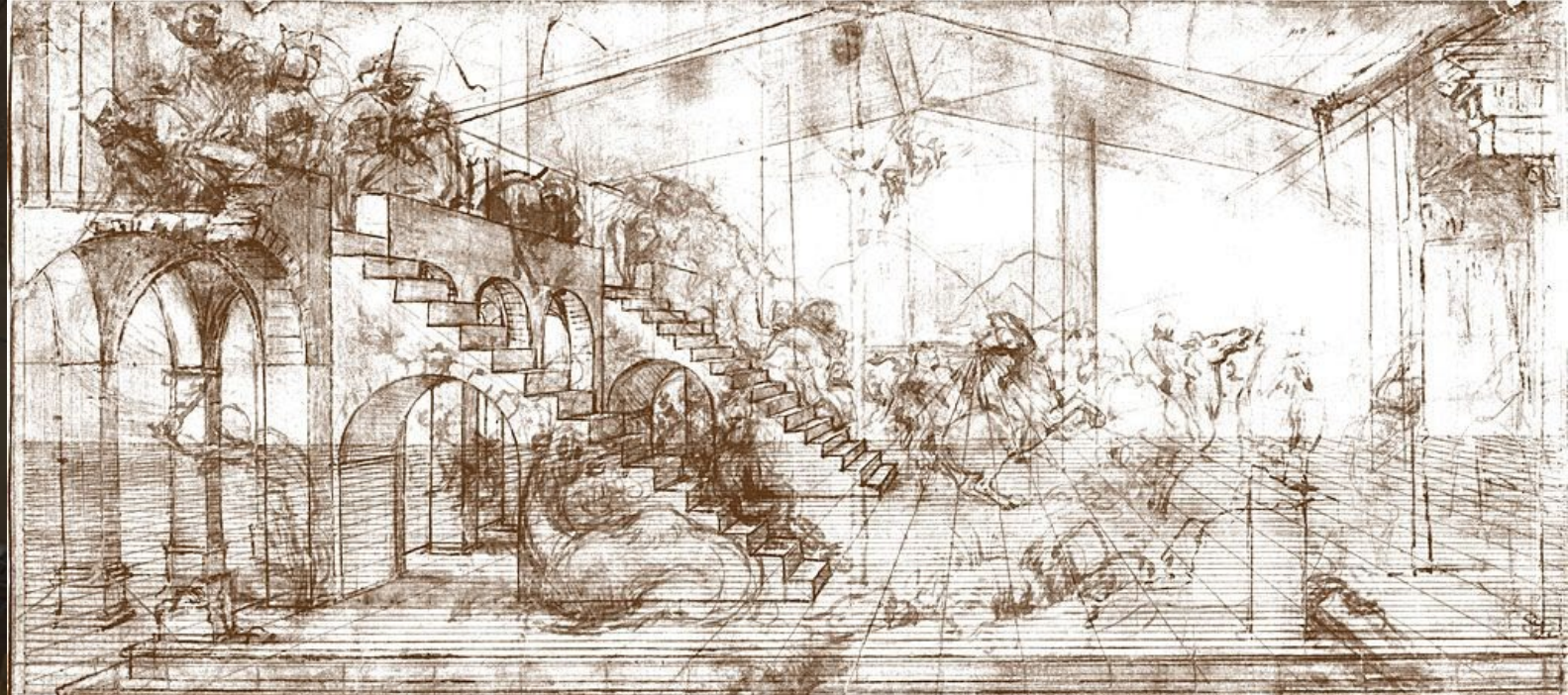
1990s GPS

2008 *Structure From Motion algorithm*

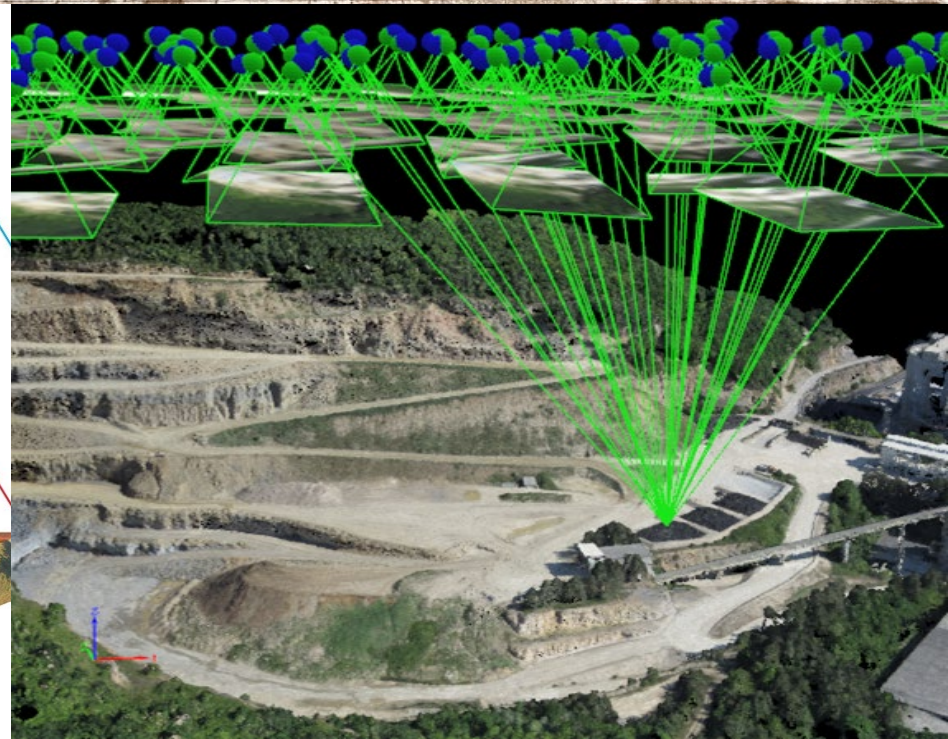
2013 DJI Phantom

2014 Pix4Dmapper

2020 Specialized Photogrammetry Solutions and Workflows

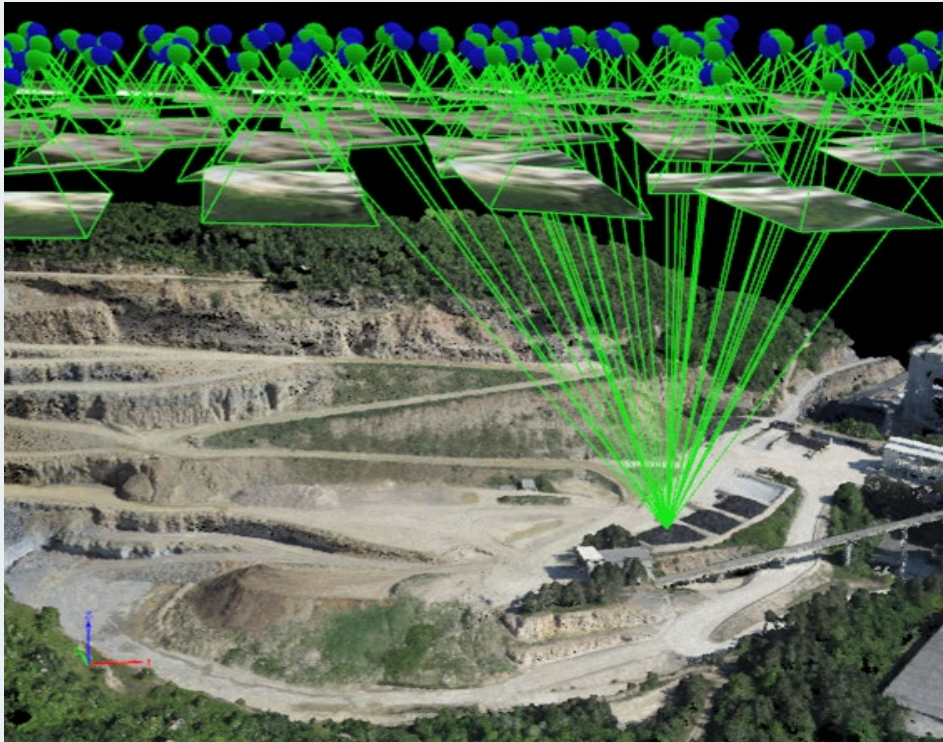


Standard 60% Stereo overlap





# Structure from Motion – Drone-based Photogrammetry



Start with Multiple Overlapping Images  
Solve Simultaneously for Camera Locations and Dense Point Cloud



# Photogrammetry Outputs



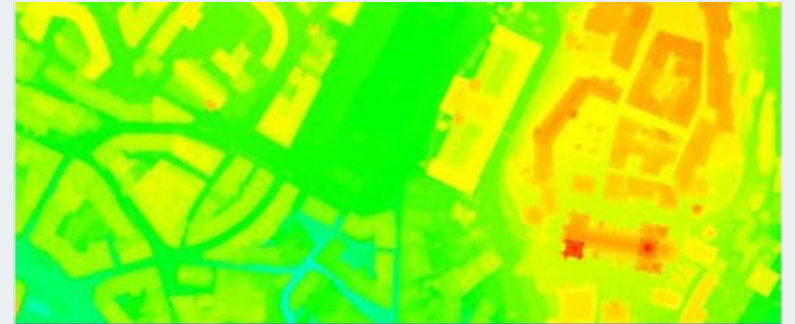
Full-color point cloud

.las, .laz, .ply, .xyz



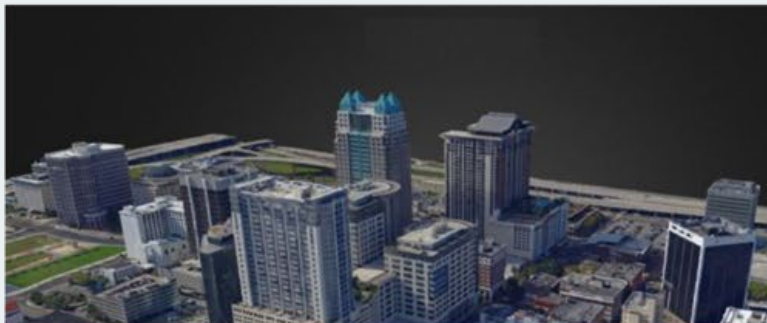
Orthomosaic

GeoTiff (.tif), .kml



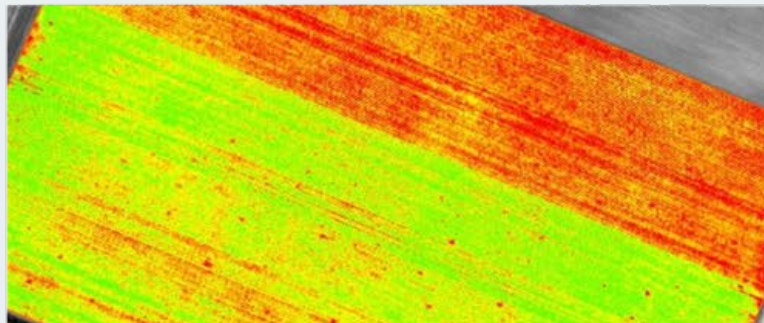
Digital surface model (DSM)

