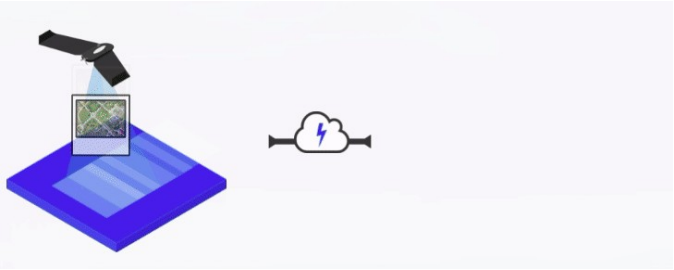
OpenDroneMap



ONLINE

FOSS4U:

Free and Open Source for Uncrewed Aerial Systems

Stephen Mather, Executive Director

FOSS4G Asia

2022 November 27

FOSS4G 2023 ASIA

Agenda

- Background
- Hands-On: Start Processing
- Outputs
- Using ODM
- Learning Resources
- Hands-On: Exercises

Background

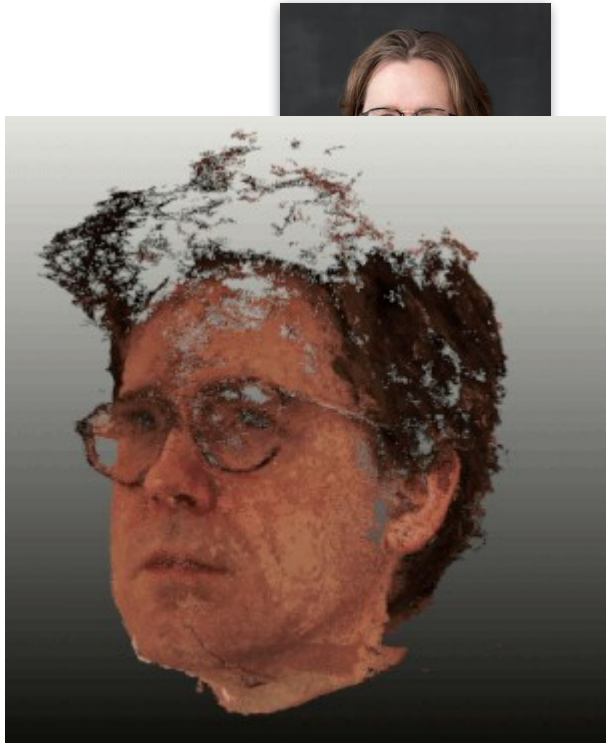
About Me

Stephen (Steve) Mather

- OpenDroneMap Ecosystem co-founder (with Piero Toffanin)
- Specialize in large-scale elevation model creation from photogrammetry
- Writing:
  - Co-Author of the PostGIS Cookbook
  - Blog at https://smathermather.com
- Certified Remote Pilot (US FAA Part 107)

About Me

Stephen Mather



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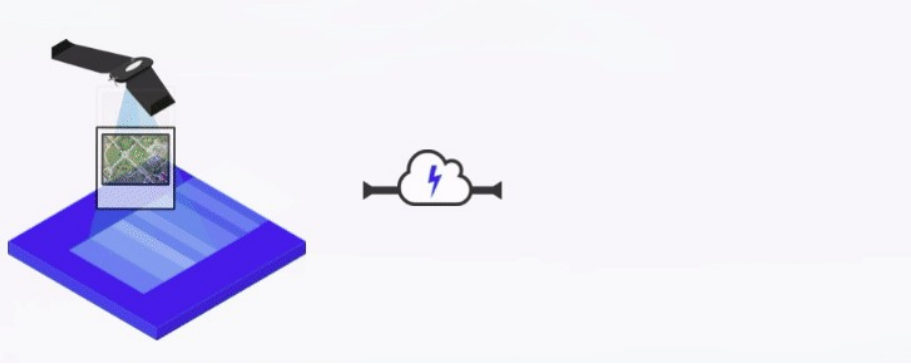
What is ODM?



GIF via WebODM.net

- Free and open-source toolkit for photogrammetry from UAS imagery and other camera data
- Georeferenced 2D and 3D outputs
  - Orthophoto, DSM, DTM
  - Point Cloud, Textured Mesh
- Used globally by 10s of thousands of users across sectors private, public, and charitable/NGO sectors
- Begun in 2014, significant improvements 2018-2021
  - Output Quality
  - Features
  - Usability

Why Open Source?

Accessible to orgs and programs with limited budgets

- Close source solutions can be as much as $300+/mo -OR- ~$5000 one-time
- **ODM is $0* (free forever)**

But ~~equally~~ more important:

- **Control** over your toolchain (change if you want)
- Shoulders of giants: many contributors, **collective wisdom**
- Core software is a public goods
- **Transparency** leads to greater
  - **Quality**
  - **Security**

**You can pay for certain parts, but not required.*

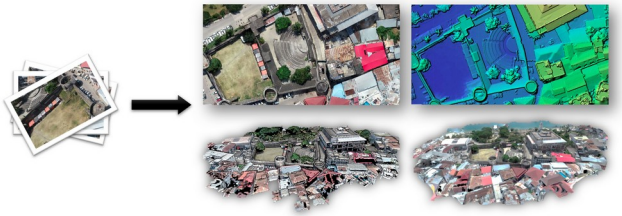
ODM History

- End of 2013 - Began as a joke on Geohipster
- End of 2014 - Funded, organized FOSS project with multiple contributors
  - Announced at State of the Map US 2014
  - Incubated quietly at FOSS4G Korea
  - Formal release, FOSS4G Portland
  - 2015-2018 – Quietly expanded and refined
  - 2018-2021 – Significant UI / feature improvements; wider adoption
  - Today – active community of international users, contributors
-

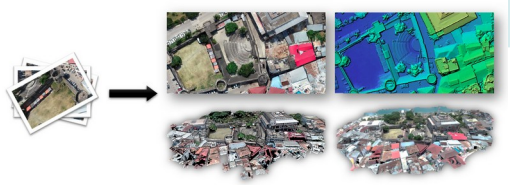
ODM Goals

- Humanitarian
- Ecology, conservation
- Research
- Data for the public good

What is ODM?



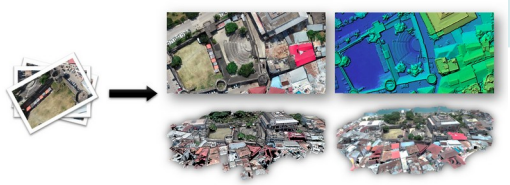
- Photogrammetry tool for general existing conditions datasets
  - Orthophoto
  - Elevation Models
  - LiDAR-like point clouds
- Digital Twin Creator



What is ODM?

Existing conditions

- Hinkley Reservation (park), near Cleveland, Ohio, USA
- Needed better terrain model than available from existing lidar datasets



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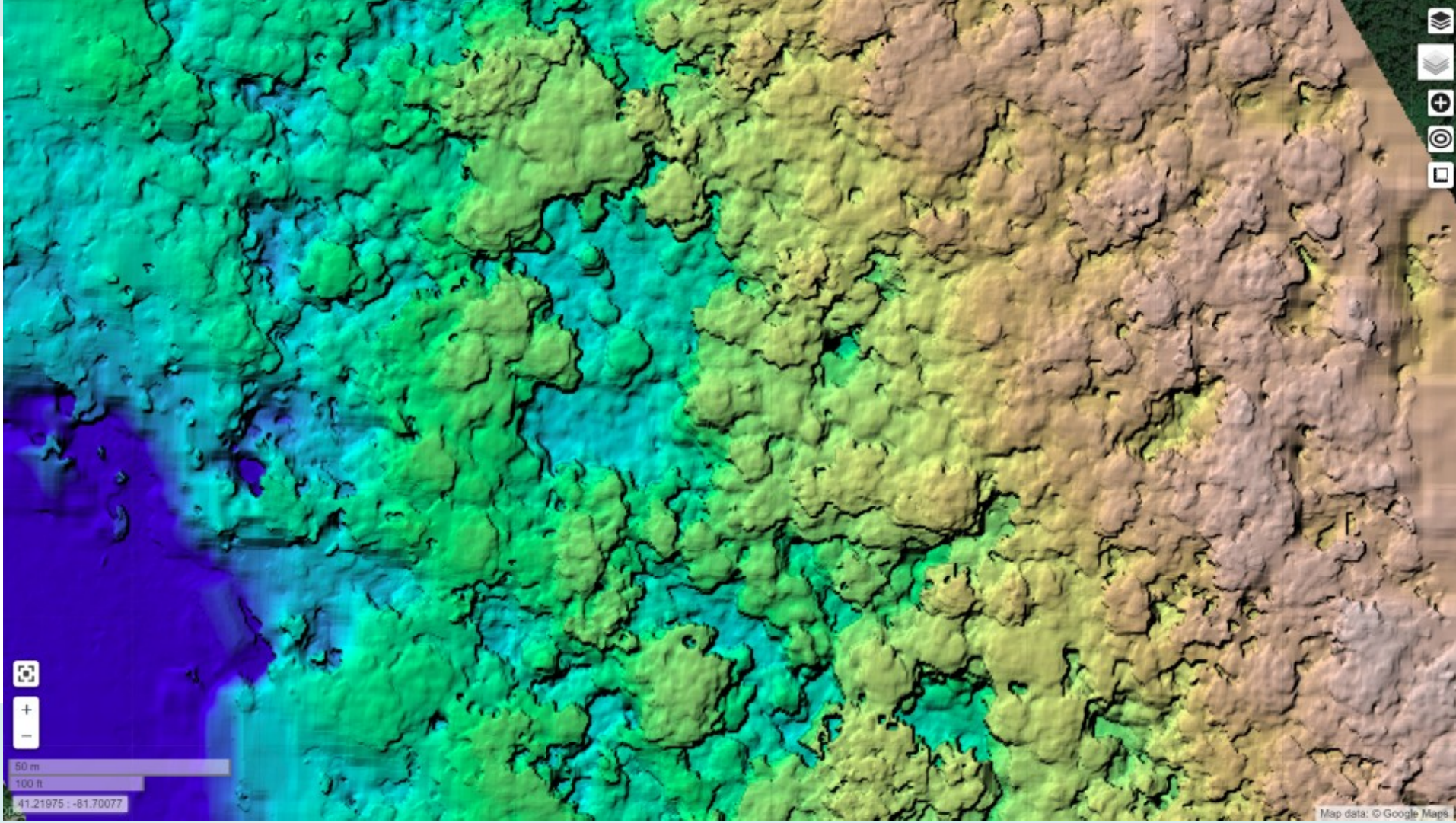
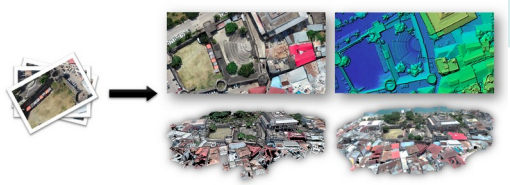
50 m
100 ft
41.22033 : -81.70354
Map data: © Google Maps


50 m
100 ft
41.21975 : -81.70077
Map data: © Google Maps



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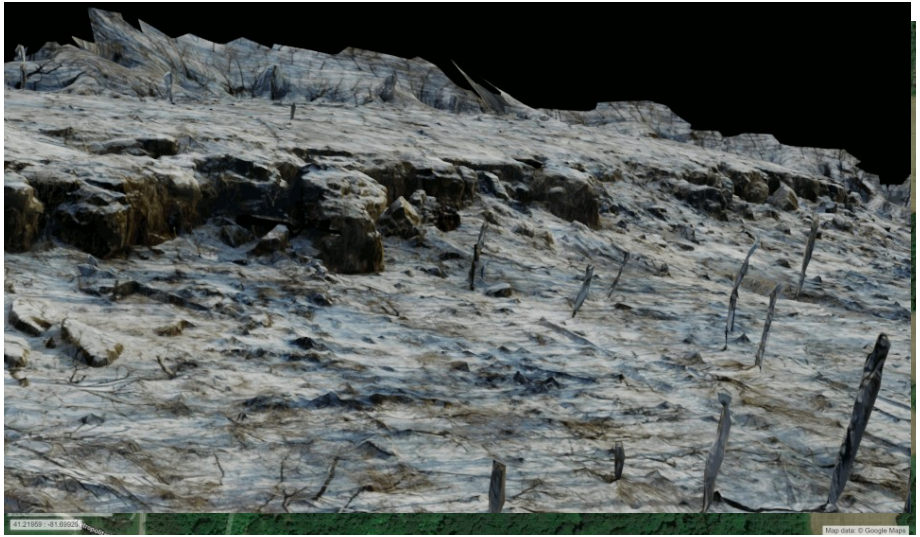

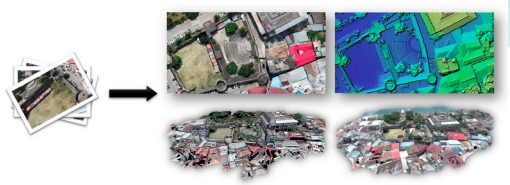

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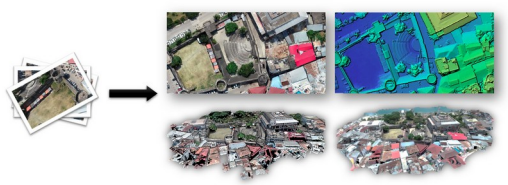

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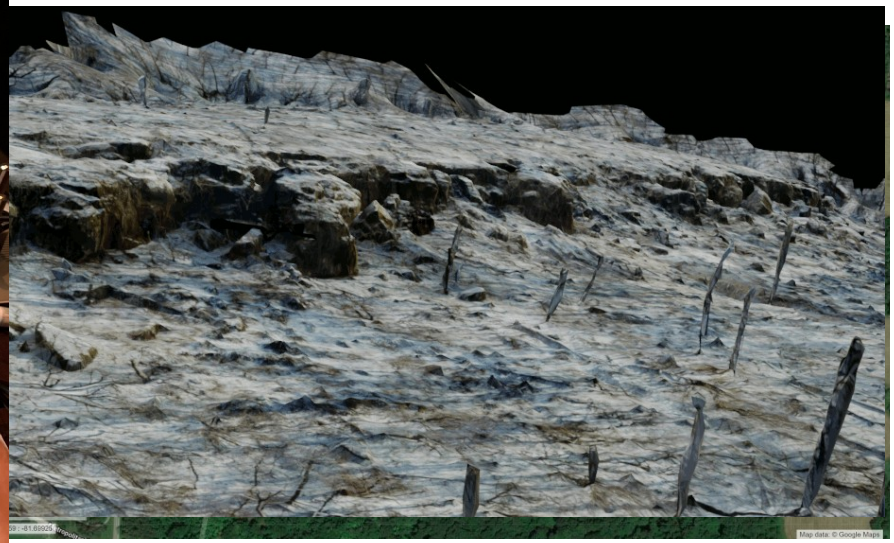
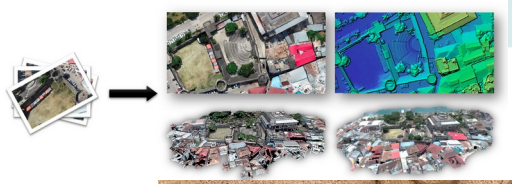
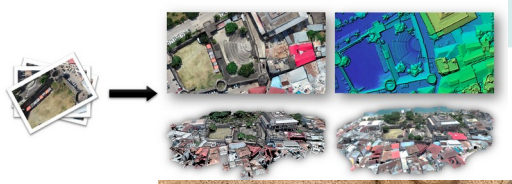




What is ODM?

Digital twins

- Building fascade, Oberlin, Ohio



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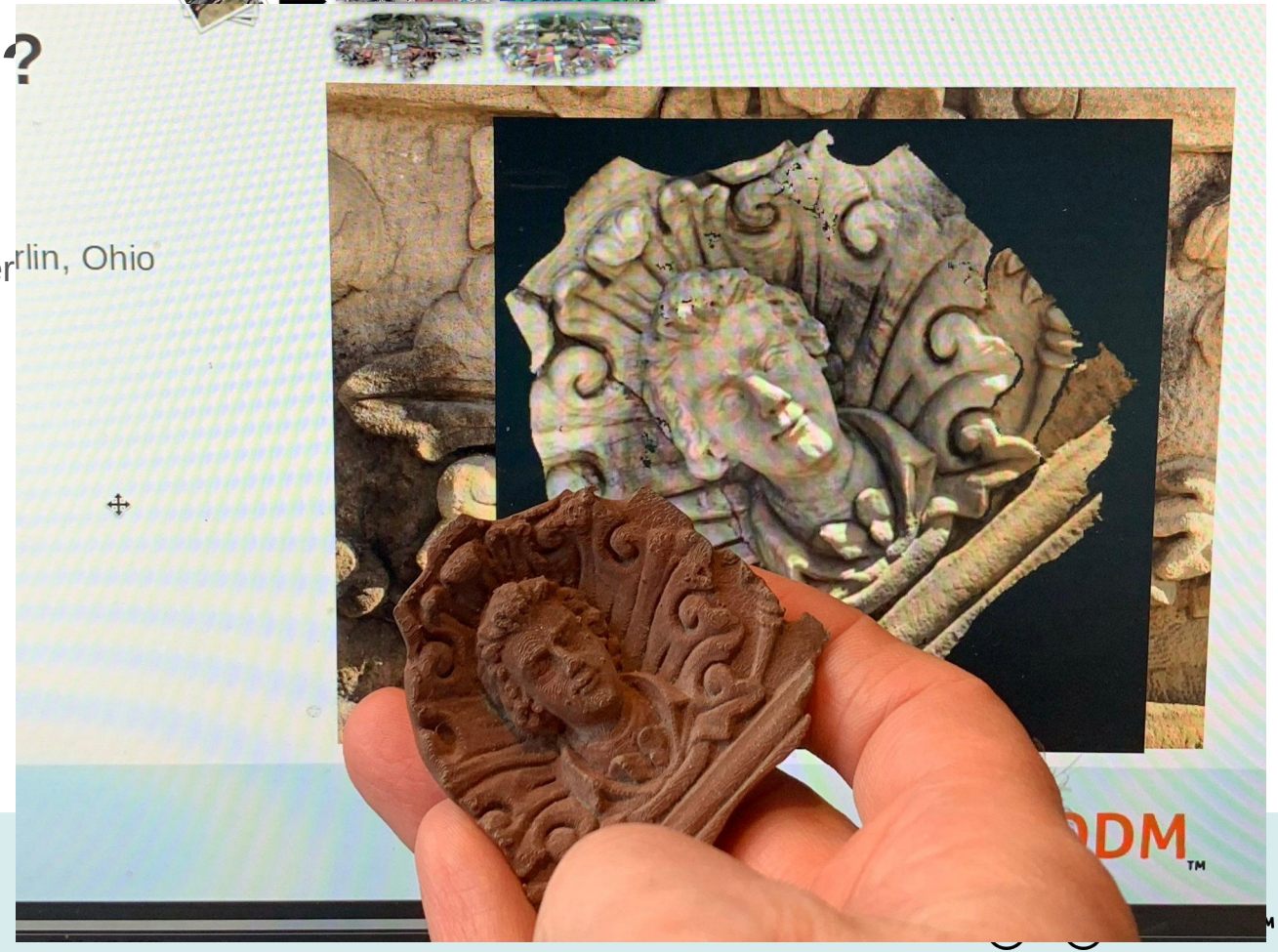
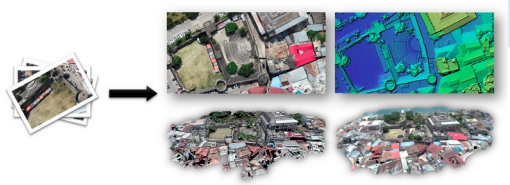


What is ODM?