GeoTiff (.tif), .xyz, .las, .laz



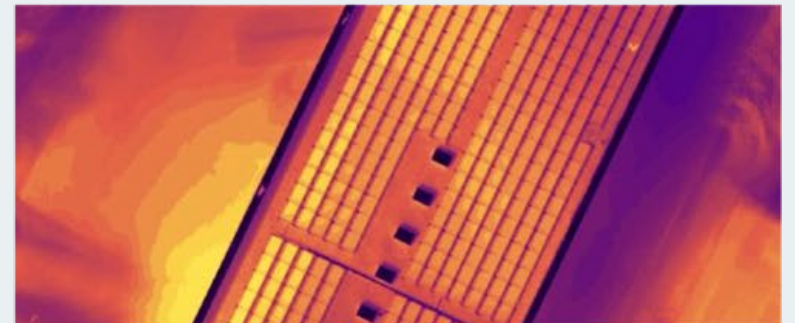
3D textured mesh

.ply, .fbx, .dxf, .obj, .pdf



Index map

GeoTiff (.tif), .shp



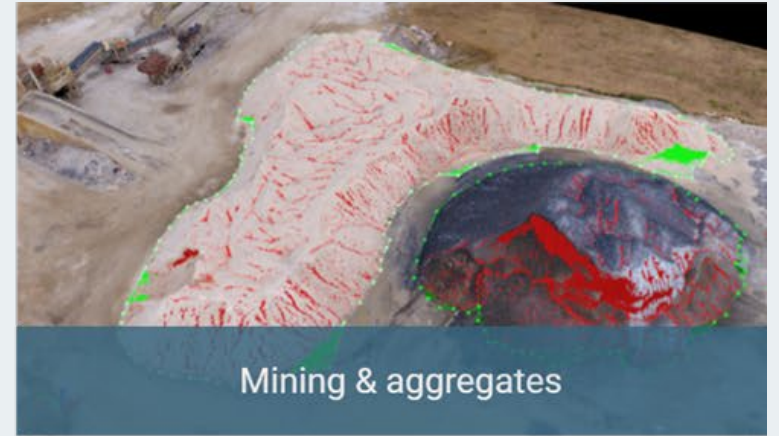
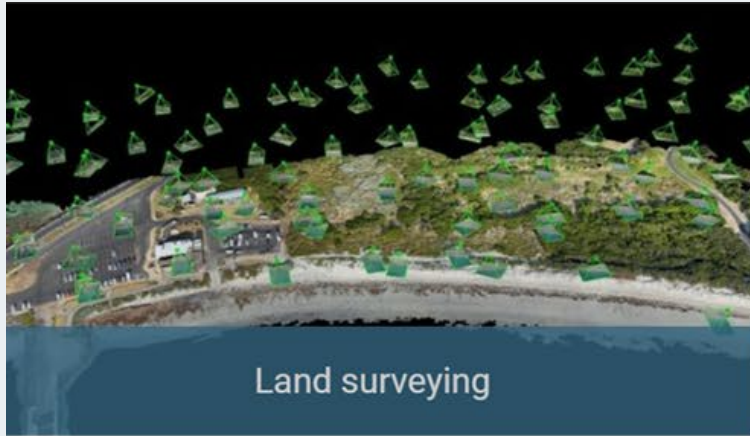
Thermal maps

GeoTiff (.tif)

And more...



# Applications





# Pix4D Products

## Free Apps



Pix4D**capture**



Pix4D**catch**

## Core Products



Pix4D**mapper**



Pix4D**matic**



Pix4D**fields**



Pix4D**cloud**



Pix4D**survey**



Pix4D**react**



Pix4D**cloud**  
Advanced

## Specialty Products



Pix4D**scan**



Pix4D**inspect**



Pix4D**engine**

# Pix4D Products for Use with ENVI

## Free Apps



Pix4D**capture**

## Core Products



Pix4D**mapper**



Pix4D**cloud**



Pix4D**cloud**  
Advanced



Pix4D**matic**



Pix4D**survey**



Pix4D**fields**



Pix4D**react**



# Pix4D-ENVI Disaster Response Use Case

## Free Apps



Pix4D**capture**

## Core Products



Pix4D**mapper**



Pix4D**react**



Pix4Dmapper

## Mapping Hurricane Maria





# Project Overview

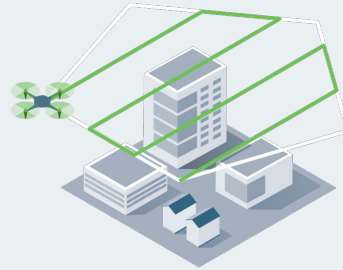




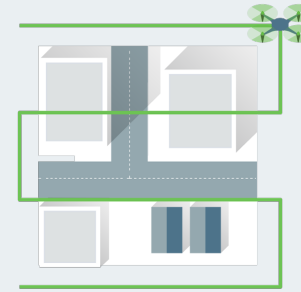
# Pix4Dcapture

- Plan and control drone flights for professional mapping and data capture
- iOS & Android
- DJI, Parrot, and Yuneec drones

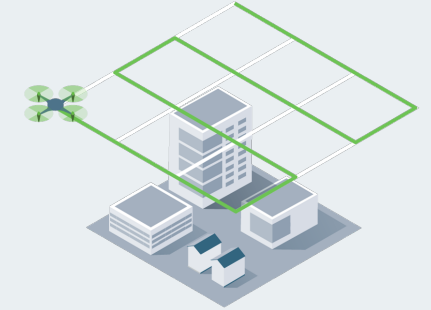
## Flight missions



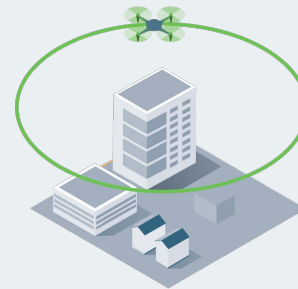
Polygon



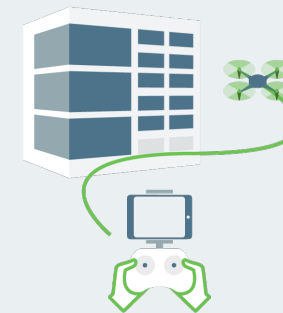
Grid



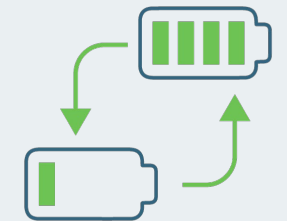
Double grid



Circular



Free flight



Multi-battery



# Acquisition

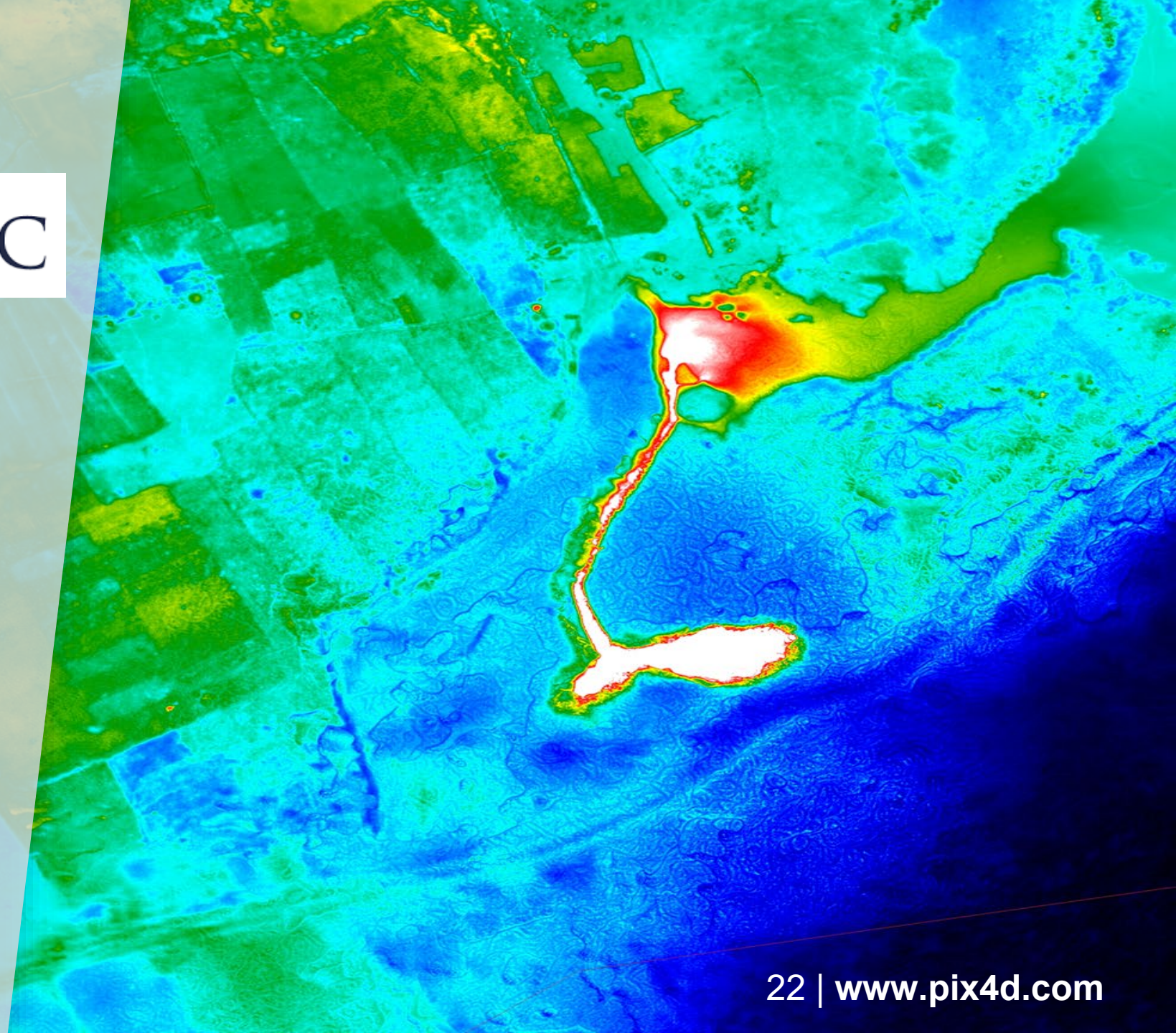


## Drone:

- DJI Inspire 1
- Camera: Zenmuse X4S

## Stats:

- 920 Images
- 153 Acres
- 345 ft. AGL
- 22 min.