Digital twins

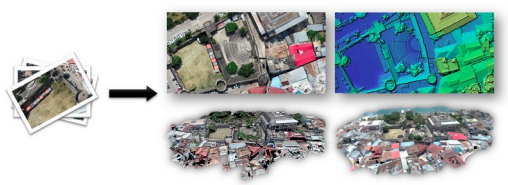
- Fictional digital twins



What is ODM?

Digital twins

- Dr. Charles Ritzler
- Cleveland Metroparks Zoo
- Project Goals: Test new method, using 3D photogrammetry, to quantify usable space in both small and large primate habitats, and compare results to that of Browning and Maple (2019)



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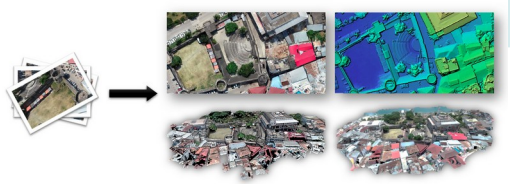

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  both small and large
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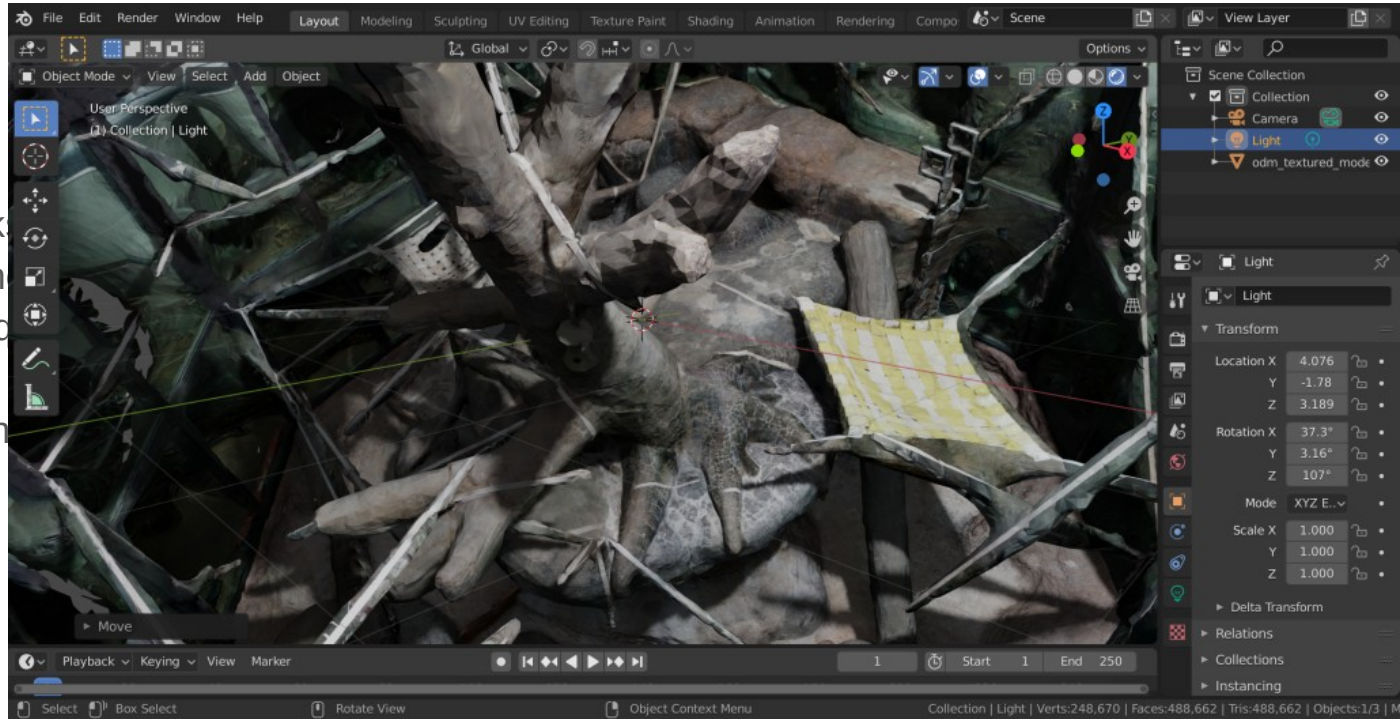
  Maple (2019)



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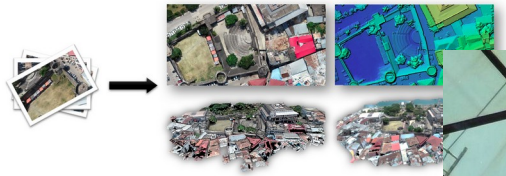
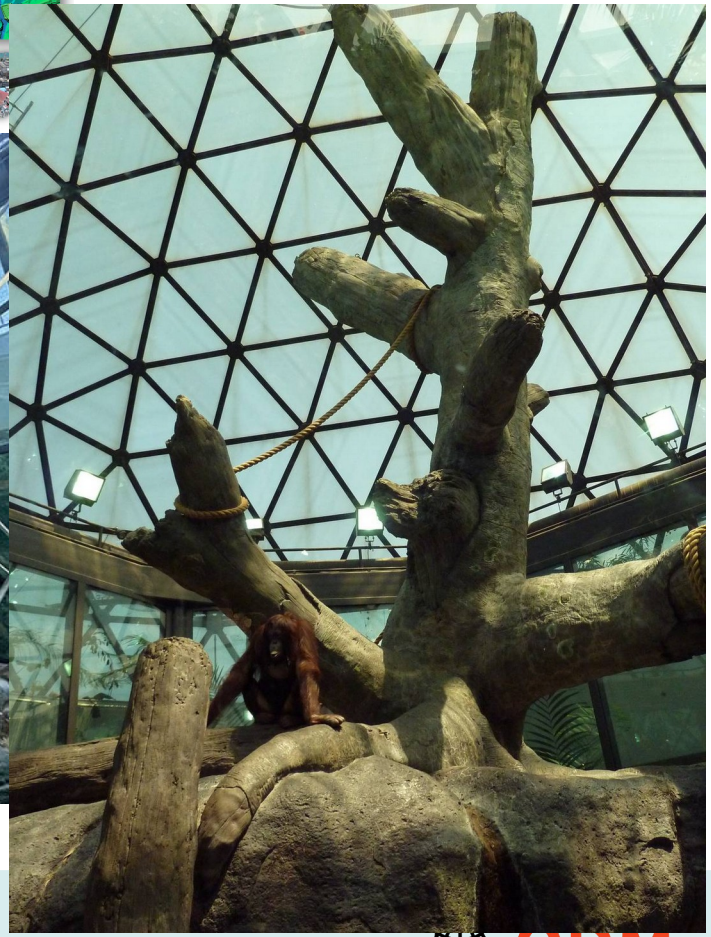
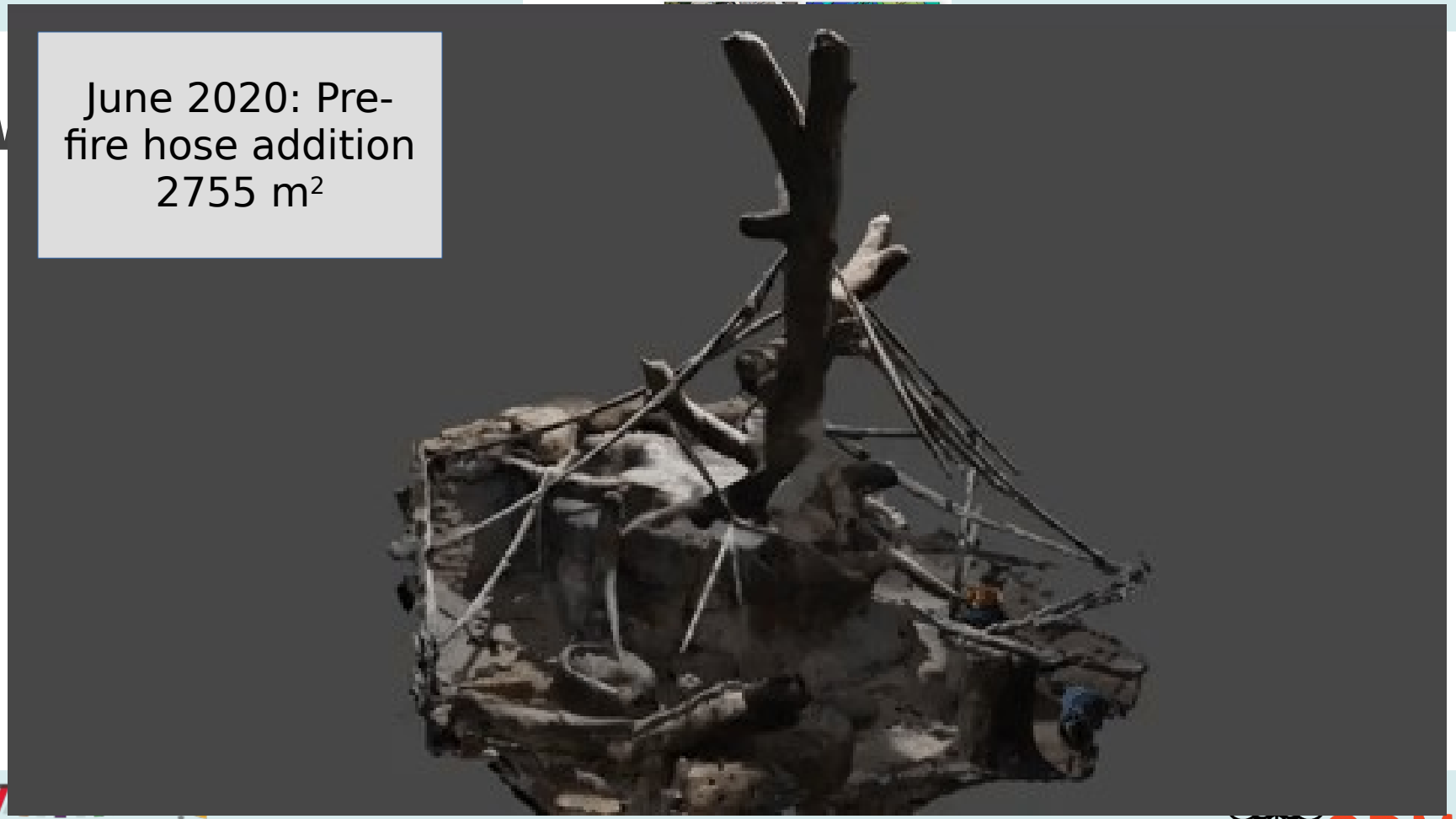
ODM™

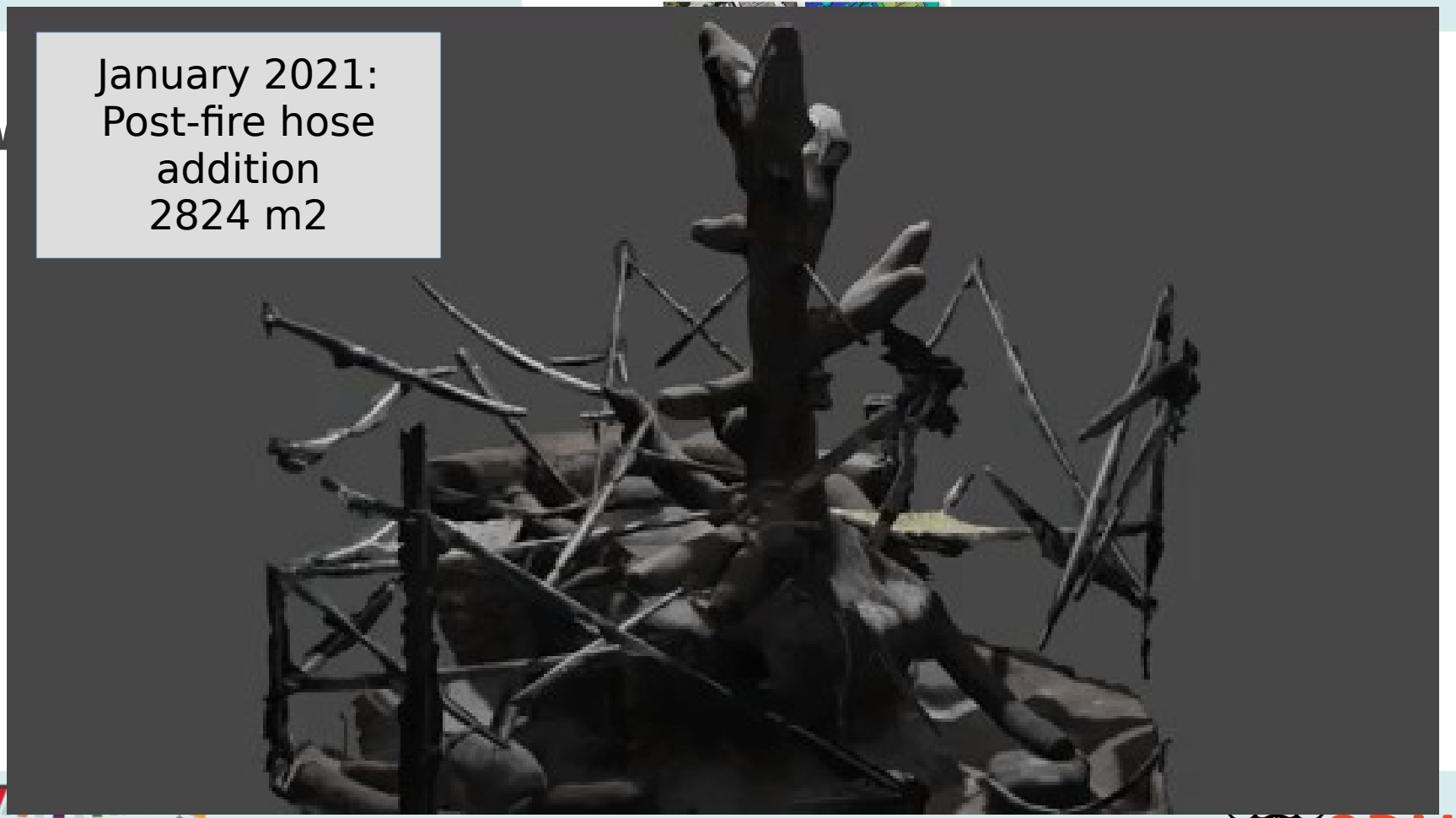
What is ODM?





June 2020: Pre-fire hose addition 2755 m^2

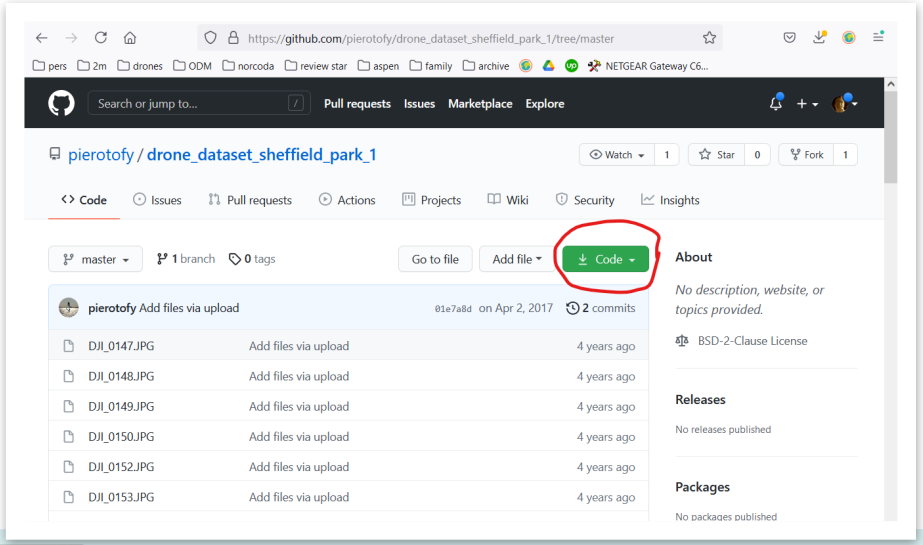


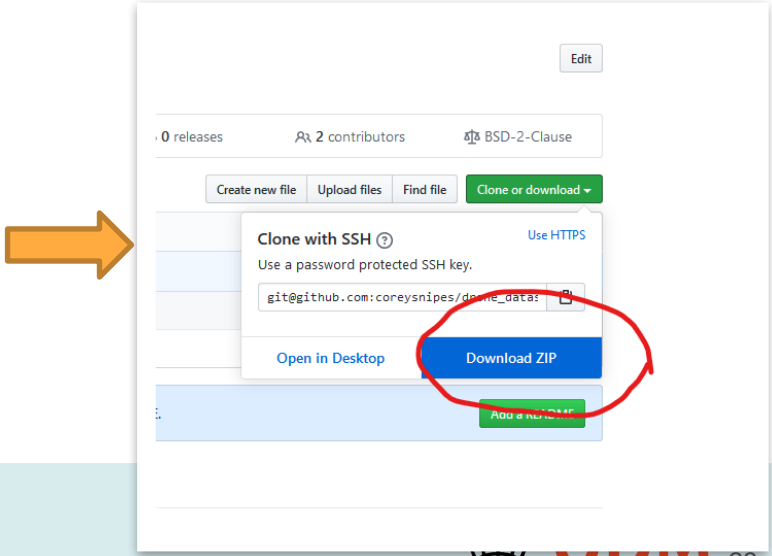

January 2021:
Post-fire hose
addition
2824 m2

Hands-On: Part A
Start Processing

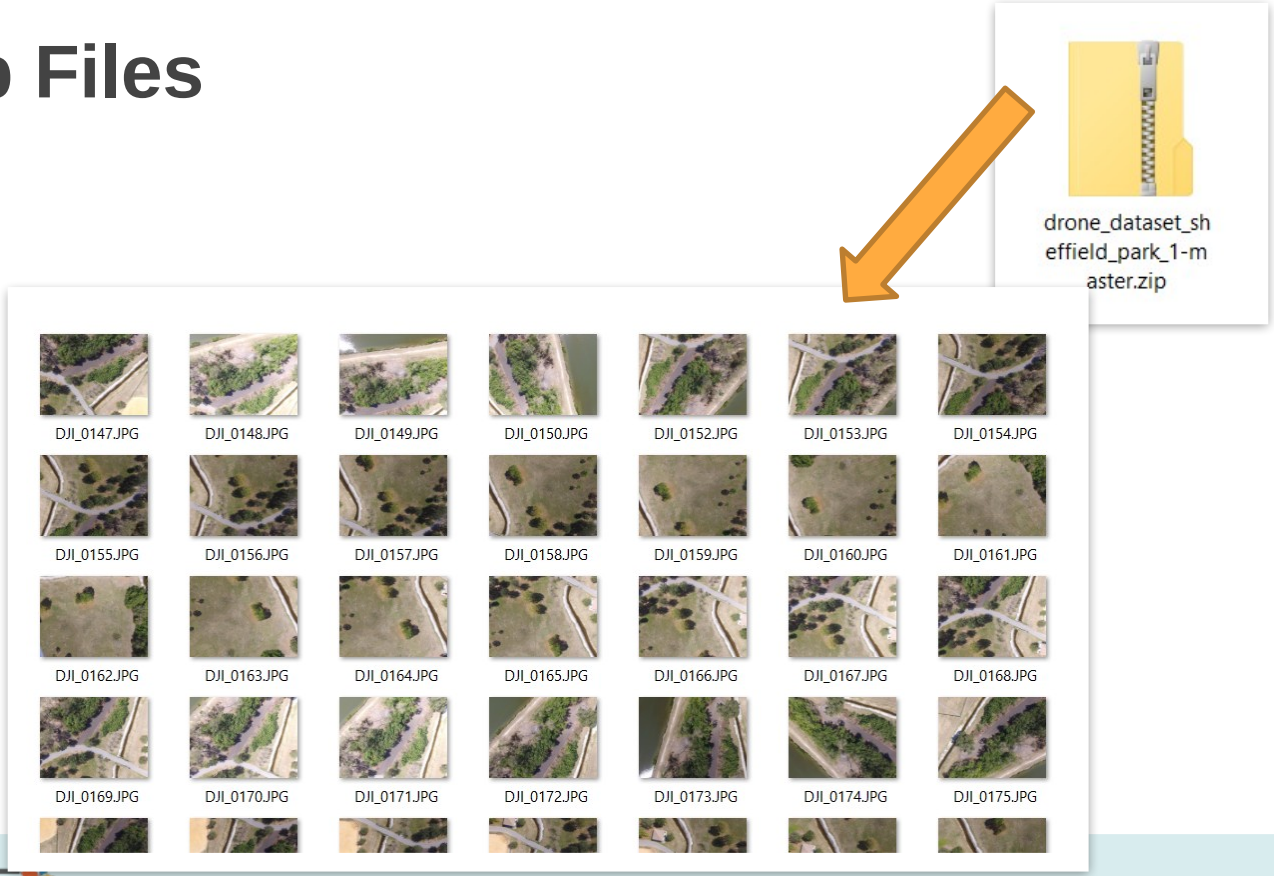
Download Sample Data

- https://github.com/pierotofy/drone_dataset_sheffield_park_1/tree/master
- https://tinyurl.com/sheffield-bb