# Processing



Pix4Dmapper

## Computer Specs:

**CPU:** Intel i7-7700

**RAM:** 32 GB

**GPU:** NVIDIA GeForce GTX  
1060

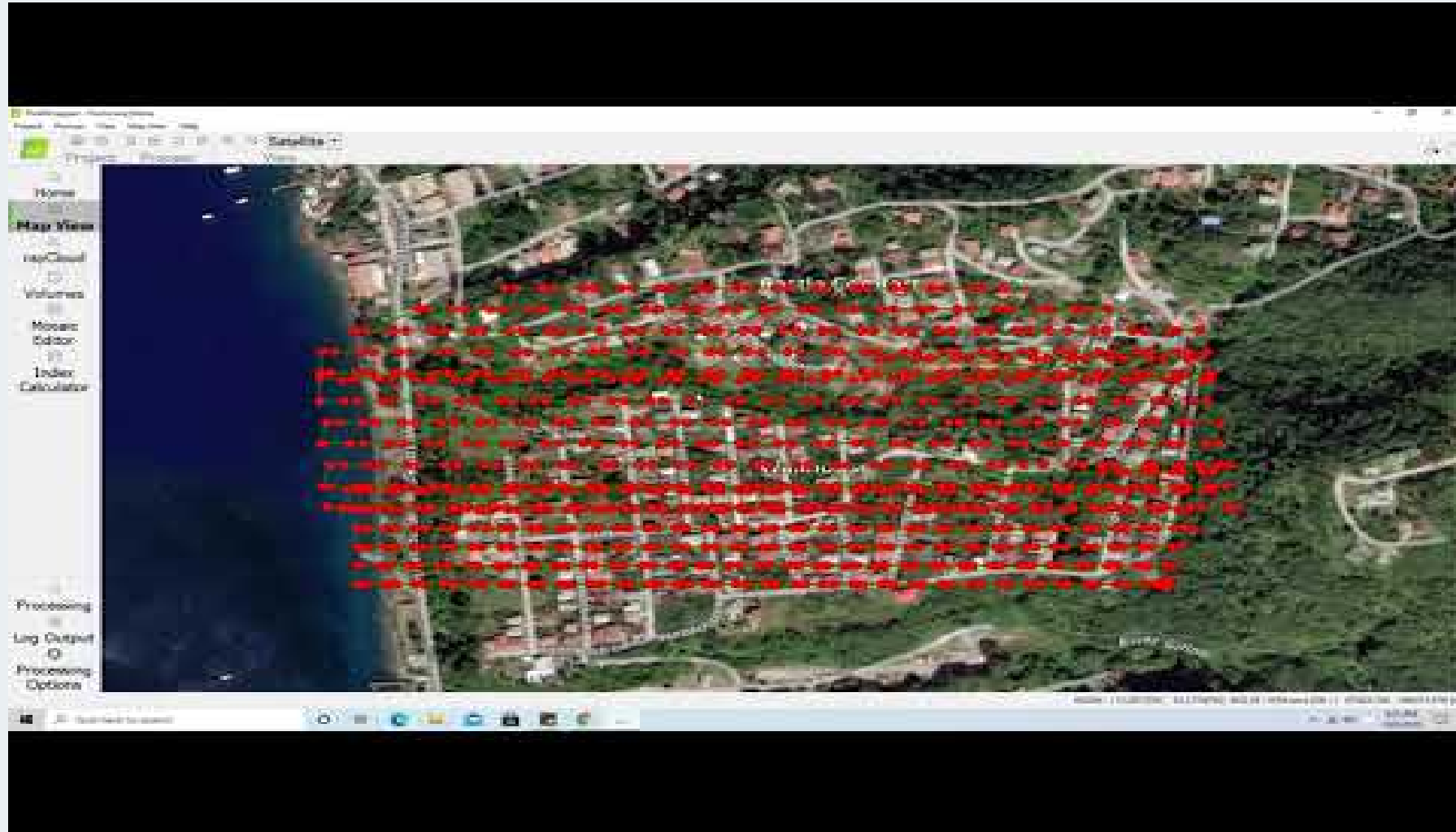
**Project Setup:** 5 minutes

**Processing:** 9 hours

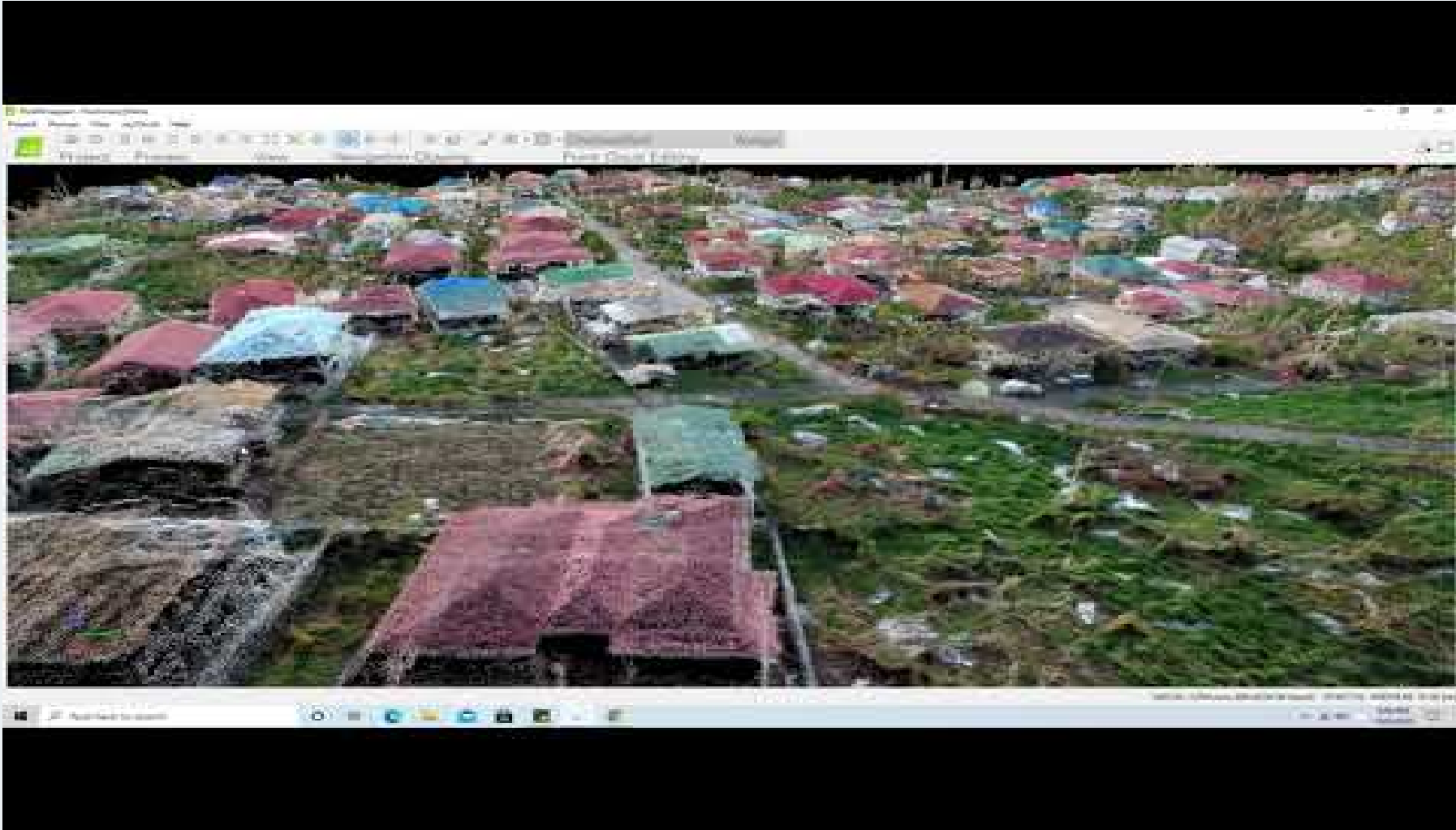




# Project Setup

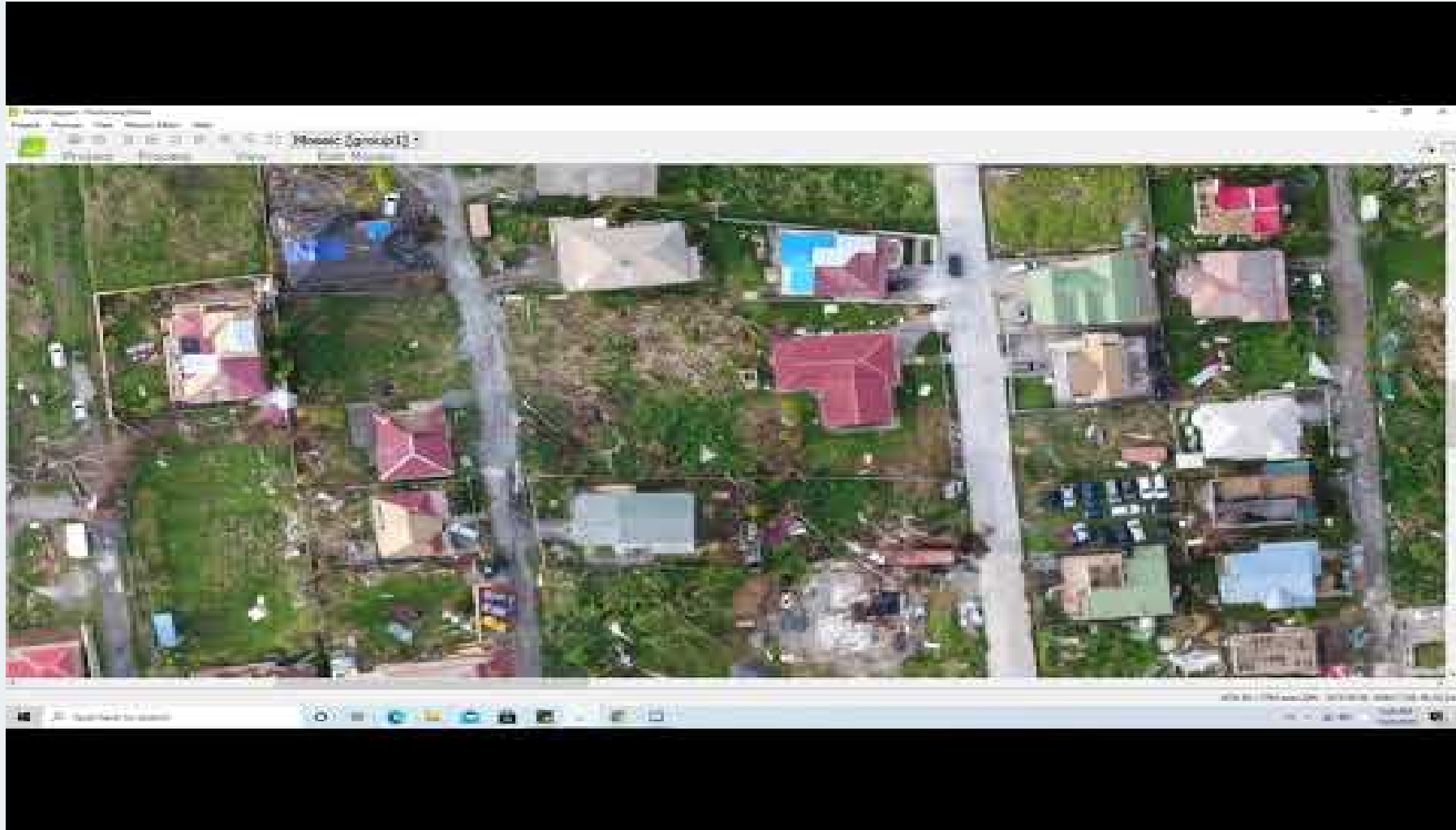


# Outputs - Point Cloud

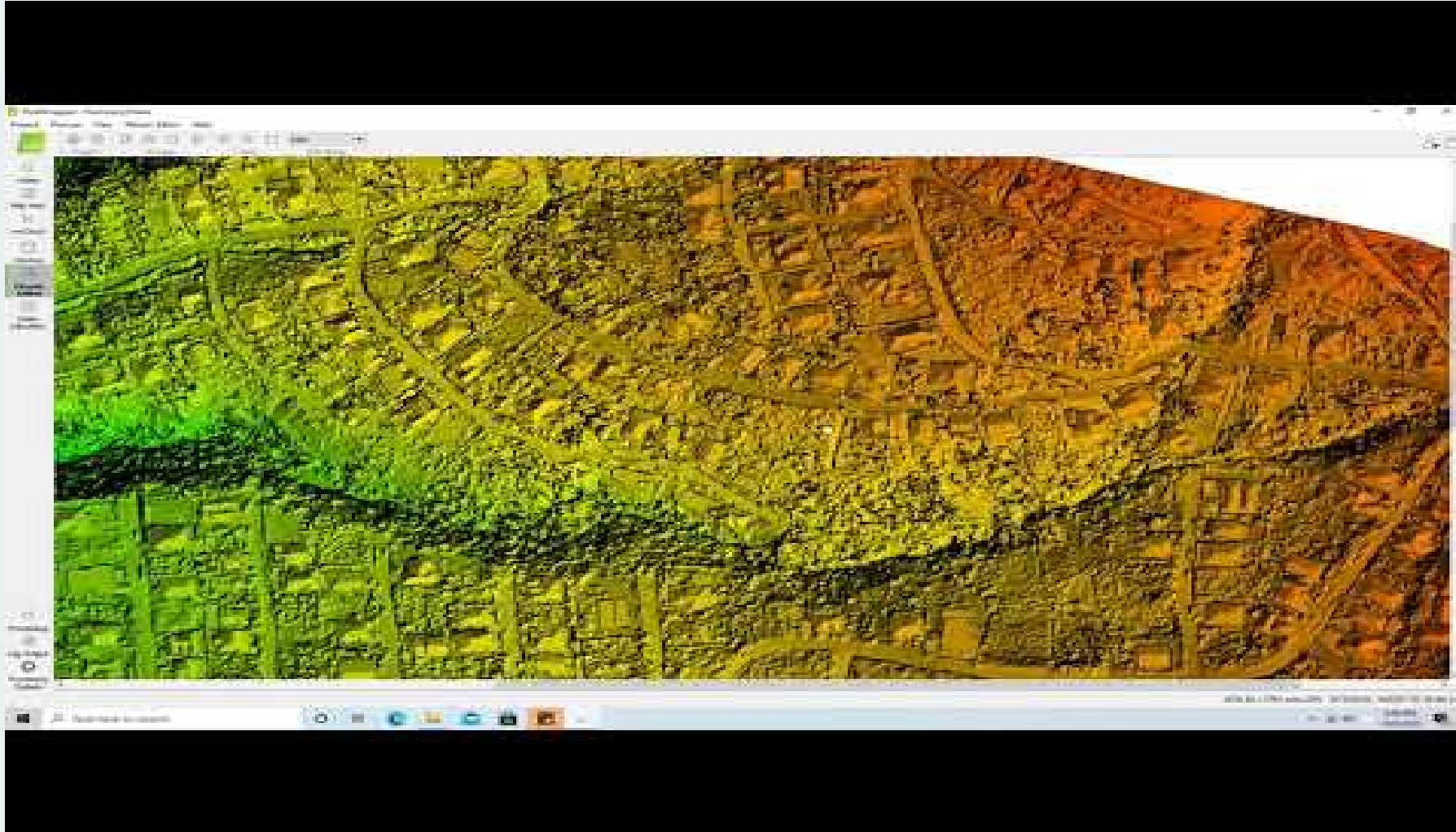




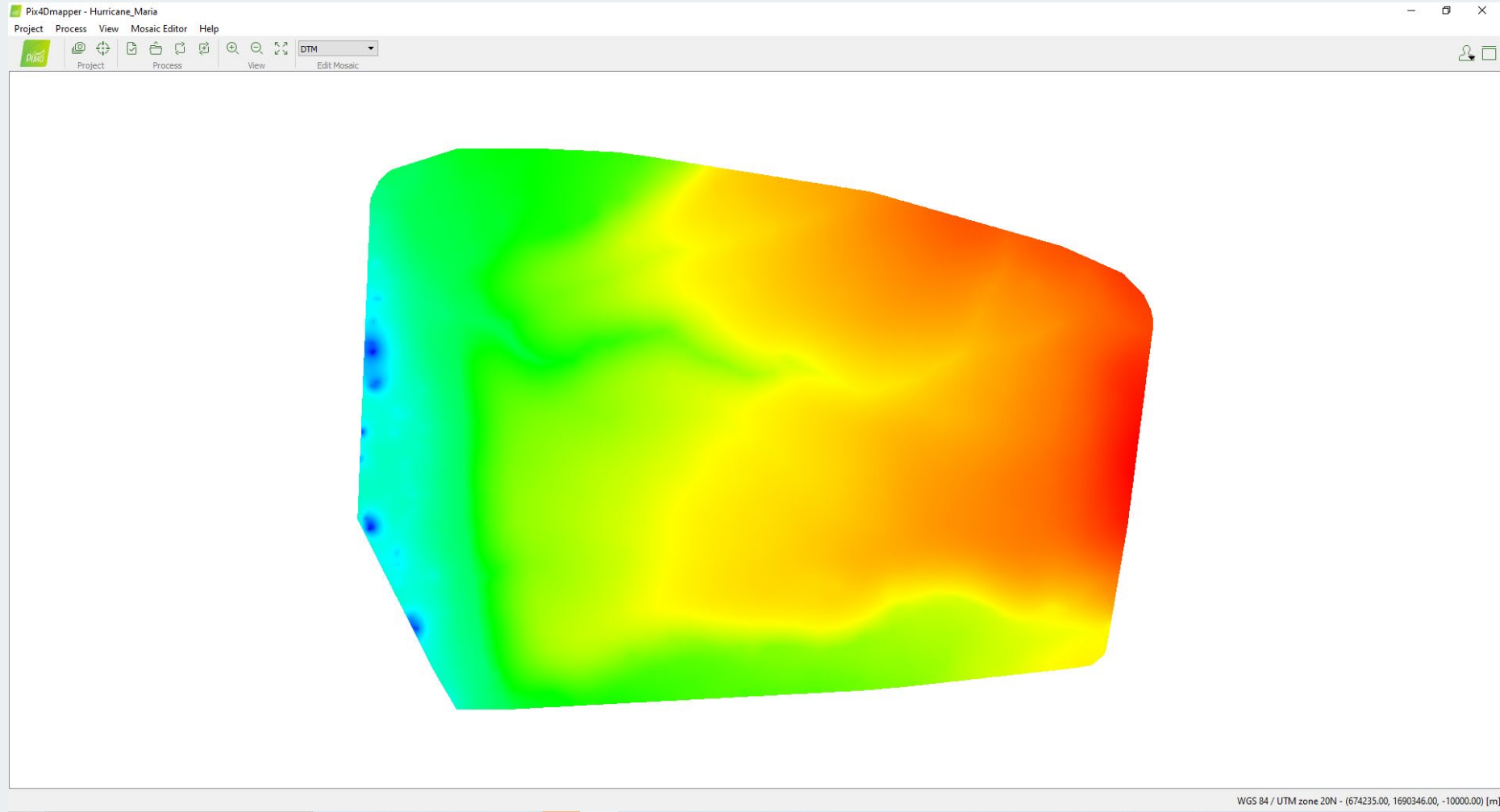
# Outputs - Orthomosaic



# Outputs - Digital Surface Model (DSM)

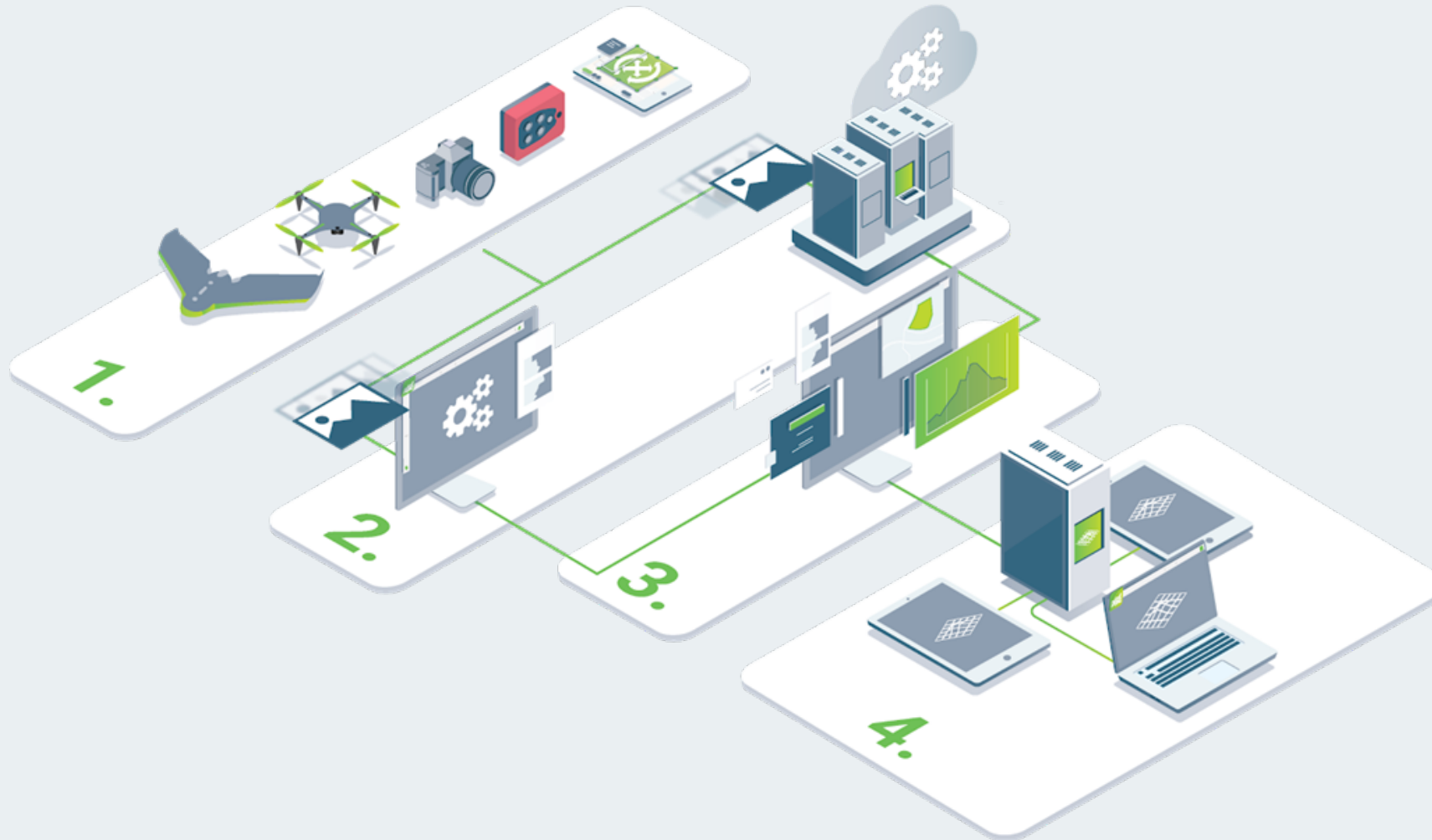


# Outputs - Digital Terrain Model (DTM)





# Pix4D to Envi

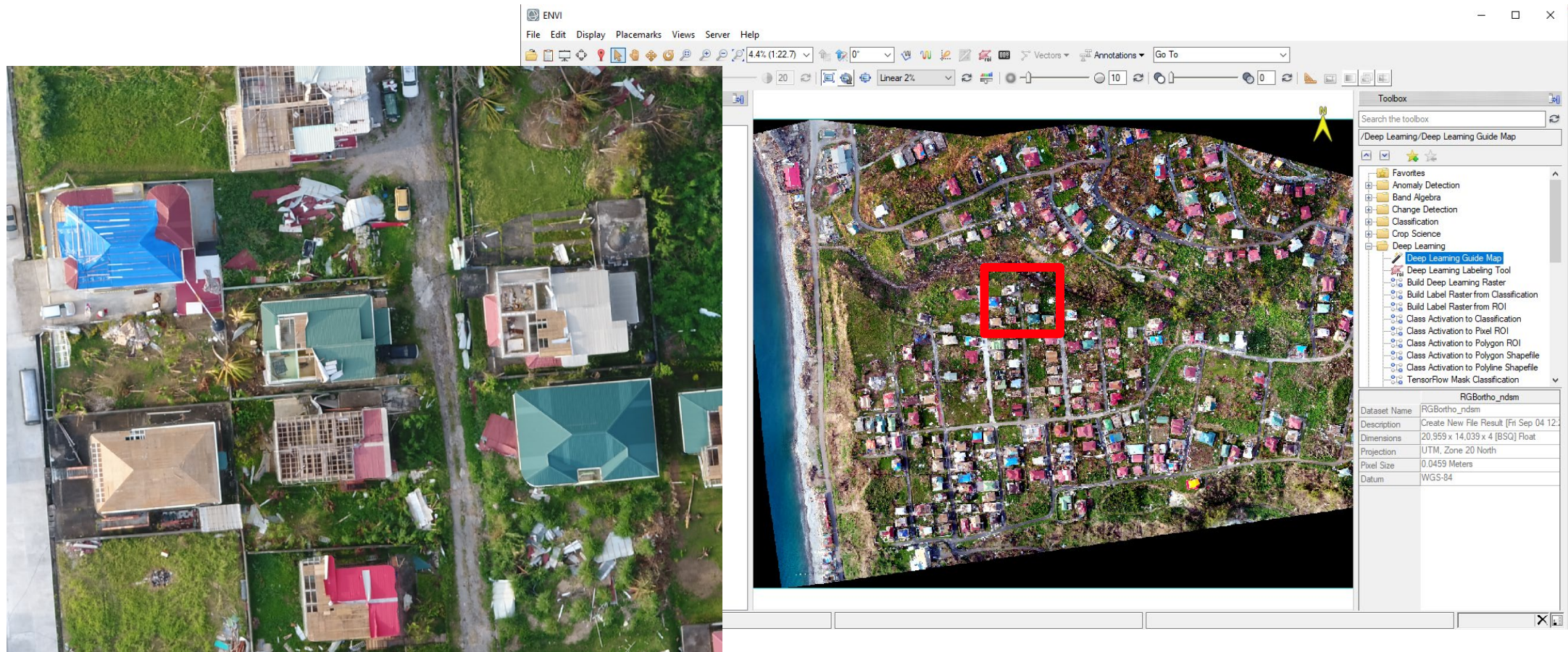


1. Capture
2. Process
3. Export Data
4. ENVI Import

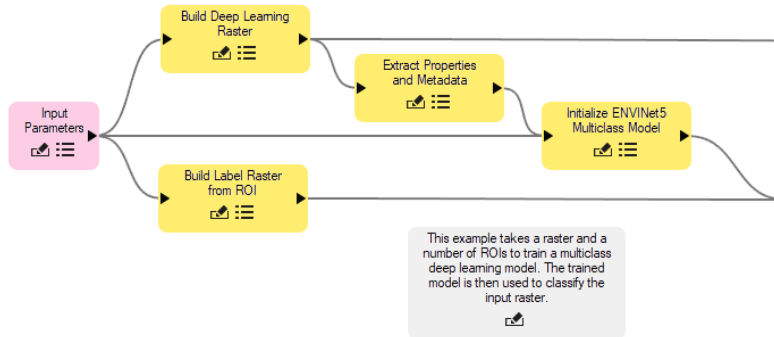
# Extracting information with ENVI



What do we want to do with it?