Unzip Files


drone_dataset_sheffield_park_1-master.zip
DJI_0147.JPG
DJI_0148.JPG
DJI_0149.JPG
DJI_0150.JPG
DJI_0152.JPG
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DJI_0154.JPG
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DJI_0174.JPG
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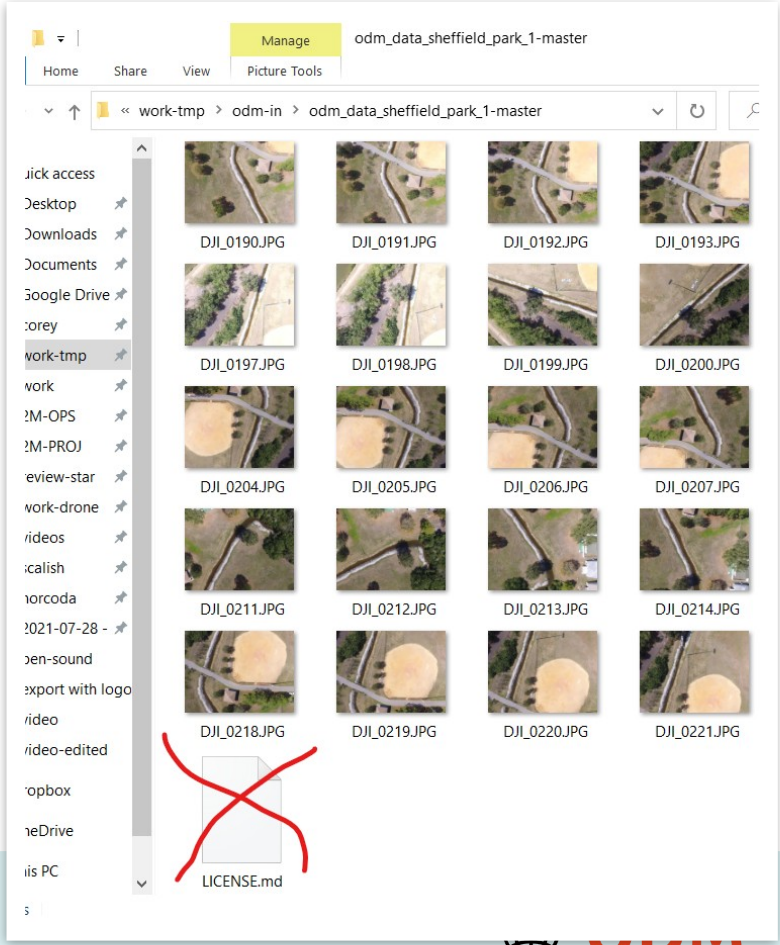
Remove LICENSE.md file

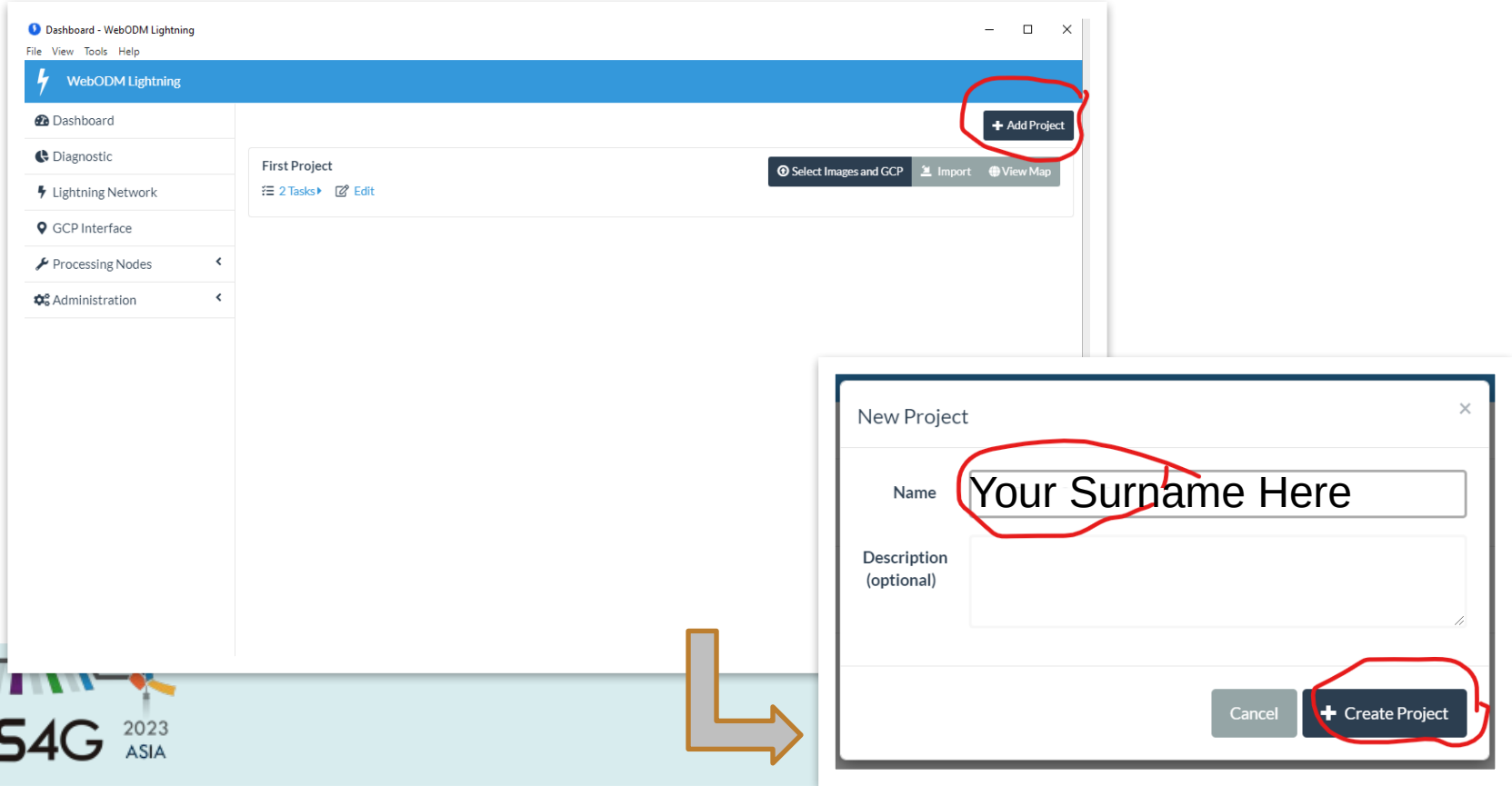


FOSS4G 2023 ASIA

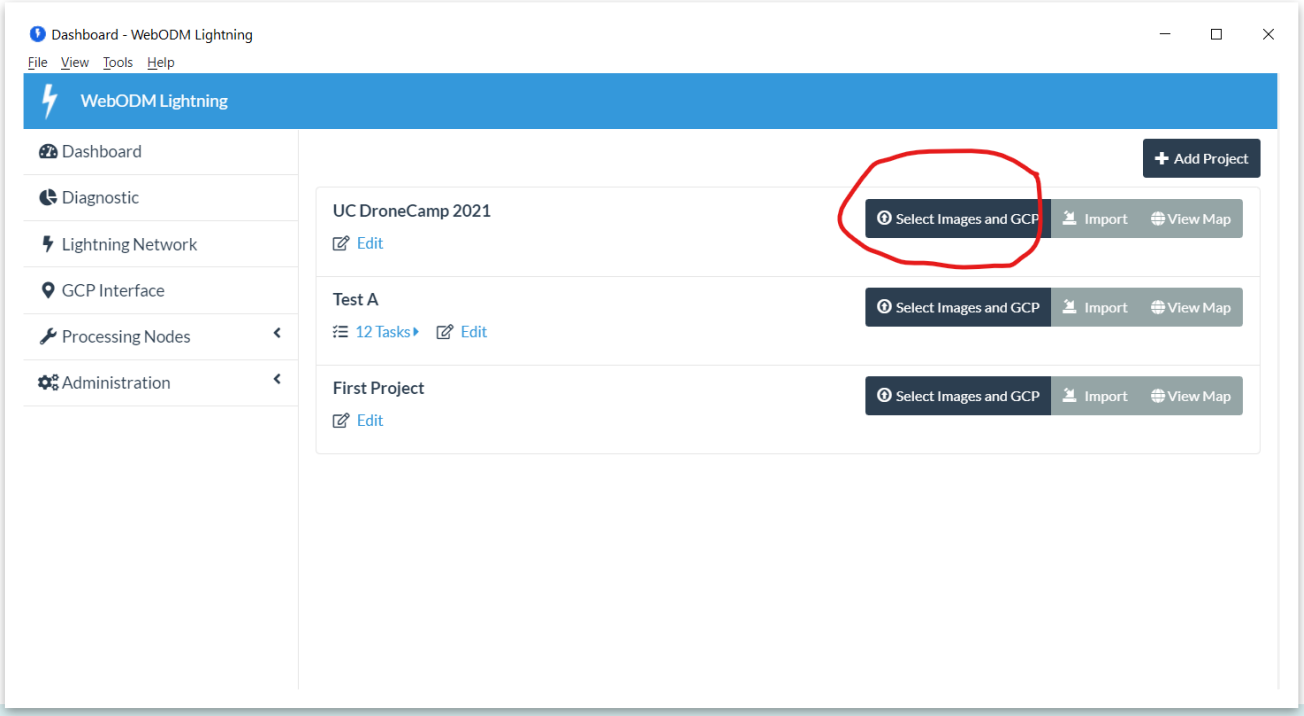
Open crankyserver.com

- Point your browser to:
  - https://crankyserver.com
  - Username:
    - FOSS4G_Asia
  - Password:
    - FOSS4G_Asia_2023_Seoul+Geo+BBQ+Soju

Open crankyserver.com

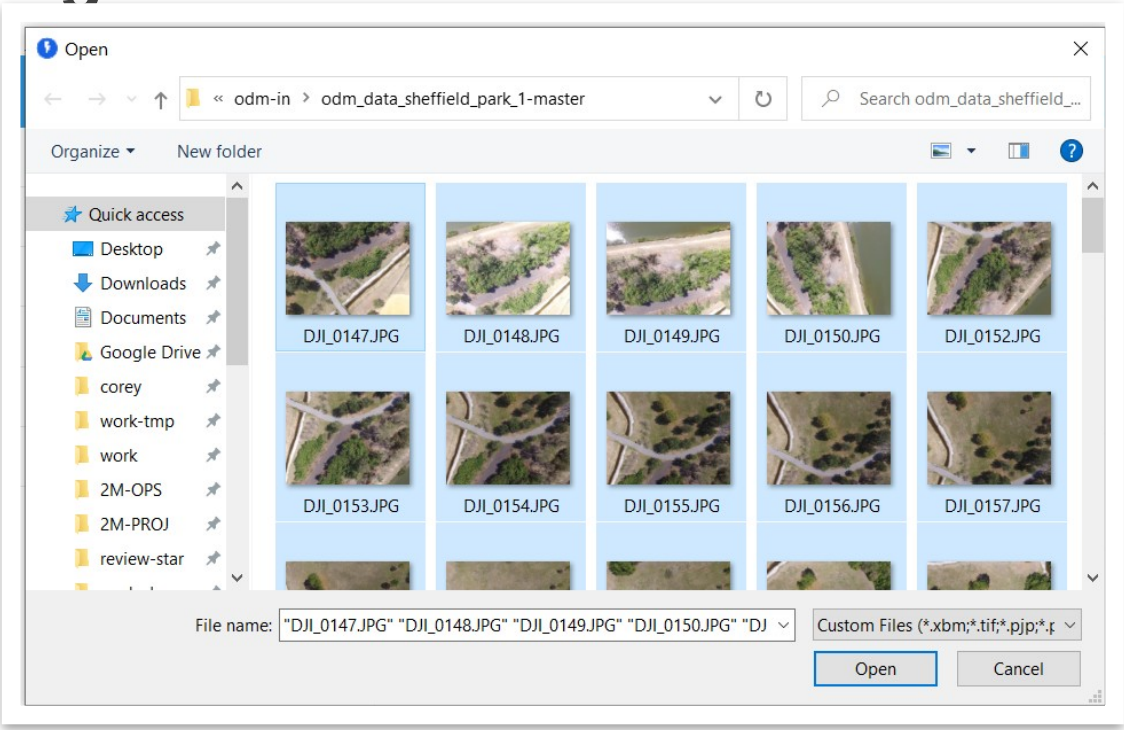


Add Images

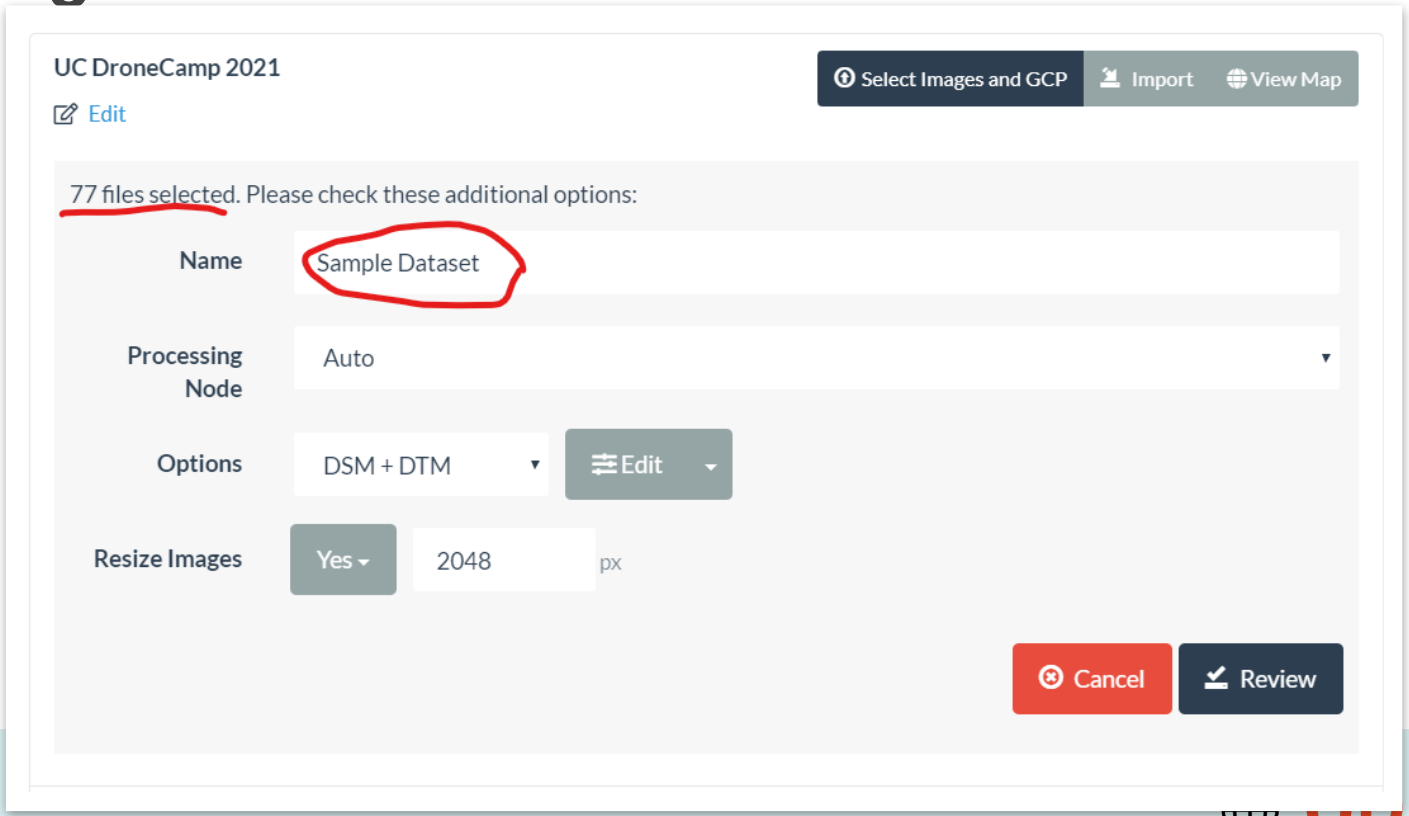

Dashboard - WebODM Lightning
File View Tools Help
WebODM Lightning
Dashboard
Diagnostic
Lightning Network
GCP Interface
Processing Nodes
Administration
Add Project
UC DroneCamp 2021
Edit
Select Images and GCP
Import
View Map
Test A
12 Tasks
Edit
Select Images and GCP
Import
View Map
First Project
Edit
Select Images and GCP
Import
View Map

Add Images

(No Ground Control Points, today)



Set Configuration



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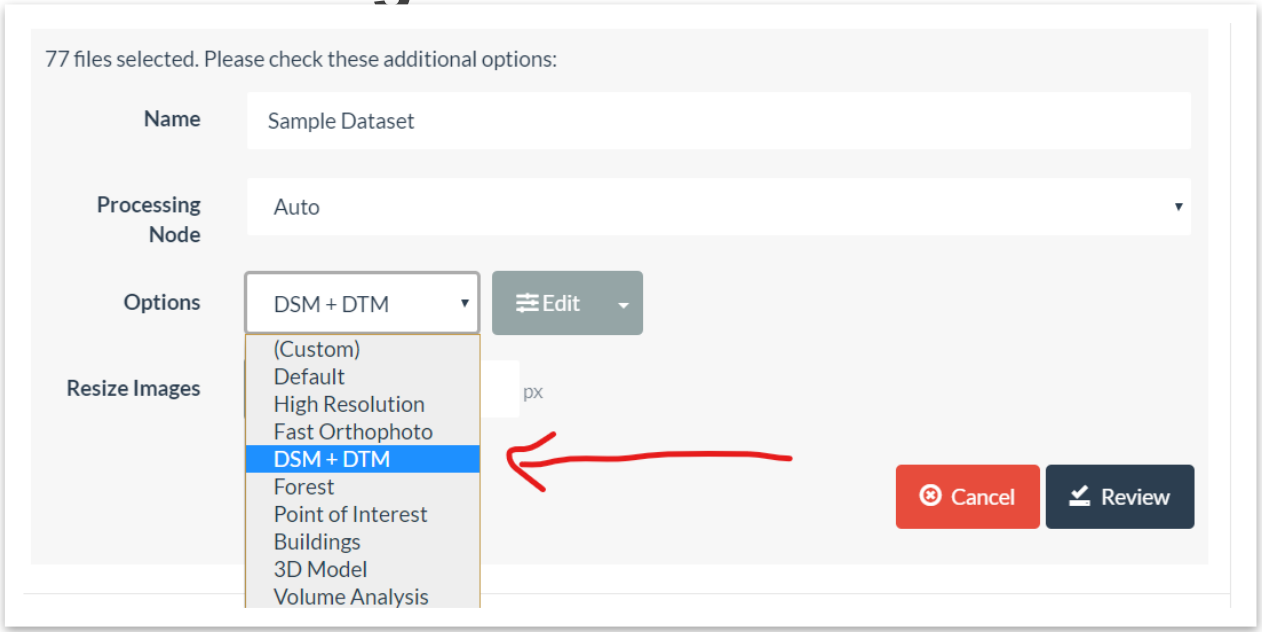

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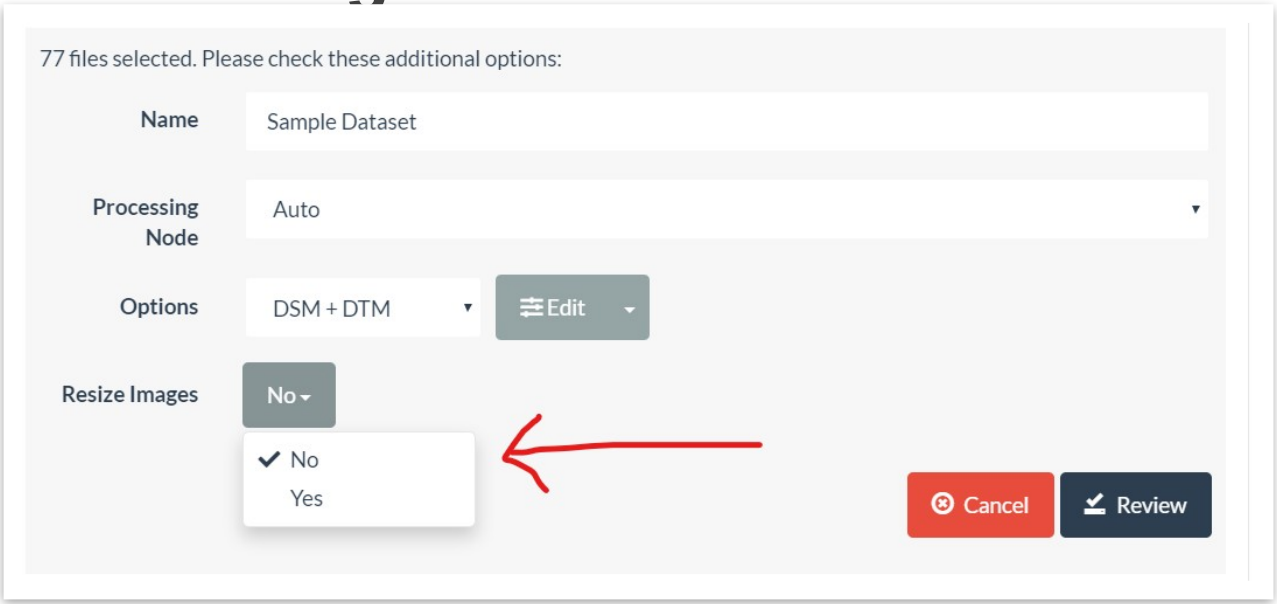
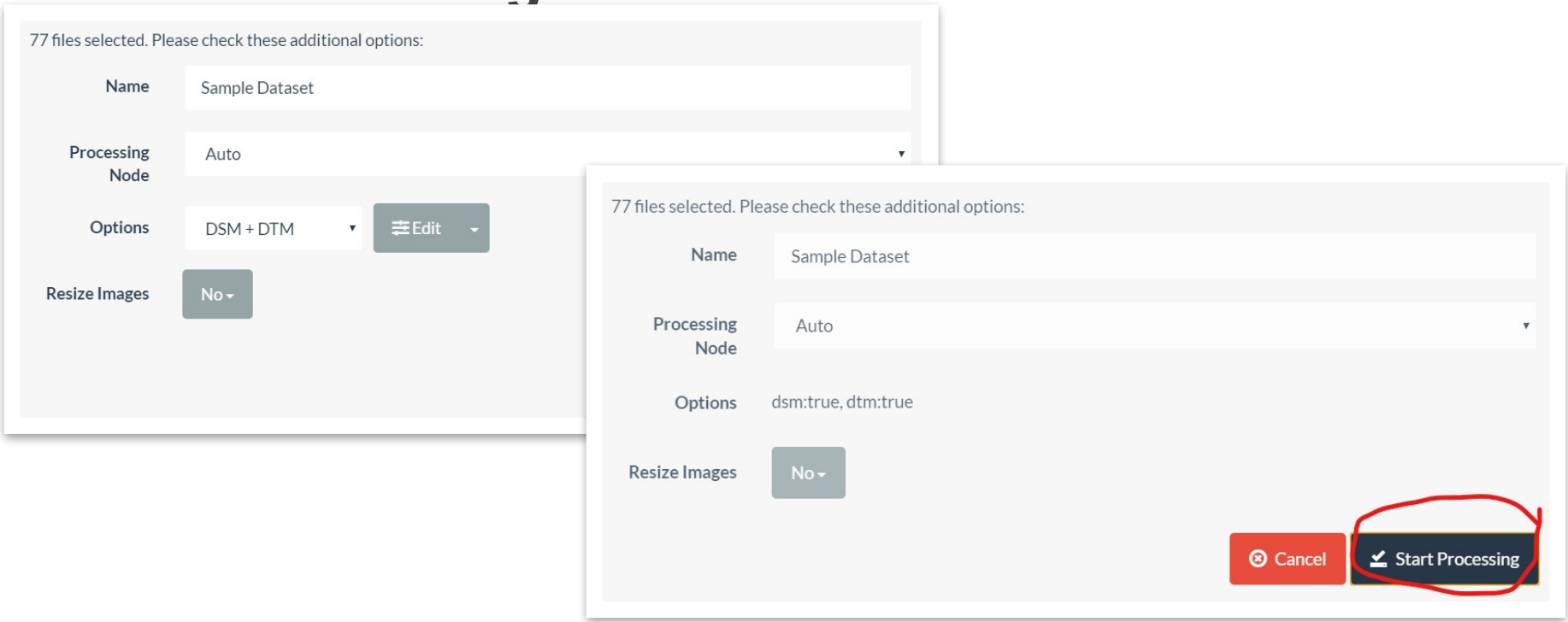
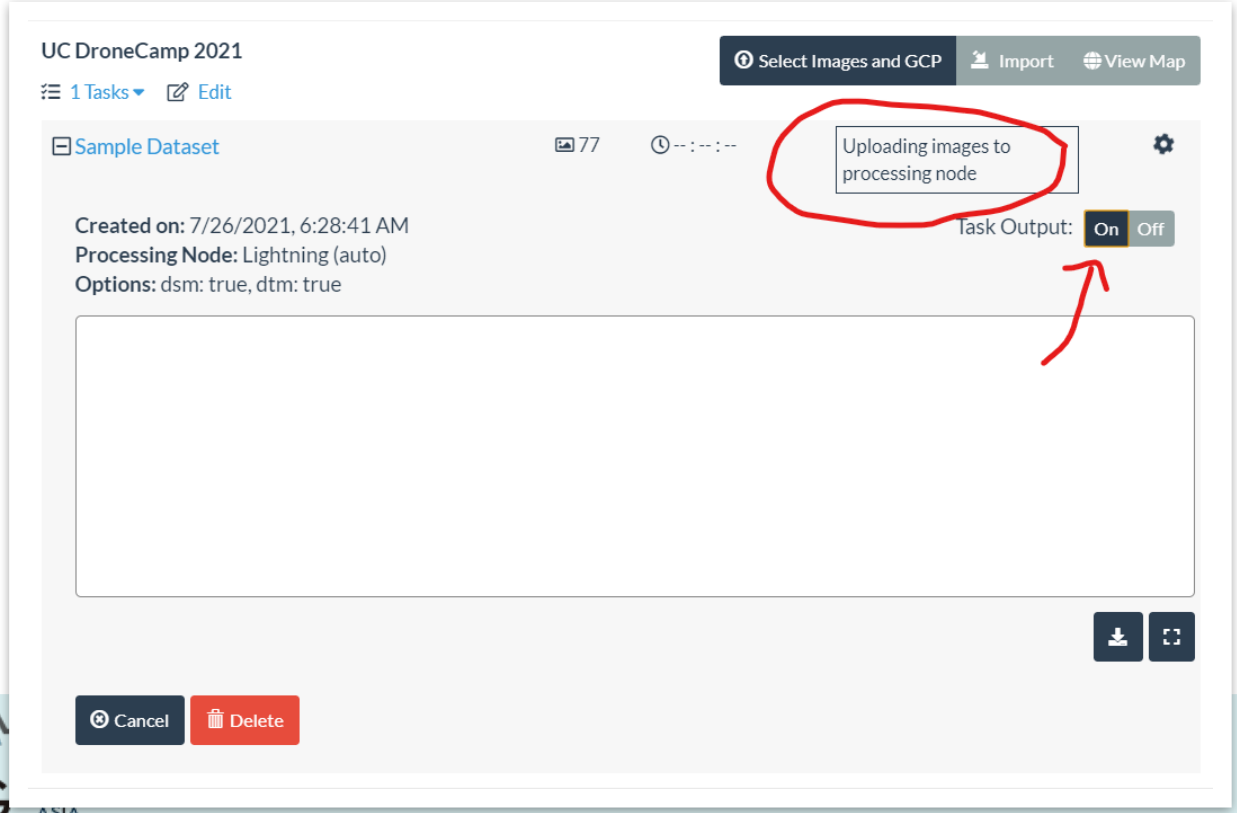


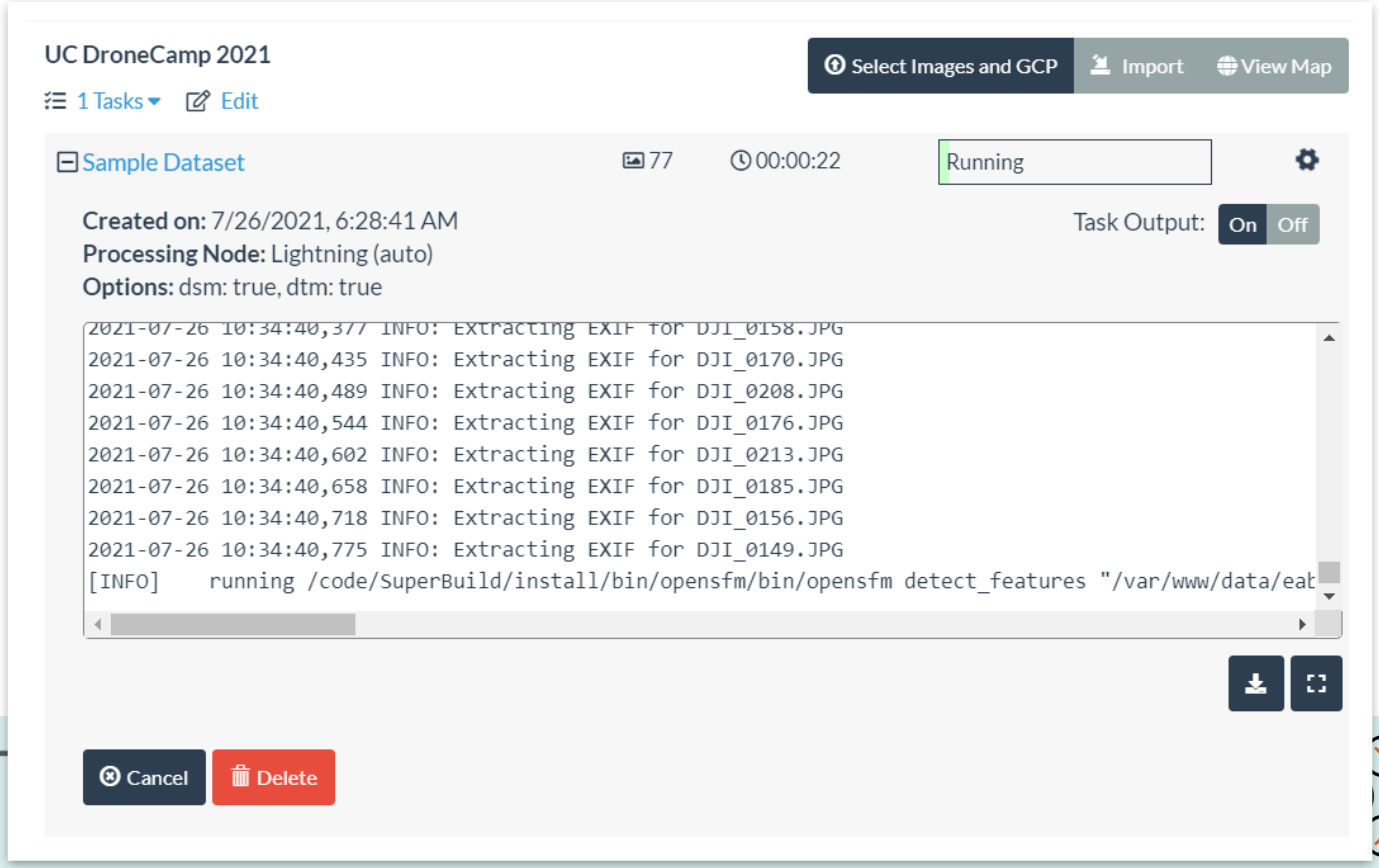
Start Processing



Processing Status

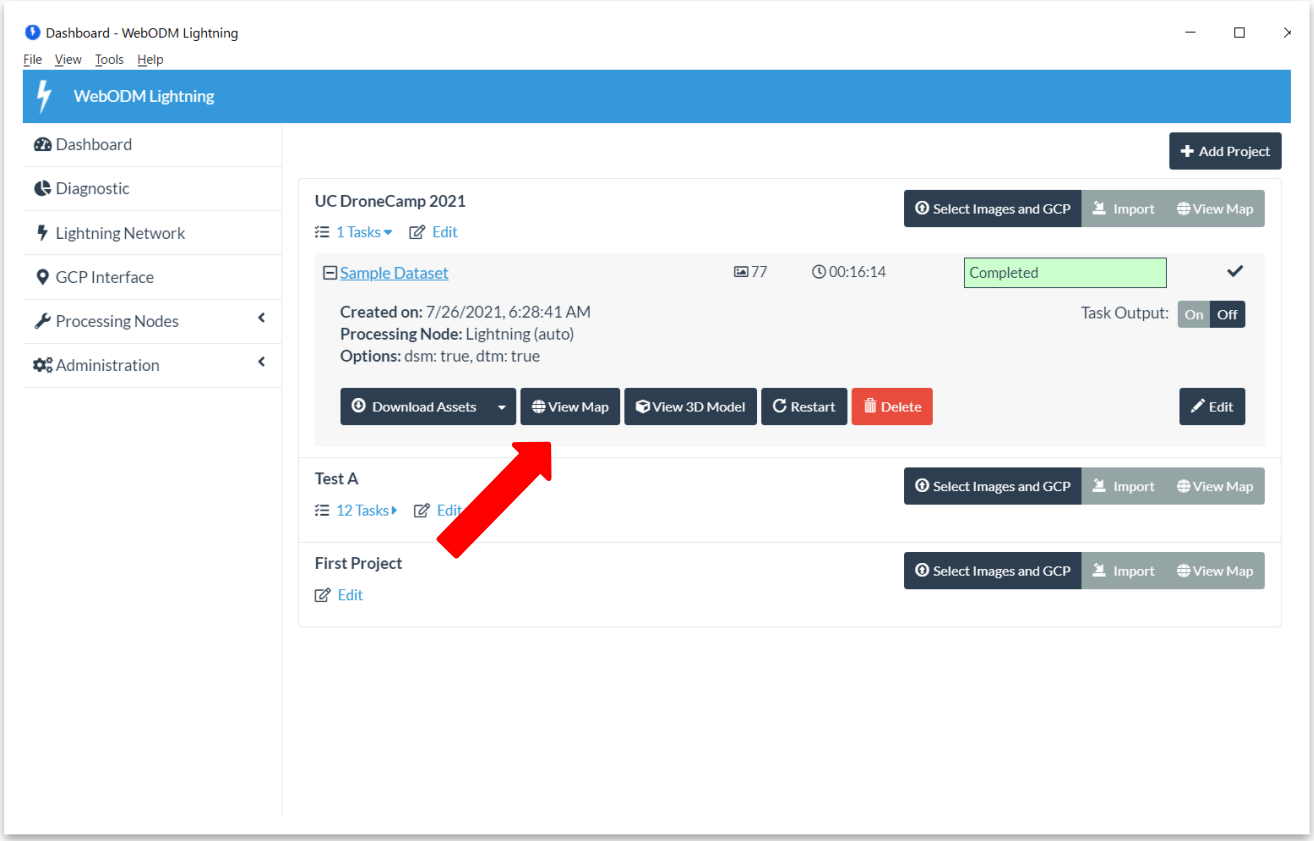


Running


UC DroneCamp 2021
Select Images and GCP
Import
View Map
1 Tasks
Edit
Sample Dataset
77
00:00:22
Running
Created on: 7/26/2021, 6:28:41 AM
Processing Node: Lightning (auto)
Options: dsm: true, dtm: true
Task Output:
On
Off
2021-07-26 10:34:40,377 INFO: Extracting EXIF for DJI_0158.JPG
2021-07-26 10:34:40,435 INFO: Extracting EXIF for DJI_0170.JPG
2021-07-26 10:34:40,489 INFO: Extracting EXIF for DJI_0208.JPG
2021-07-26 10:34:40,544 INFO: Extracting EXIF for DJI_0176.JPG
2021-07-26 10:34:40,602 INFO: Extracting EXIF for DJI_0213.JPG
2021-07-26 10:34:40,658 INFO: Extracting EXIF for DJI_0185.JPG
2021-07-26 10:34:40,718 INFO: Extracting EXIF for DJI_0156.JPG
2021-07-26 10:34:40,775 INFO: Extracting EXIF for DJI_0149.JPG
[INFO] running /code/SuperBuild/install/bin/opensfm/bin/opensfm detect_features "/var/www/data/eat
Cancel
Delete