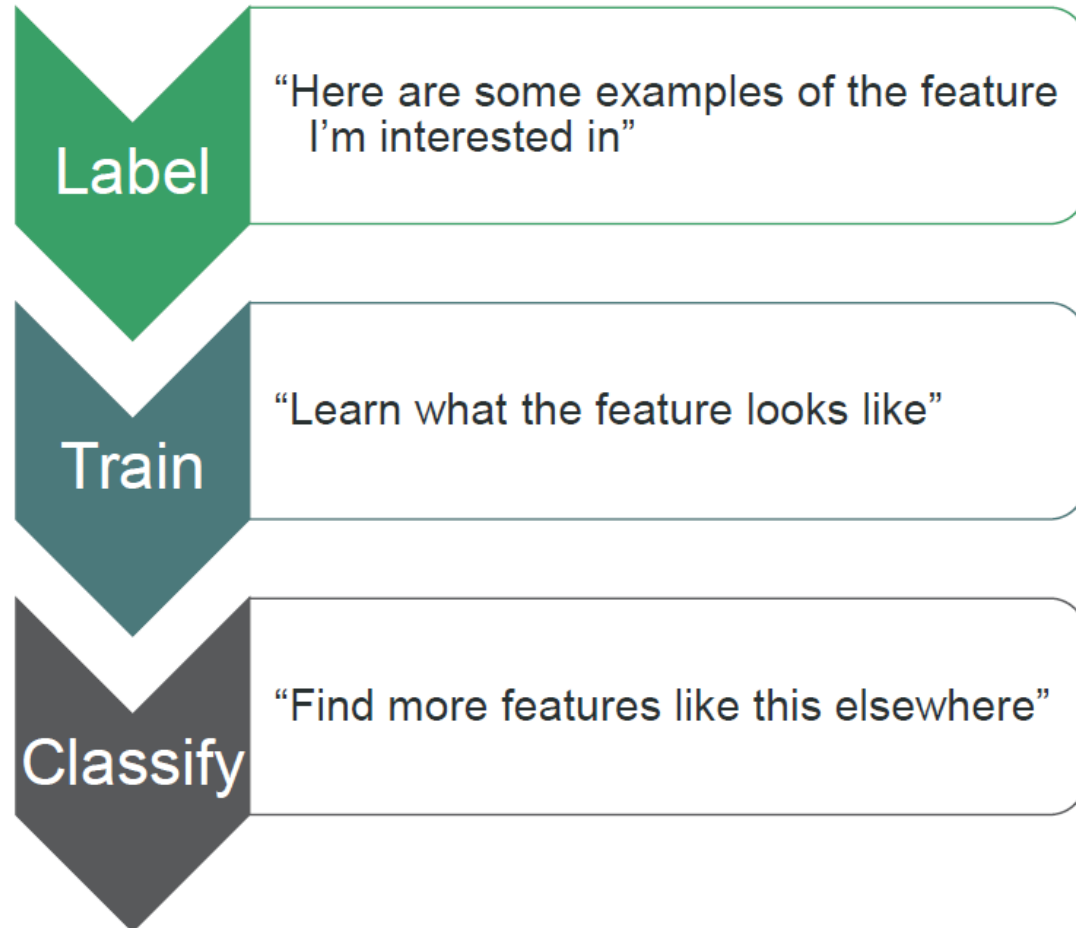
# ENVI Deep Learning Module



Based on the TensorFlow Deep Learning Framework and designed for object identification from geospatial imagery

Integrated into ENVI with easy to use GUI for all processing steps including labelling, training, and inference – no programming!

Available as a module to ENVI





# Training Classes



## Structural Damage

- Roof material removed
- Grid pattern from roof rafters
- Higher elevation compared to ground

## Debris

- Mostly roofing material
- Low elevation

## Fallen Trees

- Tree trunks exposed
- Appears white in RGB



# Normalized Digital Surface Model (nDSM)

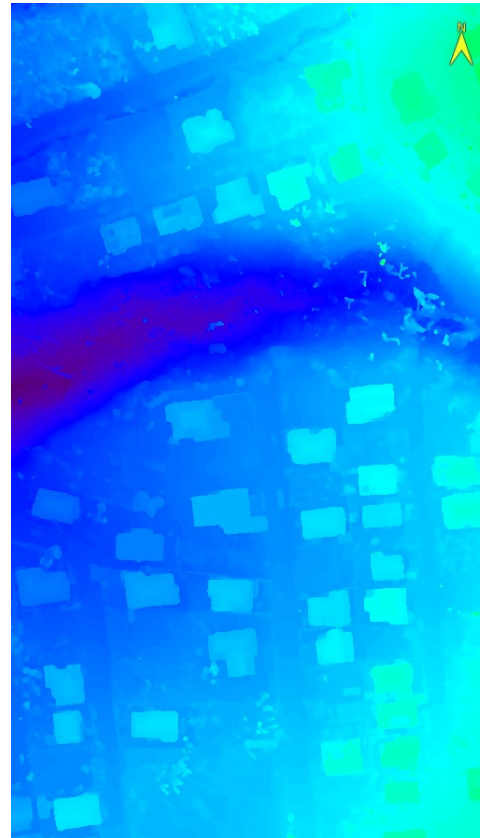
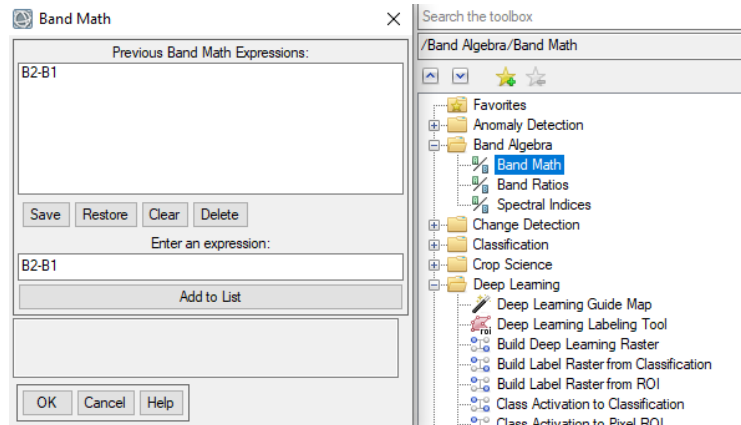


Subtract DTM from DSM

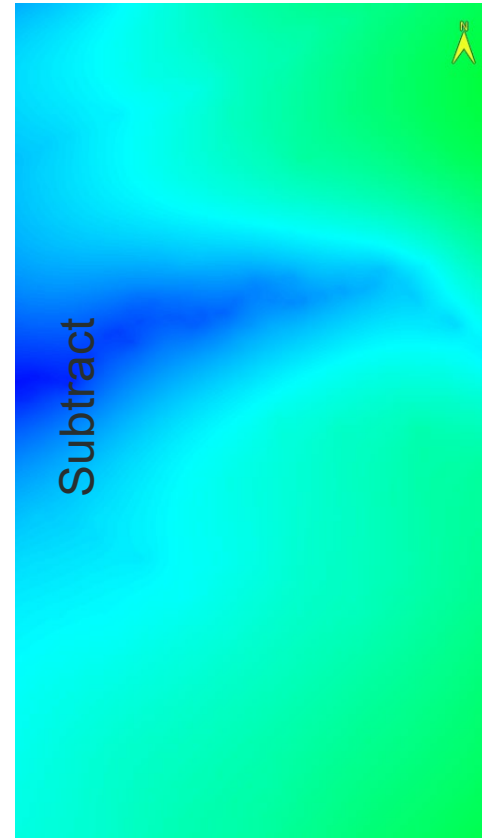
Useful for:

Isolating objects above ground

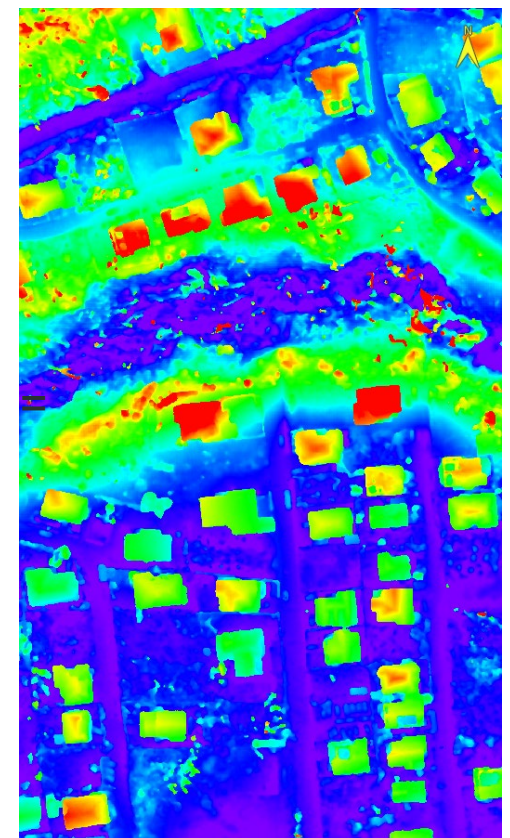
Finding absolute height



DSM



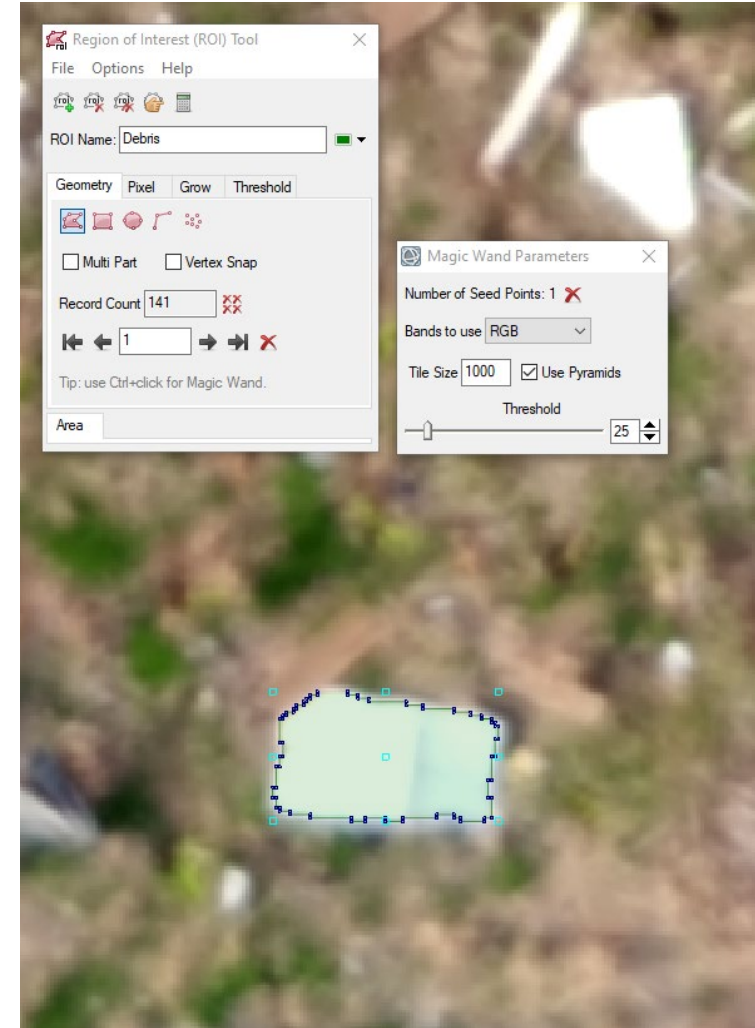
DTM



nDSM






# Labeling



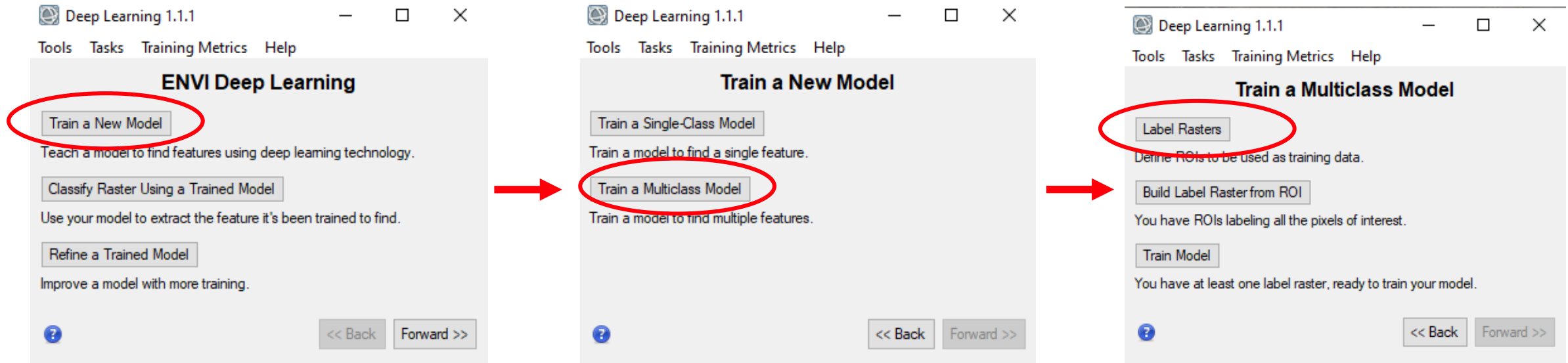


# Labeling



-  Structural Damage
-  Fallen Tree
-  Debris

# Deep Learning Workflow





# Training Parameters



Deep Learning Labeling Tool - [New Hurricane Labeling With Rescaled nDSM]

File Help

Class Definitions

	Name	Color
1	Debris	
2	Fallen Tree	
3	Structural Damage	

Rasters

	Name	ROIs	Label Raster
1	_Masked_ortho_ndsm_rescaled_R1C2.dat	3 / 3	OK
2	_Masked_ortho_ndsm_rescaled_R3C2.dat	3 / 3	OK
3	_Masked_ortho_ndsm_rescaled_R2C2.dat	3 / 3	OK
4	_Masked_ortho_ndsm_rescaled_R3C3.dat	3 / 3	OK
5	_Masked_ortho_ndsm_rescaled_R2C4.dat	3 / 3	OK

Train Deep Learning Model

Patch Size: 640 Larger is faster, but uses more memory.

Training/Validation Split (%):  80

Shuffle Rasters

Number of Epochs: 20

Number of Patches per Image: 100

Solid Distance: Debris: 6, Fallen Tree: 6, Structural Damage: 0

Blur Distance: Debris: 1, 8, Fallen Tree: 1, 8, Structural Damage: 1, 8

Class Weight: Min 0, Max 3

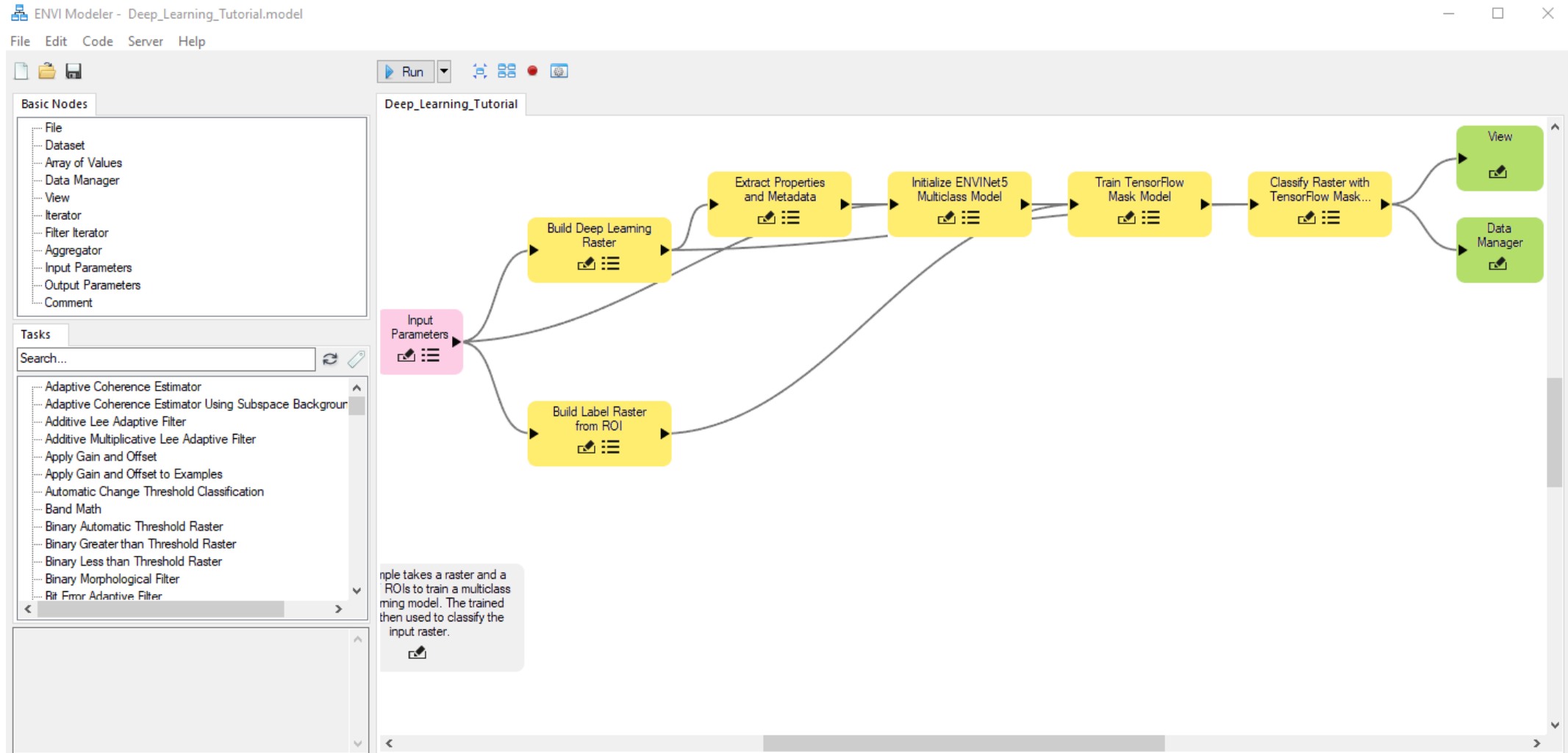
Loss Weight: 0 (0.0 or higher)