Outputs

2D Ortho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File View Tools Help
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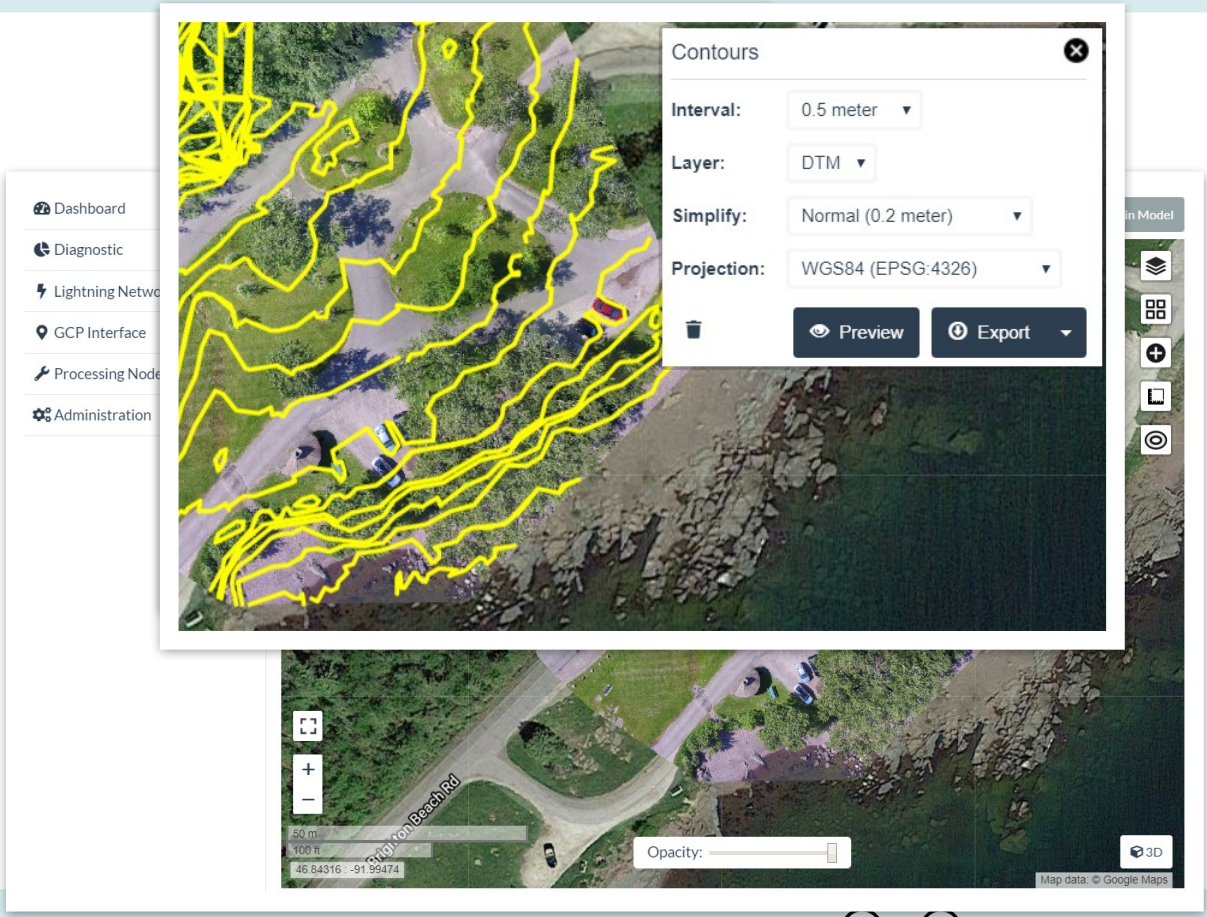
Add Project
UC DroneCamp 2021
Select Images and GCP
Import
View Map
1 Tasks
Edit
Sample Dataset
77
00:16:14
Completed
Created on: 7/26/2021, 6:28:41 AM
Processing Node: Lightning (auto)
Options: dsm: true, dtm: true
Task Output:
On
Off
Download Assets
View Map
View 3D Model
Restart
Delete
Edit
Test A
12 Tasks
Edit
Select Images and GCP
Import
View Map
First Project
Edit
Select Images and GCP
Import
View Map

2D Orthophoto

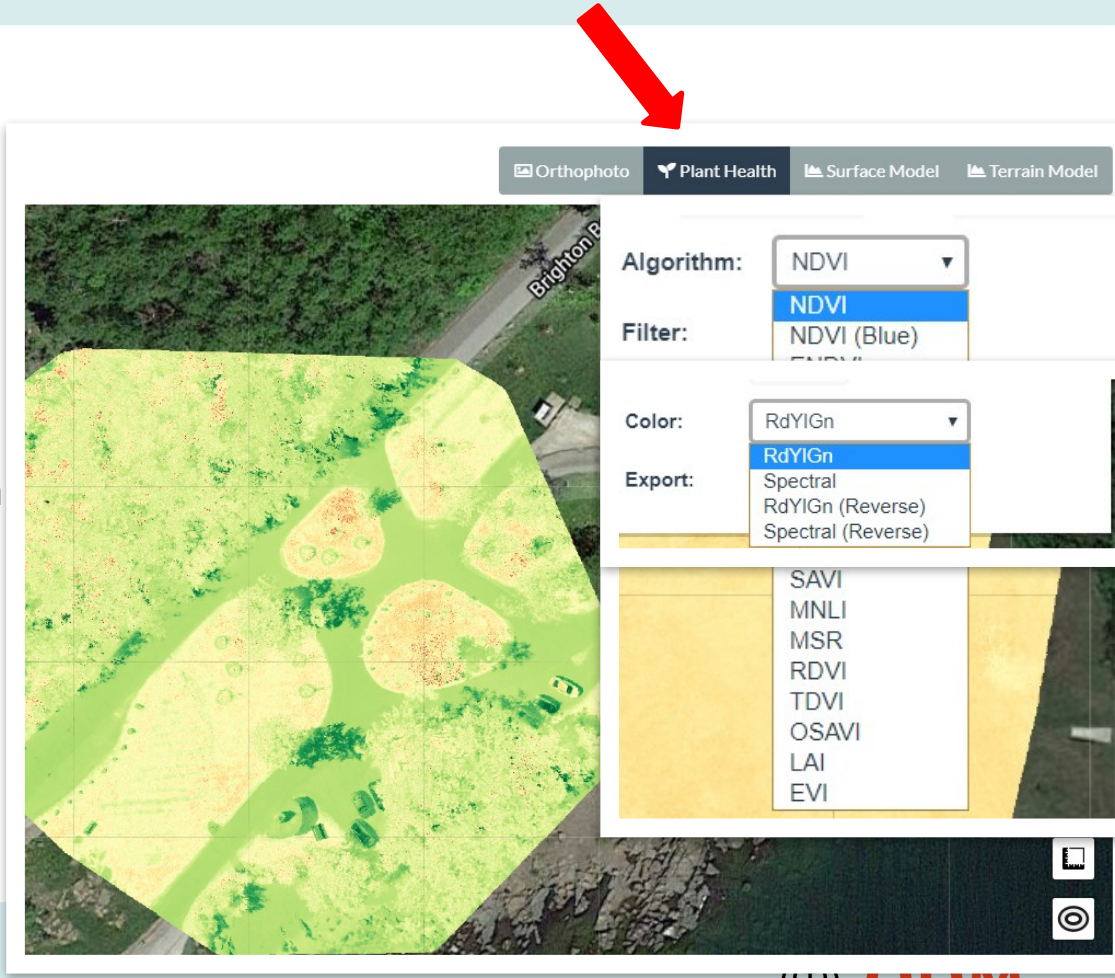
- Overlay on Google Map, OpenStreetMap, etc
- Measurements (linear, area, volume)
- Contour Lines

- QGIS/ArcGIS
- Object detection/counting via FieldMapR, rastervision.io



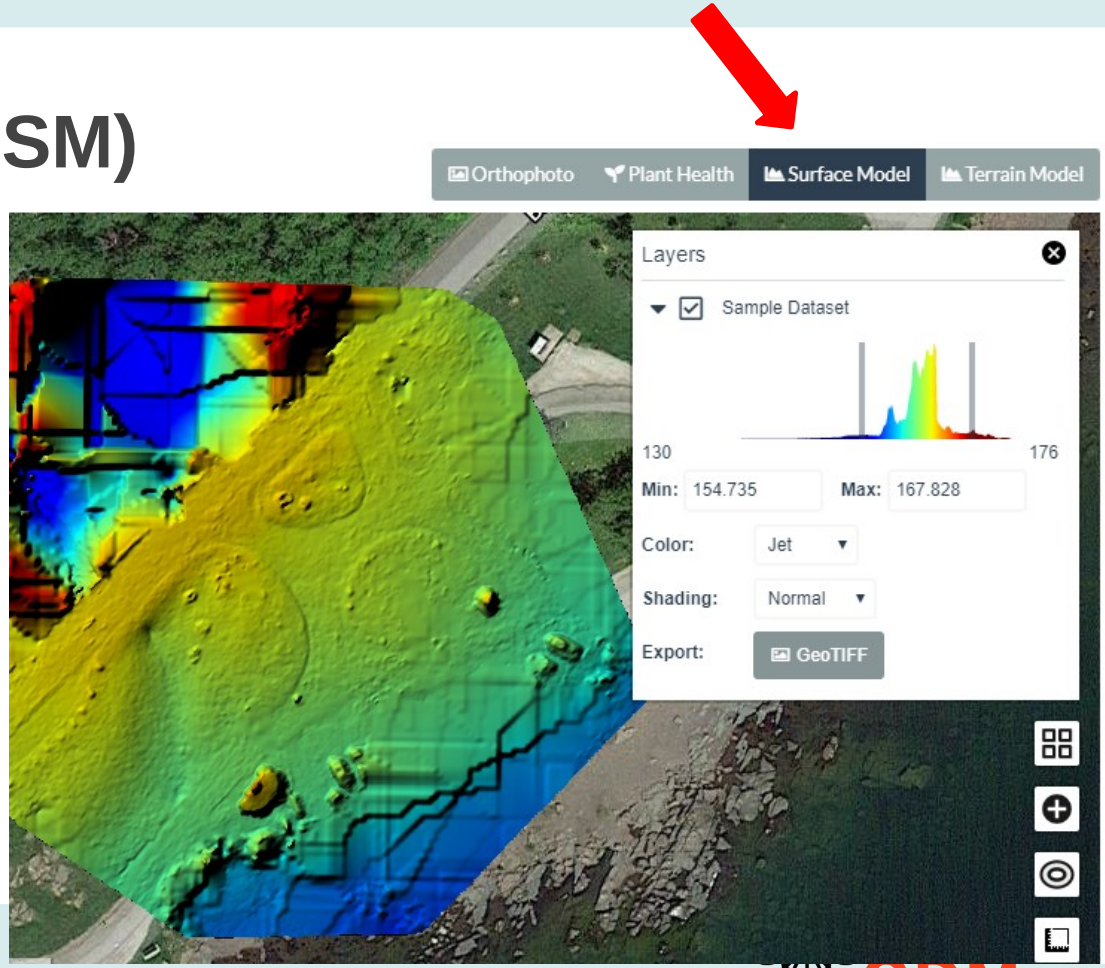
Plant Health Index

- Images from multi-spectral cameras (Micasense, Sentera, etc)
- Wavelengths beyond visible spectrum
- Algorithms:
  NDVI, RDVI, GLI, SAVI, more



2D Surface Model (DSM)

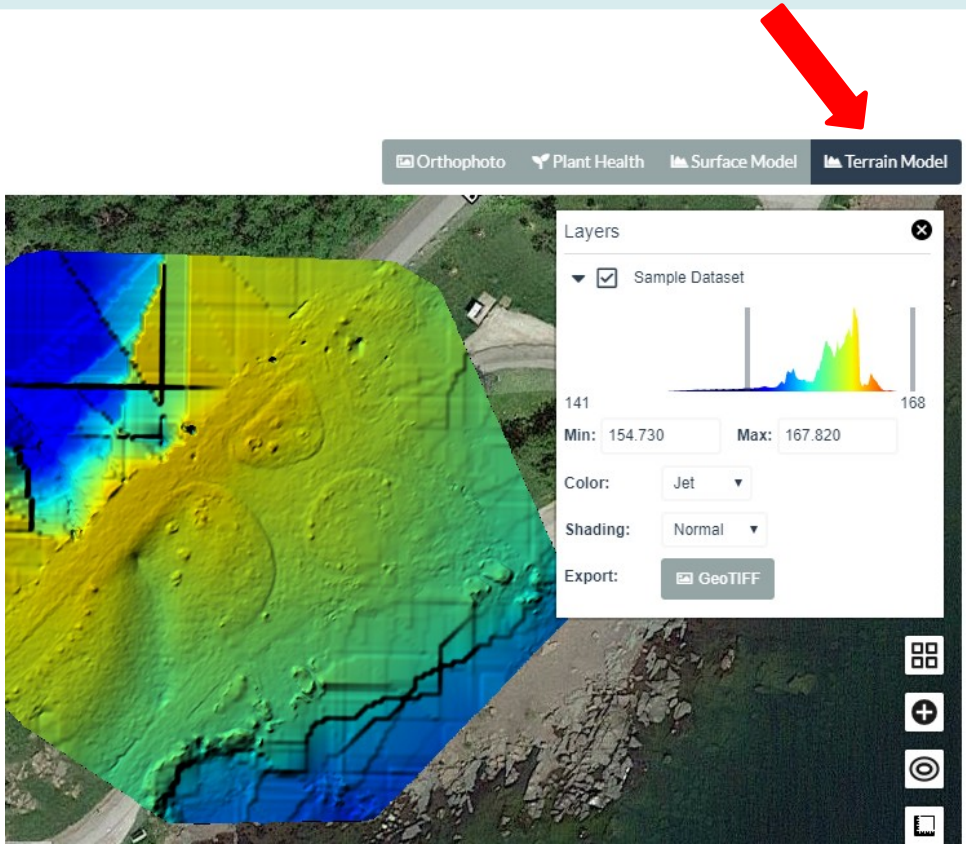
- Highlights surface altitude
- Adjustable color ramps
- Export GeoTIFF



2D Terrain Model (DTM)

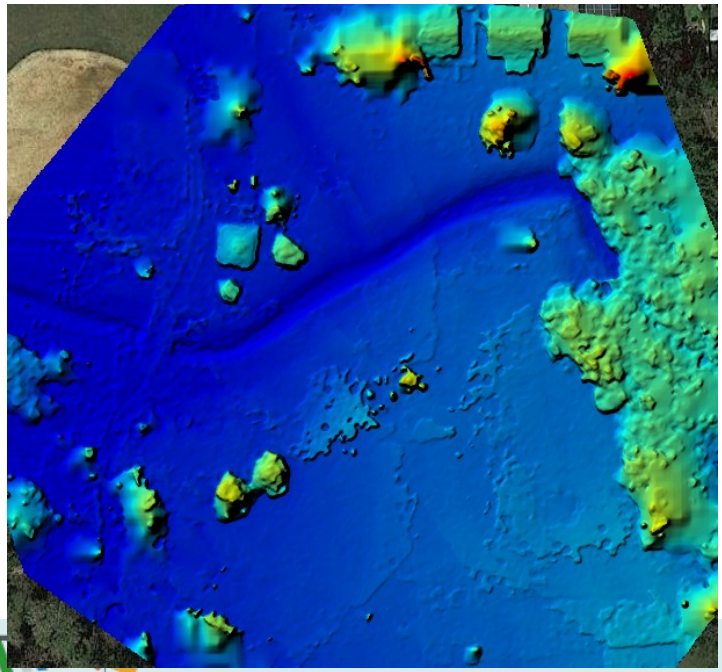
“The DSM without the trees and buildings”

- Uses point classification to remove objects from the surface model
- Ground (terrain) profile
- Contour lines

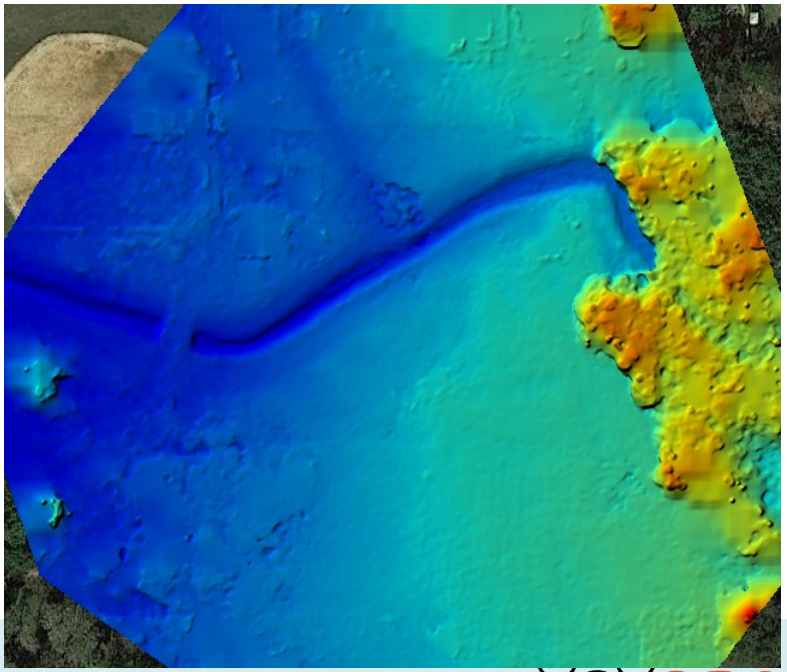


2D Terrain Model (DTM)

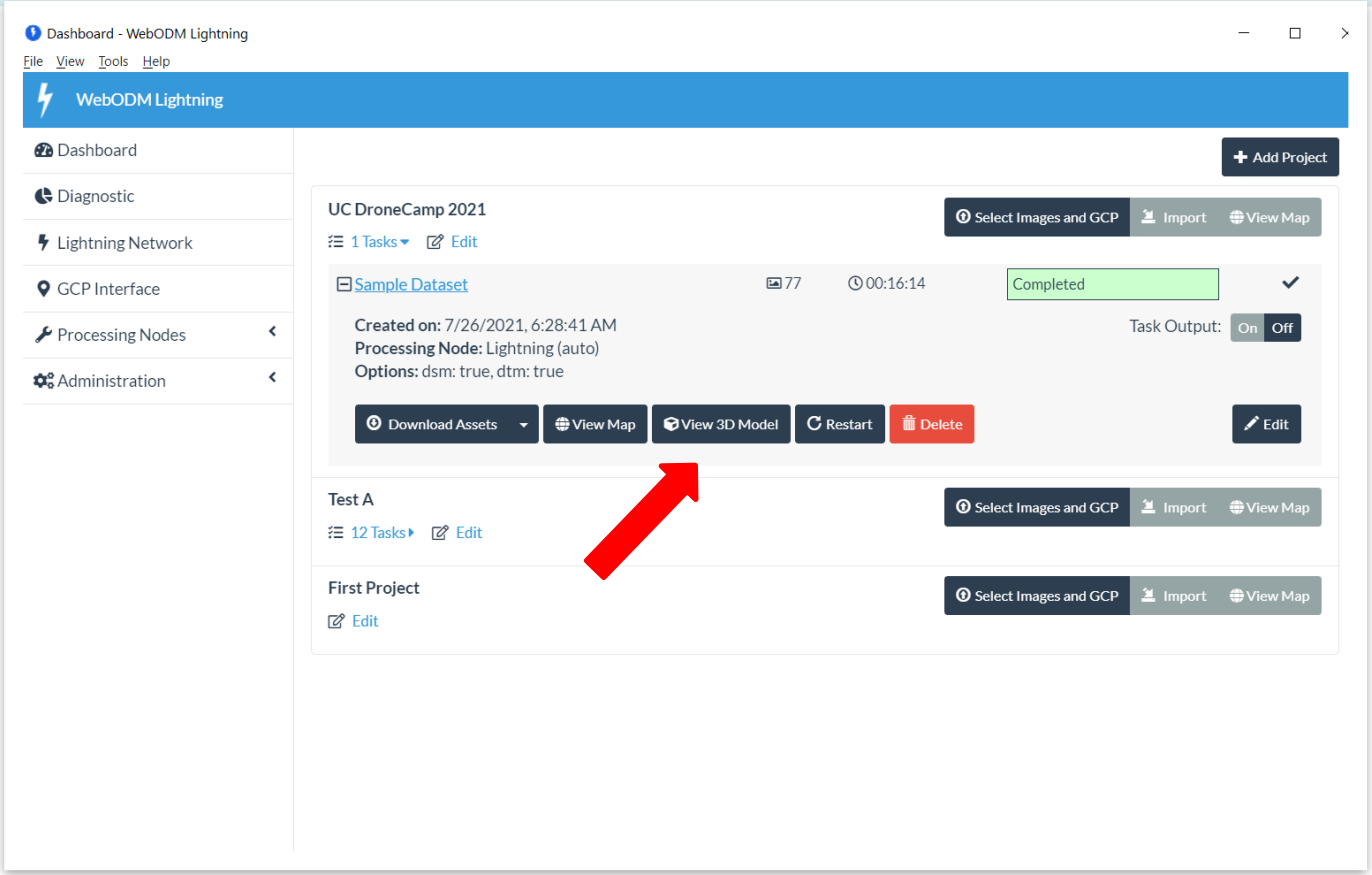
DSM



DTM



3D Model


Dashboard - WebODM Lightning
File View Tools Help
WebODM Lightning
Dashboard
Diagnostic
Lightning Network
GCP Interface
Processing Nodes
Administration
Add Project
UC DroneCamp 2021
Select Images and GCP
Import
View Map
1 Tasks
Edit
Sample Dataset
77
00:16:14
Completed
Created on: 7/26/2021, 6:28:41 AM
Processing Node: Lightning (auto)
Options: dsm: true, dtm: true
Task Output:
On
Off
Download Assets
View Map
View 3D Model
Restart
Delete
Edit
Test A
Select Images and GCP
Import
View Map
12 Tasks
Edit
First Project
Select Images and GCP
Import
View Map
Edit

Point Cloud

- Individual points
- X, Y, Z
- Measurements

CloudCompare for analysis

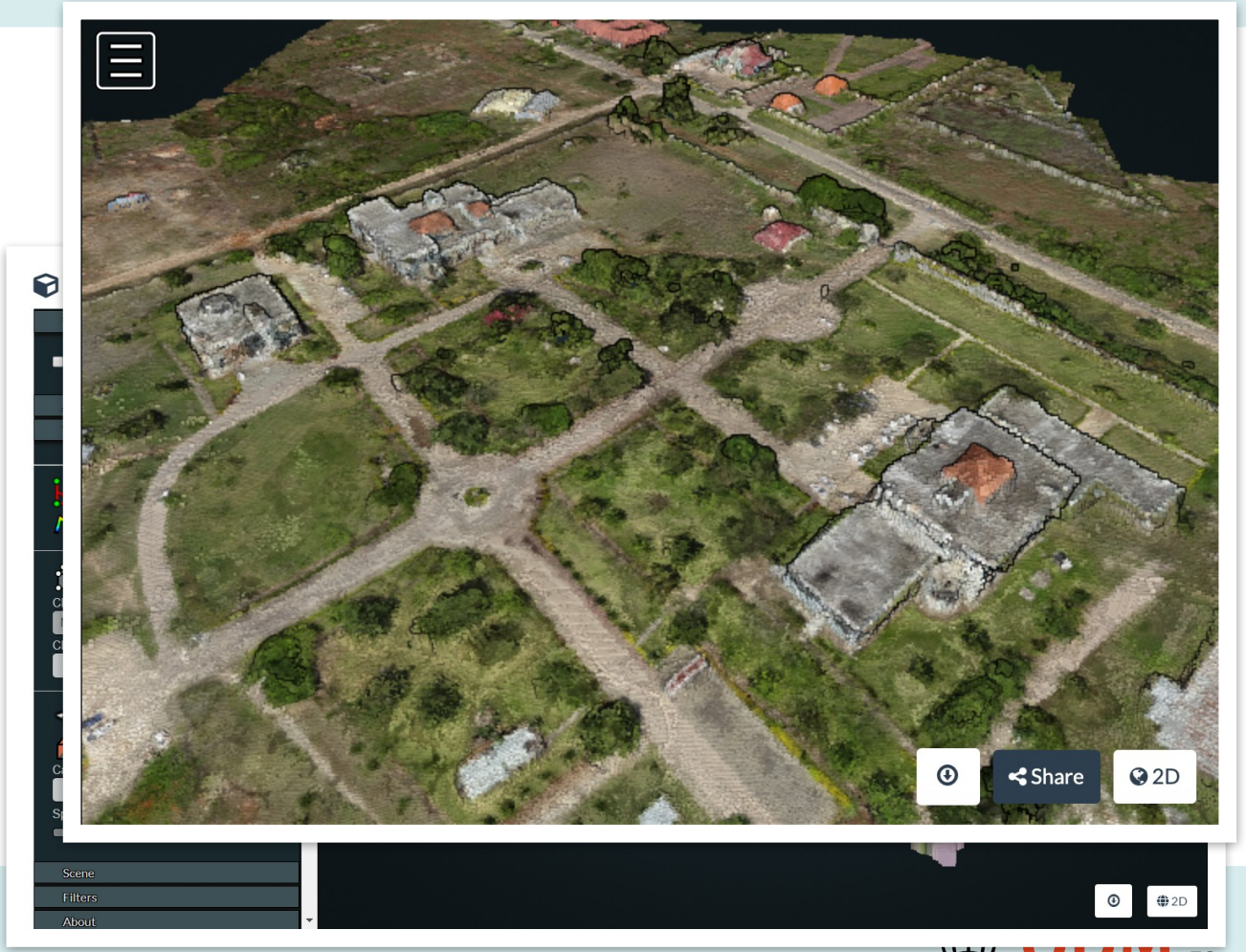


Image: opendronemap.org

Textured Model

- Identify surface triangles
- Point Cloud -> Surface Mesh

- Sketchfab, et al for sharing
- CAD, Blender
- 3D print

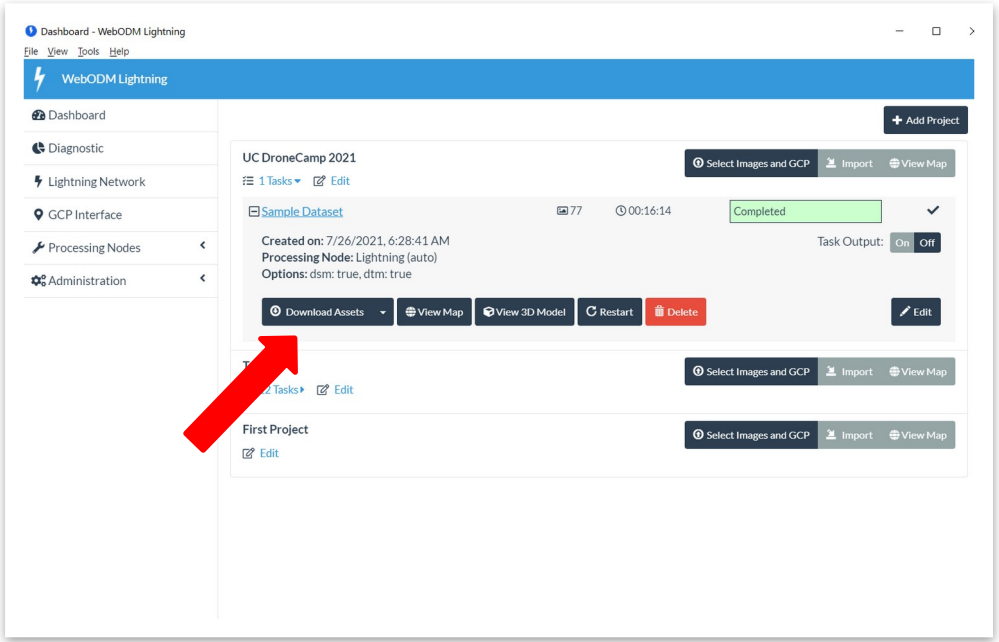
Image: opendronemap.org

3D Measurements

- Linear
- Area
- Angle
- Height
- Height Profile
- Volume

Download

- Orthophoto (GeoTIFF)
- Terrain Model / DTM (GeoTIFF)
- Surface Model / DSM (GeoTIFF)
- 3D Point Cloud (.laz)
- 3D Textured Model (.obj)
- Camera Parameters
- Quality Report
- Everything (all.zip)



Using ODM

Supported Systems

- Windows 10 (Docker, or native)
- Ubuntu Linux (Docker, or native)
- MacOS
- 16+ GB RAM (more is better)
- 50+ GB Disk (more is better)

Ways to Use ODM

- WebODM – most common
  - Manual (free)
  - or, Installer ($)
- WebODM Lightning – easiest
  - Process on Lightning servers ($)
- Command Line ODM
- API (NodeODM)
- LiveODM (USB or DVD) ($)
- Portable OpenStreetMap (POSM)

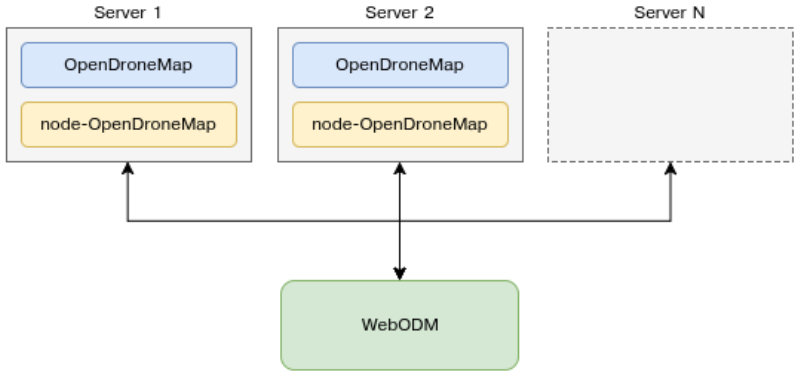


Image: opendronemap.org

Common Problems

- Many paths to get started with ODM.
  - Where to start?
  - All require some work
- Jumping in with a large dataset (start small!)
- System resources
  - Machine spec
  - Docker allocations
- Processing is hung (or is it?)
- Processing failed, but not sure why
- Output quality vs. expectation

Large Datasets

- Split/Merge
- ClusterODM

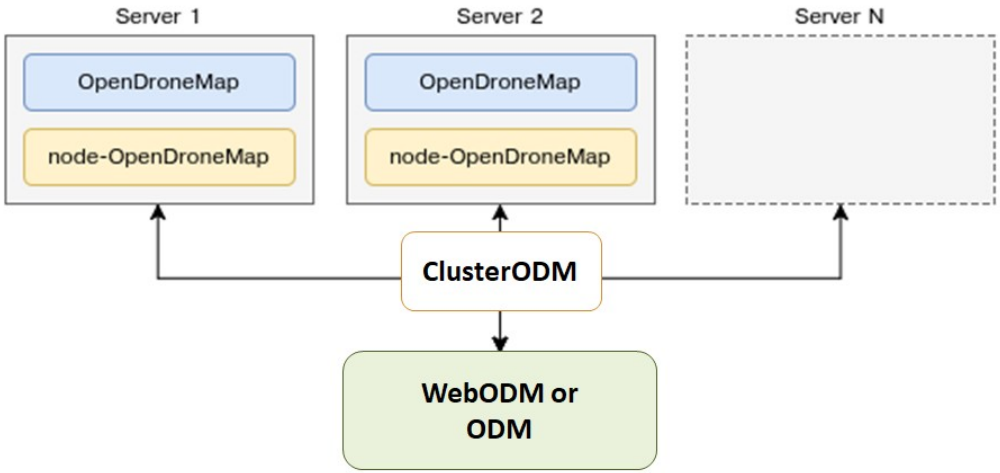
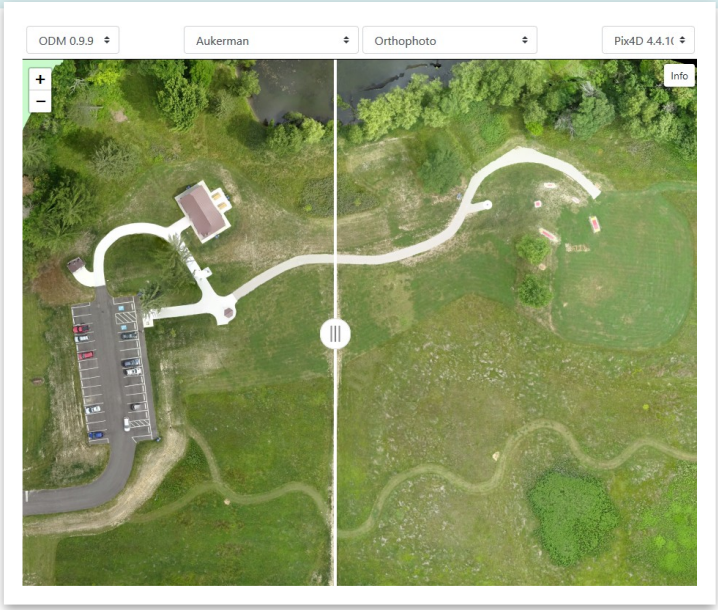


Image: opendronemap.org

Output Quality

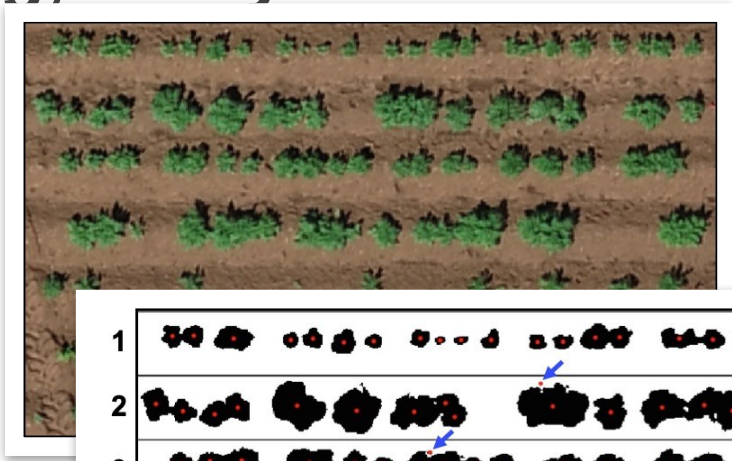
- Comparable to commercial products
- Commercial output quality can be better with:
  - Default settings
  - Poor flight coverage
- ODM produces comparable quality with:
  - Sometimes with default settings
  - Often with tuned settings
  - Good flight coverage (overlap, multiple POV)

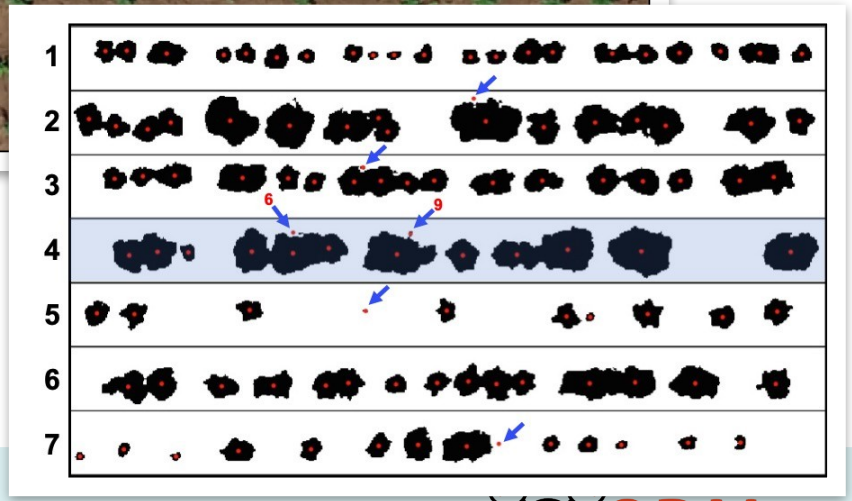


https://opendronemap.github.io/UAVArena/

Object Detection, Counting, Analysis

- Documented workflows using external tools (not within ODM)
- FIELDimageR
  - “A Tool to Analyze Orthomosaic Images From Agricultural Field Trials in R”
  - https://www.opendronemap.org/fieldimager/
- rastervision.io





Summary

Output Summary

- 2D outputs
  - Orthophoto
  - Terrain/Surface Models
  - Plant Health
- 3D outputs
  - Point cloud
  - Textured mesh

ODM Summary

- ODM is Open Source, with benefits in
  - Cost
  - Control
  - Community
  - Infrastructure
- Output quality is comp