Output Model: Deep Learning\3\_models\rescaled4band\model0.h5

Output Last Model: Learning\3\_models\rescaled4band\model0\_last.h5

OK Cancel

# ENVI Modeler





# Training Metrics



80 percent training/validation

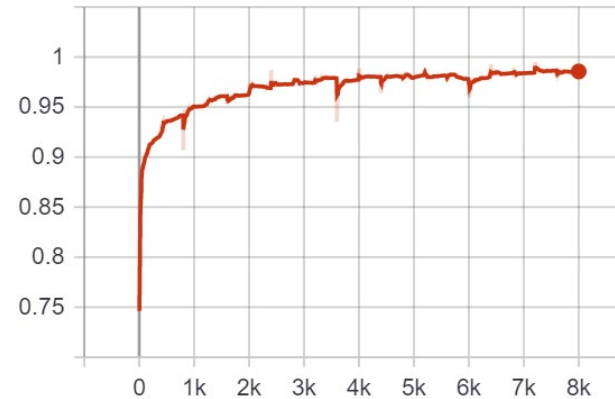
## Parameters

- # of Epochs = 20
- Blur Distance = 1-8
- Class Weight = 0 to 3
- Loss Weight = 0

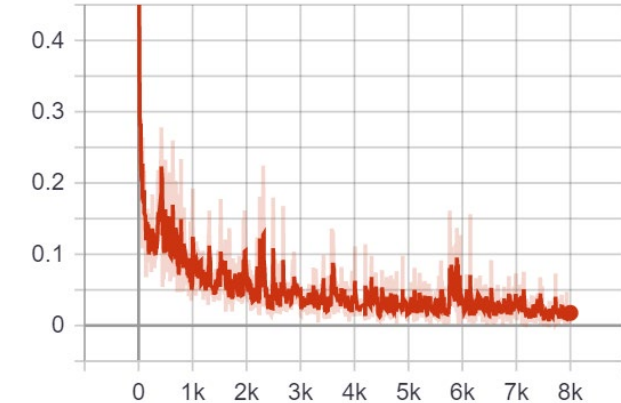
Trained using Nvidia RTX Quadro 4000  
2304 CUDA cores  
8 GB Memory

Approximately 30 minutes training time  
\*Your training time may differ

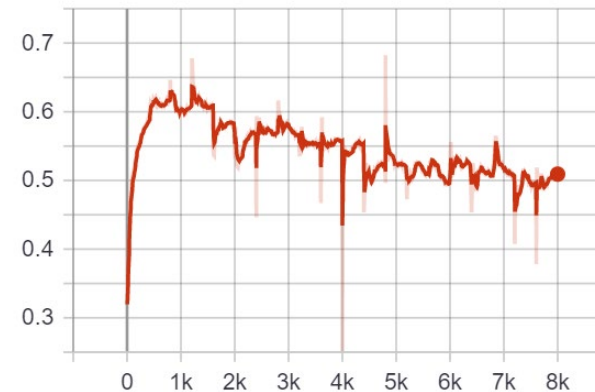
batch\_acc



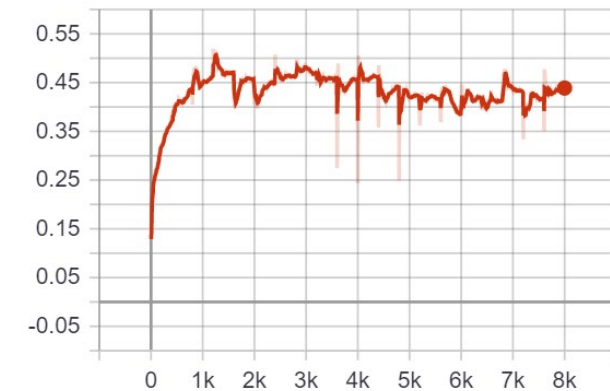
batch\_loss



batch\_precision






batch\_recall





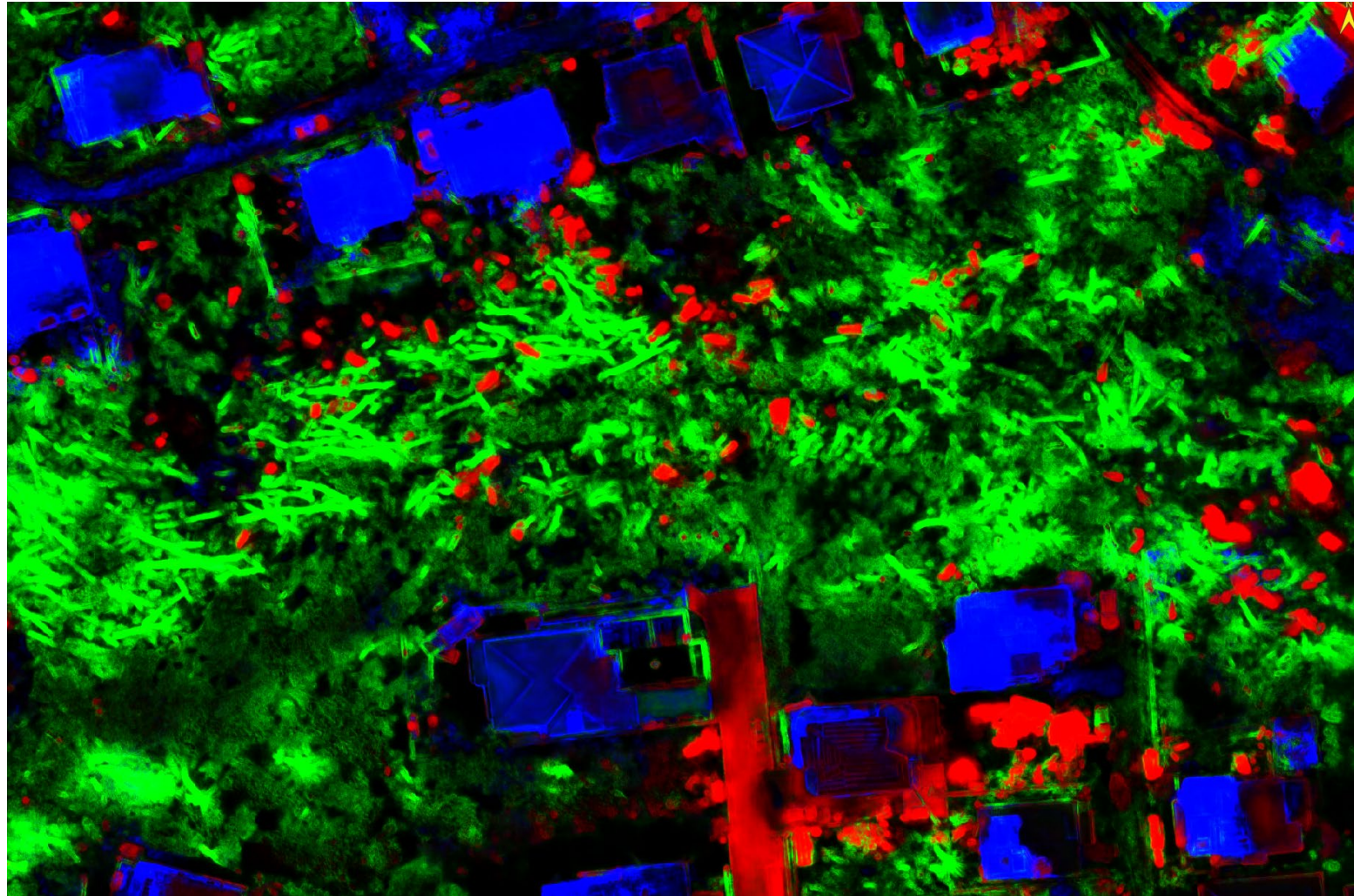
# Deep Learning Classification Result






-  Structural Damage
-  Fallen Tree
-  Debris



# Deep Learning Activation Image



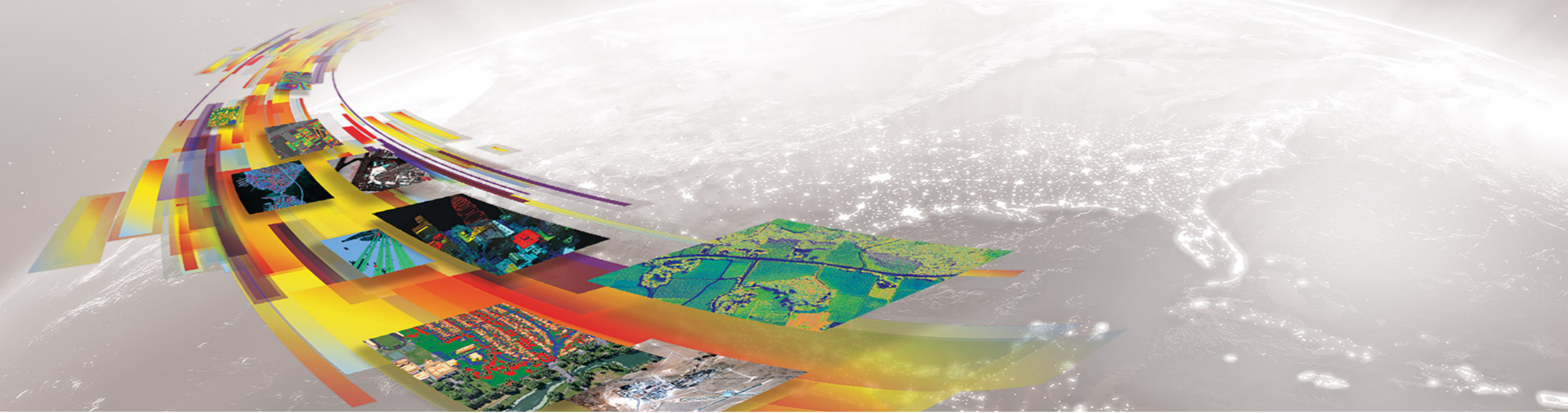
-  Structural Damage
-  Fallen Tree
-  Debris



# Structural Damage Activation







**Thank You!**

**L3Harris Geospatial**

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