Learning More

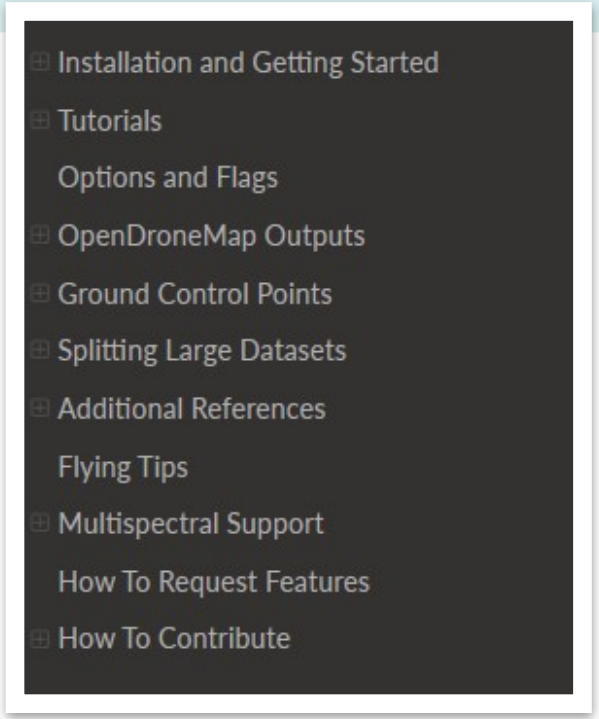
UAV Arena

- Compare Outputs
  - ODM
  - Pix4D
  - DroneDeploy
  - Agisoft Metashape
  - DroneMapper

https://opendronemap.github.io/UAVArena/

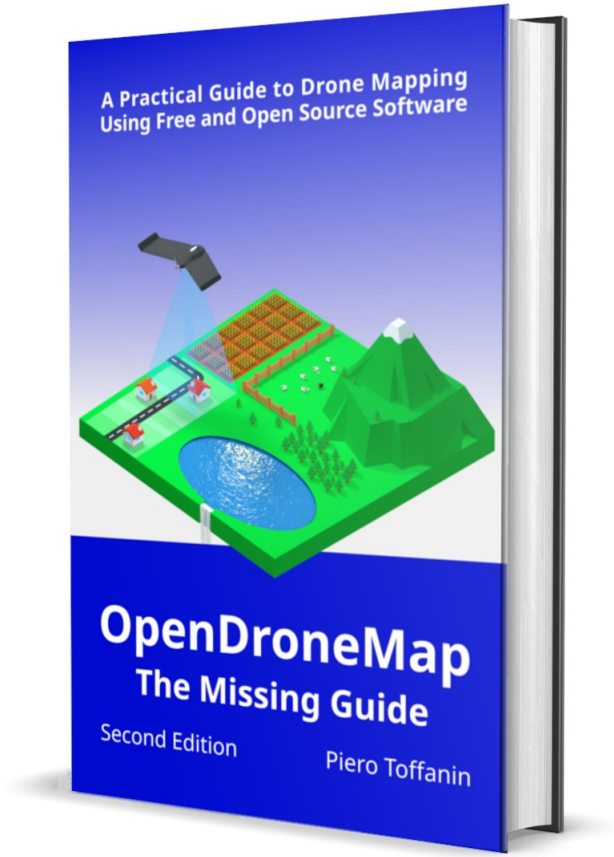
ODM Docs

https://docs.opendronemap.org



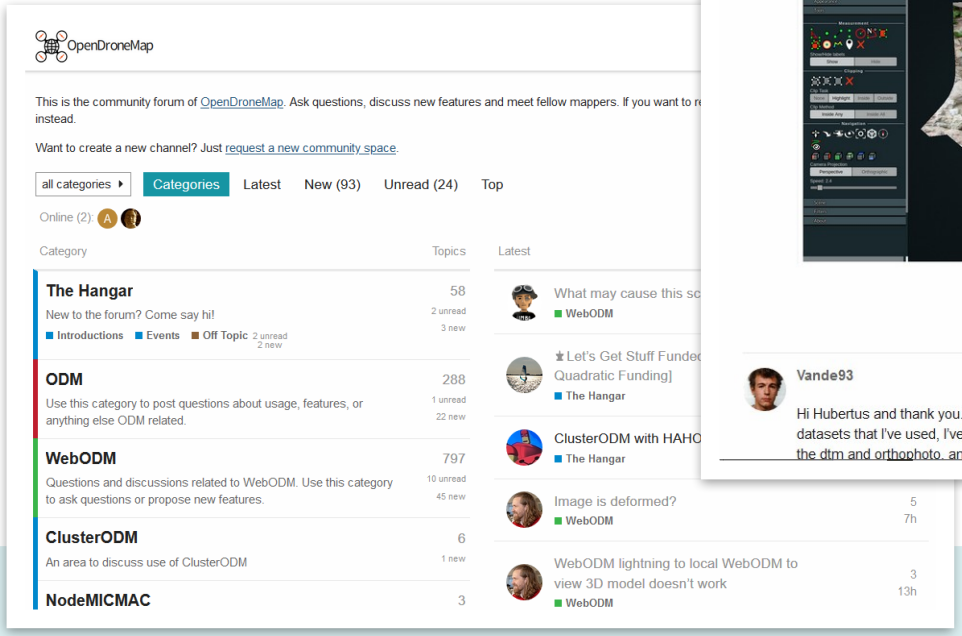
ODM Book

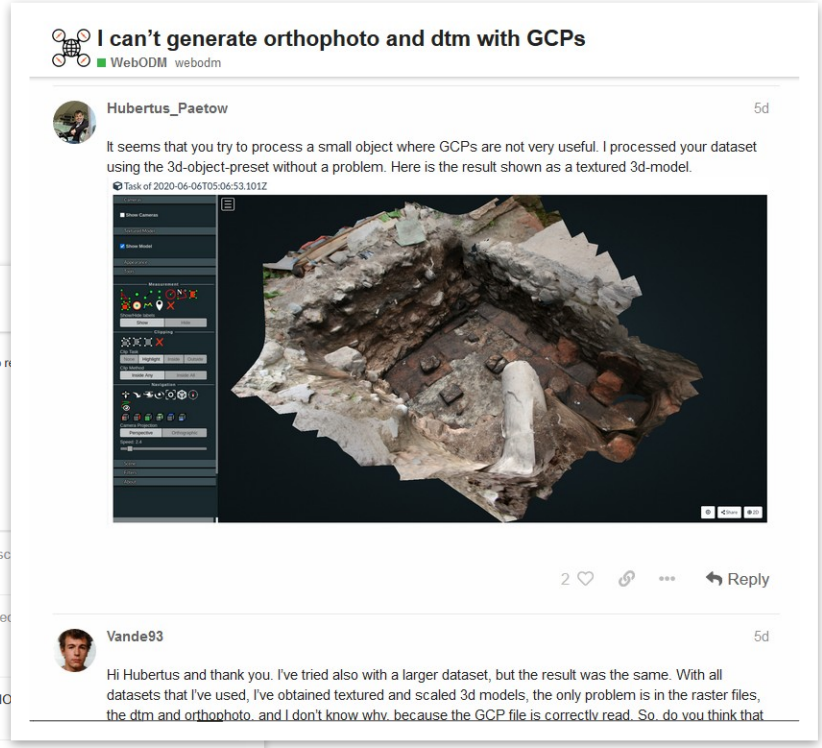
https://odmbook.com
~$30



Community Forum

https://community.opendronemap.org



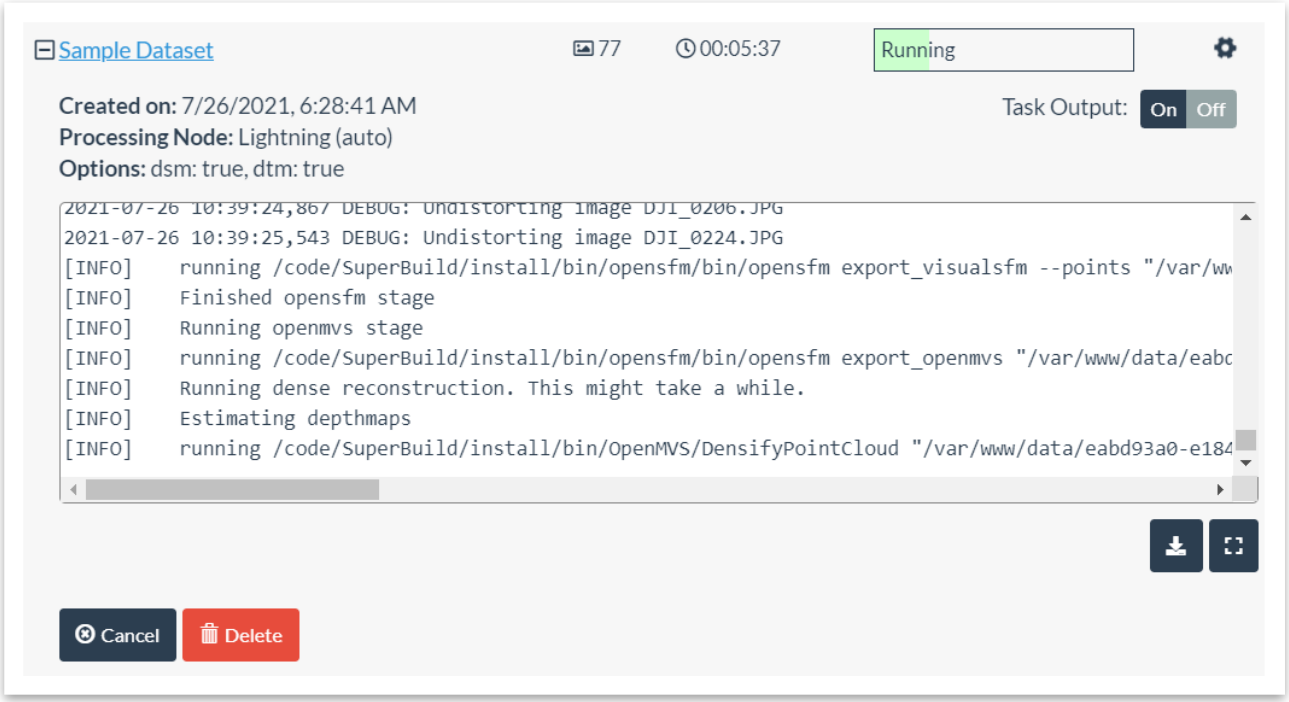


Hands-On: Part B
Working with Outputs

WebODM vs. WebODM Lightning

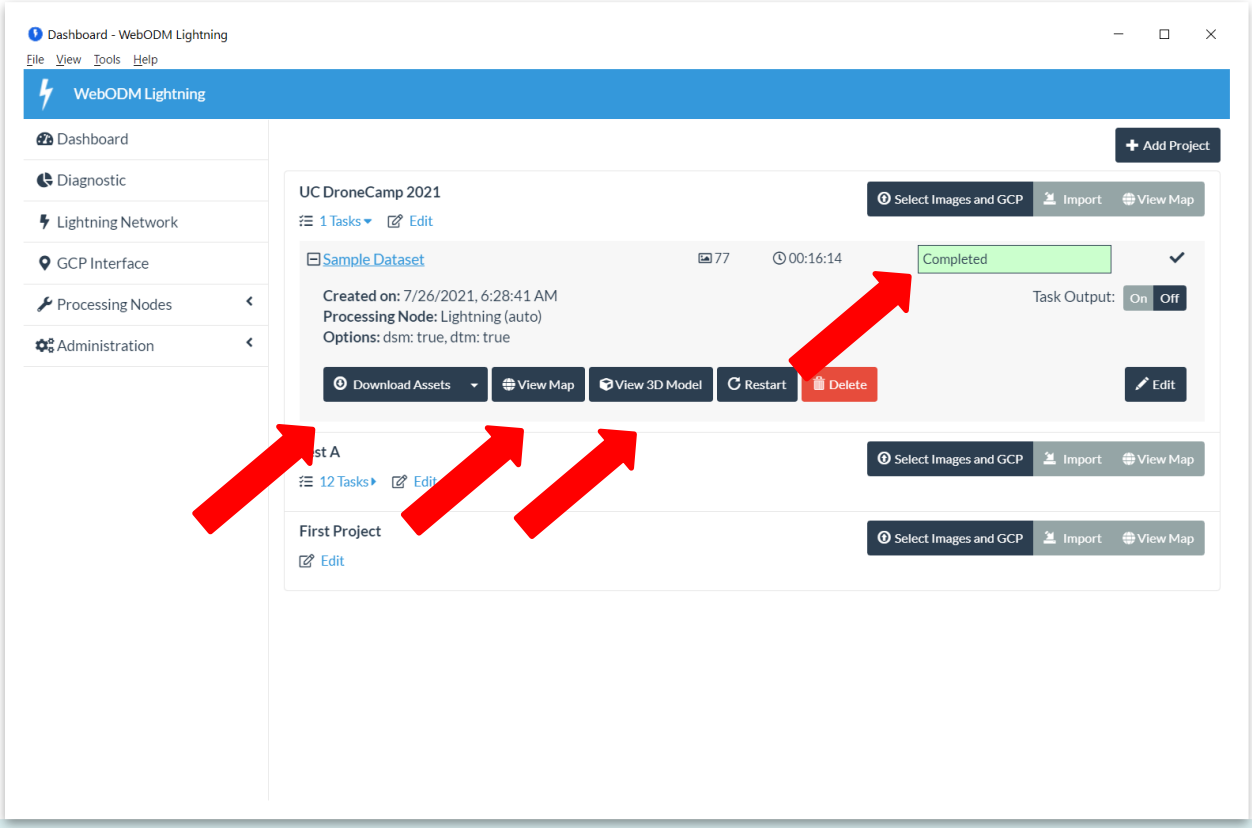
- WebODM
  - Install for free
  - Process locally for free
- WebODM Lightning
  - Commercial service
  - Install for free
  - Process in the cloud ($)

Still Running?

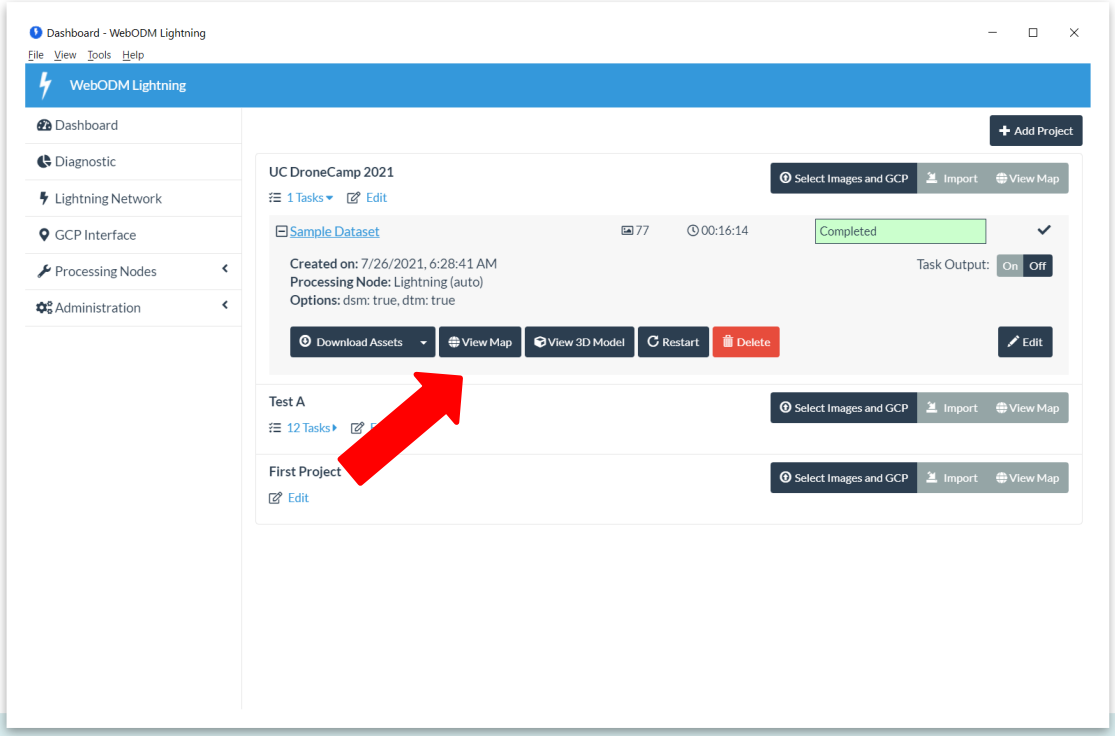


Finished

Today, Speed > Quality

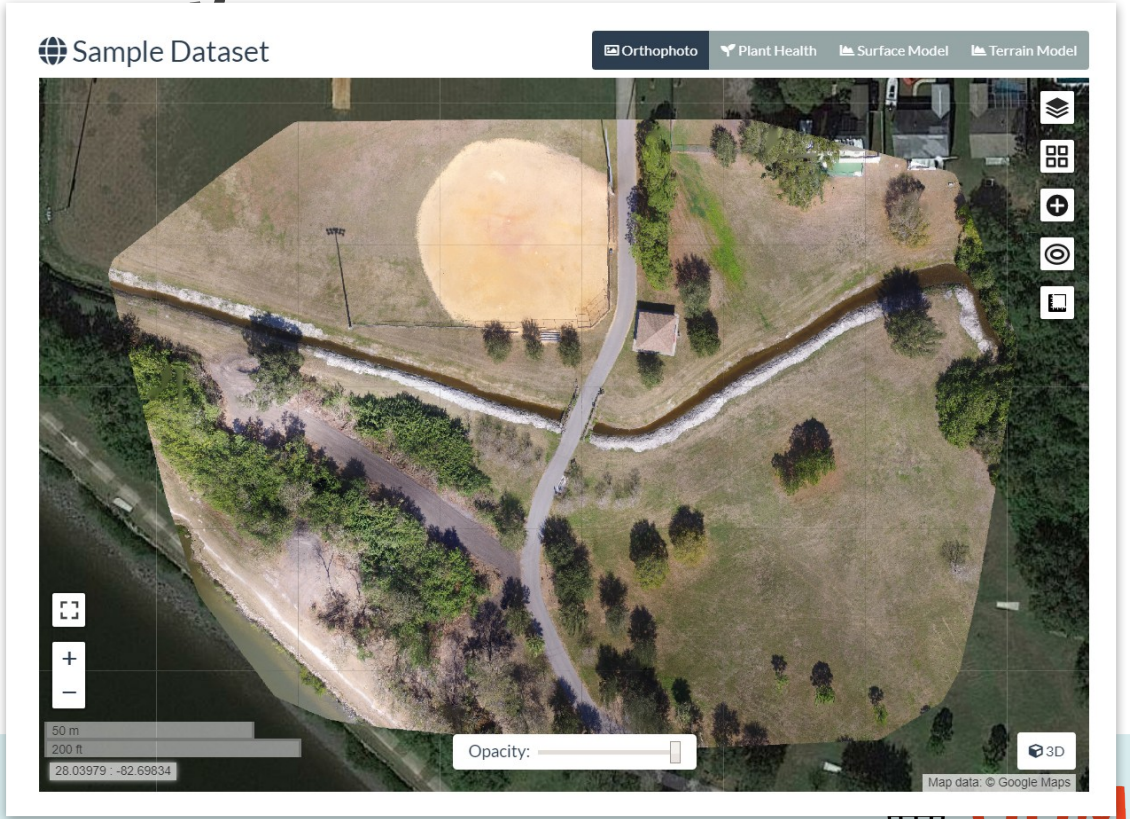


Exercises – 2D Orthophoto



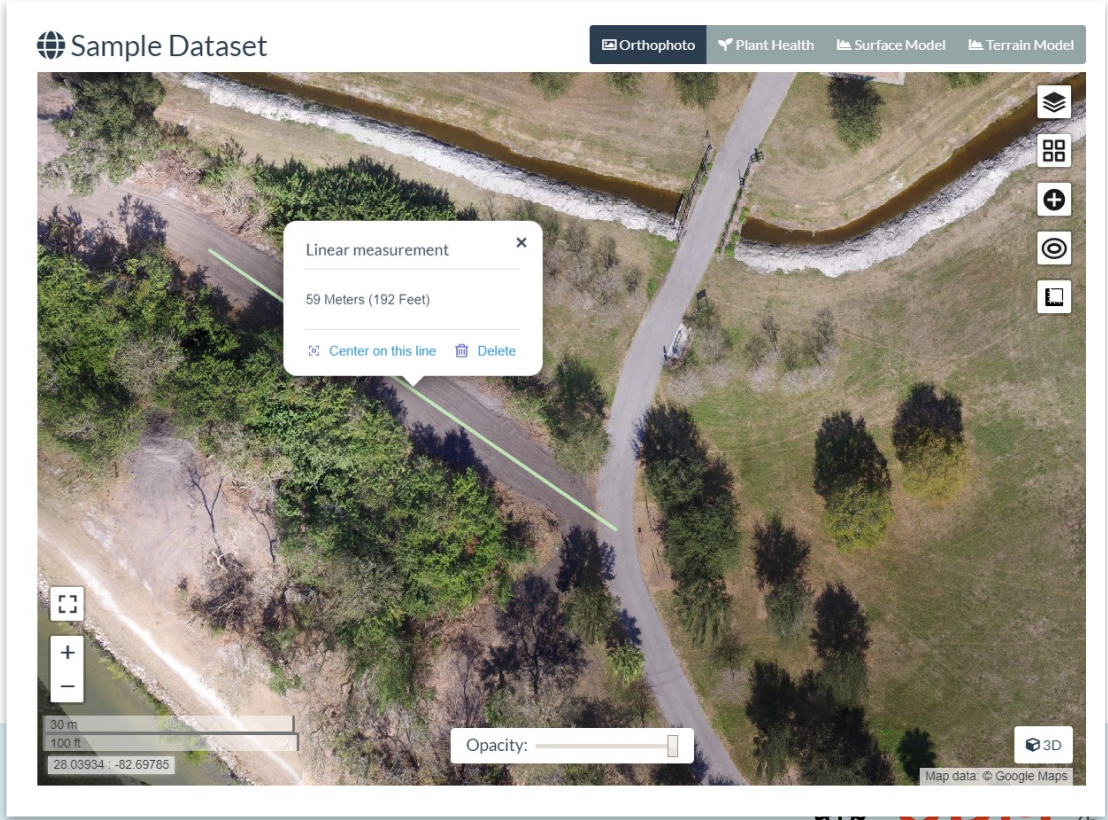
#1 – Orthophoto - Navigate

A. Click+hold = move map
B. Scroll wheel = zoom in/out
C. Map controls +/- = zoom
D. Map control square = full screen
E. Top buttons:
    A. Ortho
    B. Plant Health
    C. Surface Model
    D. Terrain Model



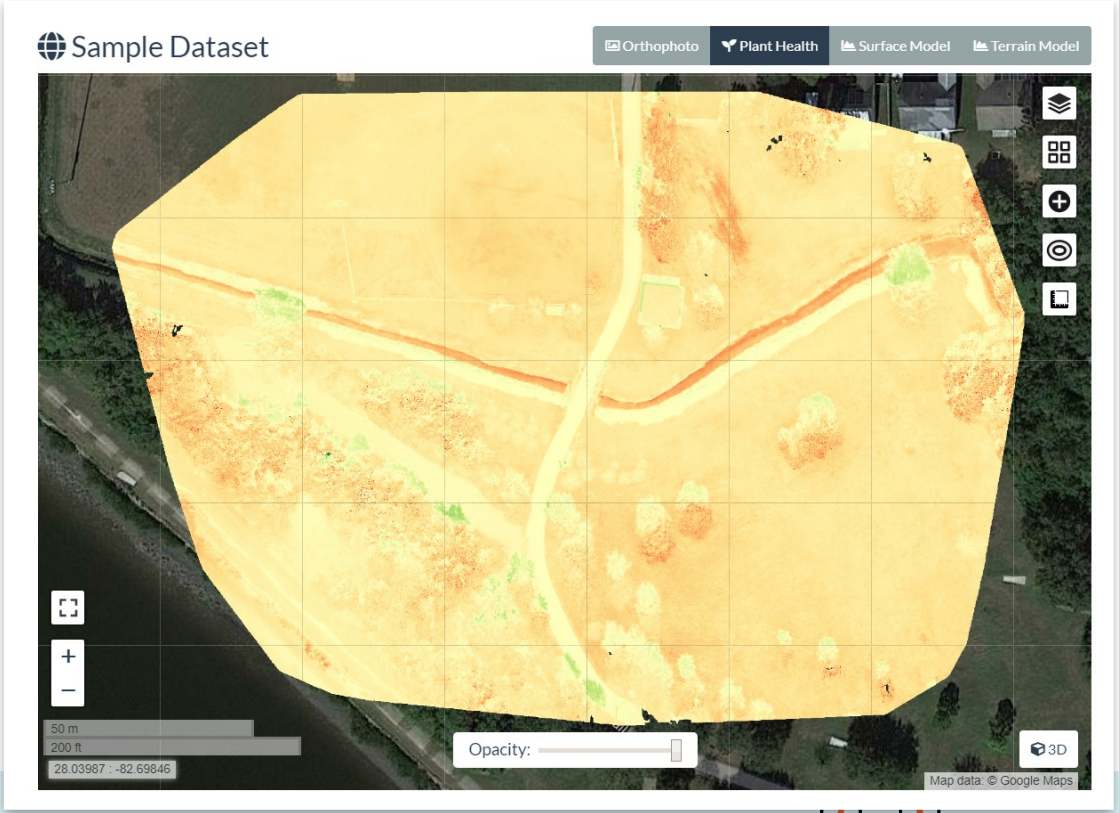
#2 – Orthophoto - Measure

A. Click ruler (5th on right)
B. Create new measurement
C. Click 2 points on map
D. Click “Finish measurement”
E. View calculations in white balloon
F. Close balloon with “x”
G. Click ruler again, new measurement
H. Click 4 points on map to make a box, click “Finish”
I. View calculations
J. Click “Delete” to remove it



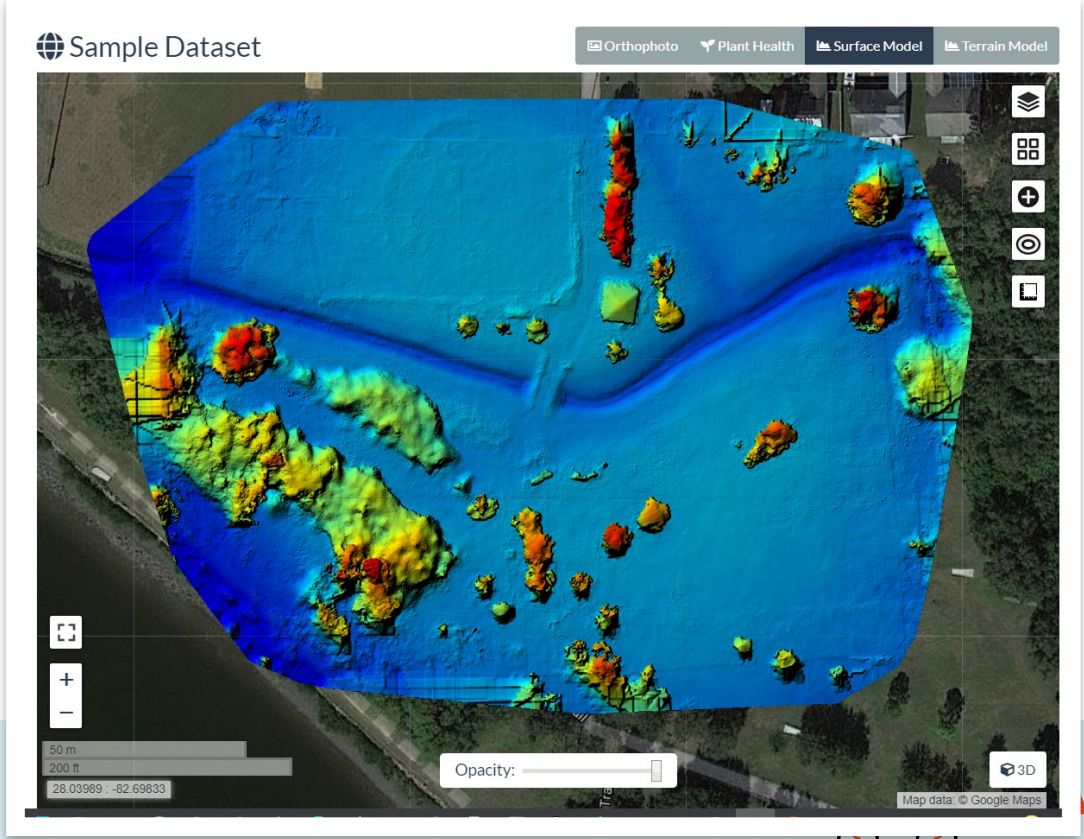
#3 – Plant Health

A. 2nd Top Button: Plant Health
B. Note color differences in different grassy areas
C. Click top right “layers” icon
D. View “Algorithm” options
E. View “Color” options
F. Drag min/max bars
G. Export GeoTIFF



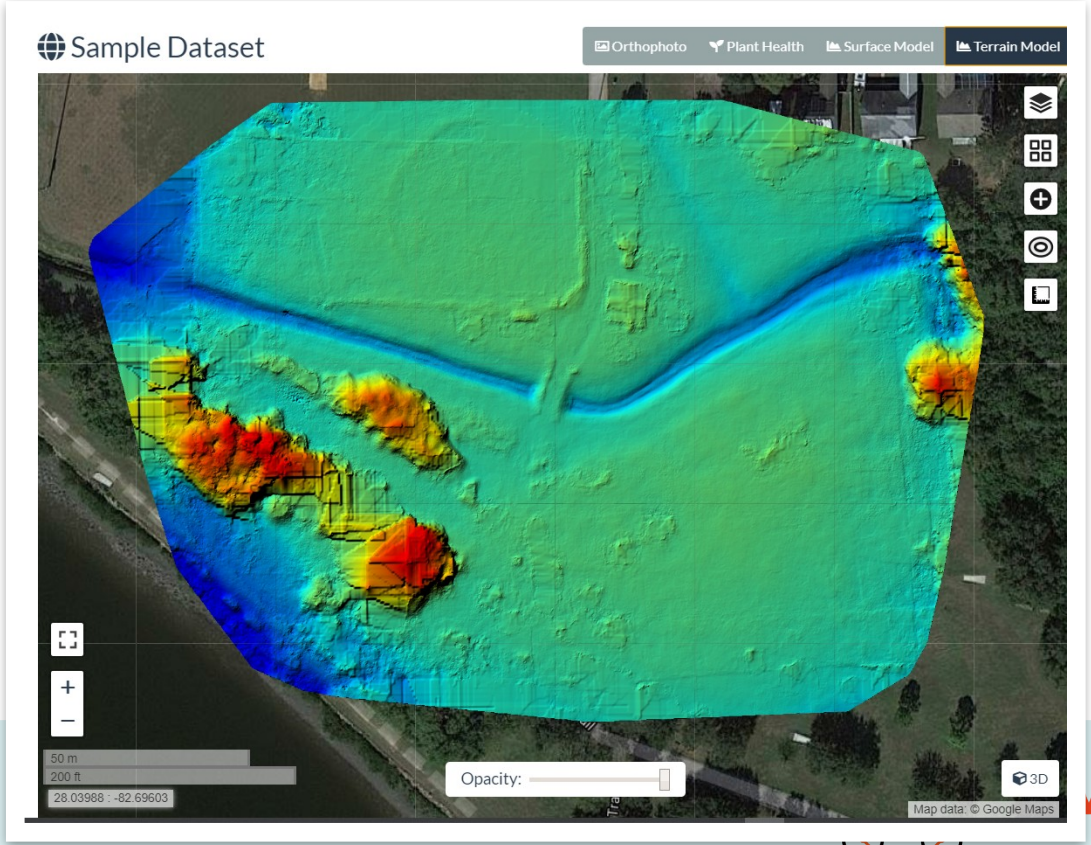
#4 – Surface Model (DSM)

A. 3rd Top Button: Surface Model
B. Wait for calc/load
C. Note color varies by altitude
D. Click top right “layers” icon
E. View “Color” options
F. Drag min/max bars
G. Wait for refresh
H. Export GeoTIFF

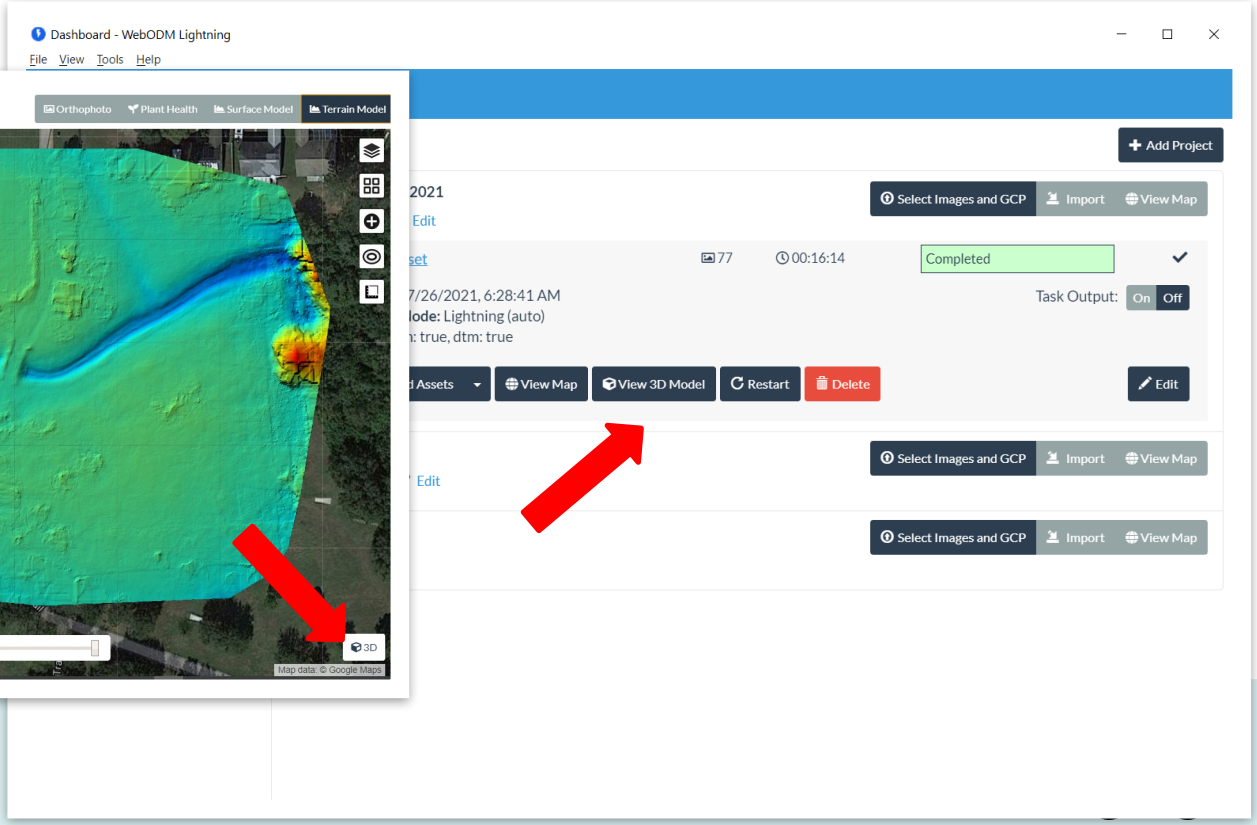


#5 – Terrain Model (DTM)

A. 4th Top Button: Terrain Model
B. Wait for calc/load
C. Note color varies by altitude
D. Click top right “layers” icon
E. View “Color” options
F. Drag min/max bars
G. Wait for refresh
H. Export GeoTIFF

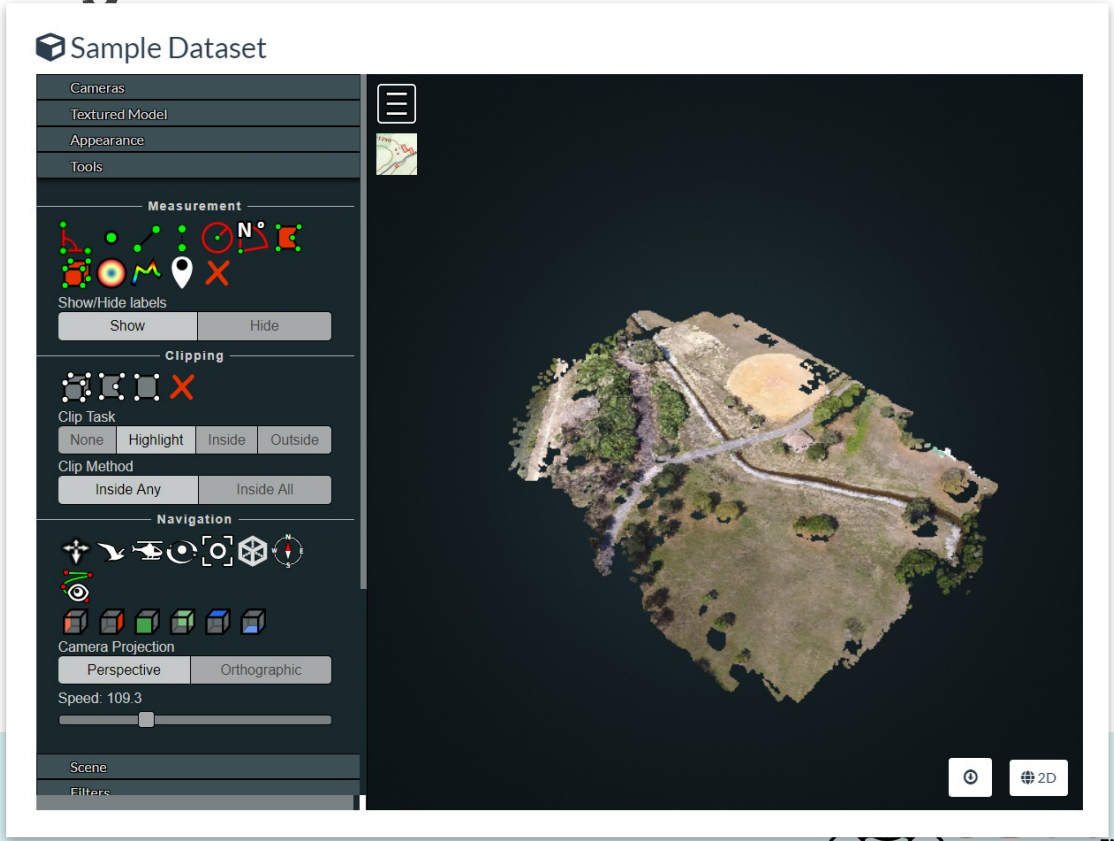


Exercises – 3D Model



#6 – 3D Model - Navigate

A. Left click+drag = rotate model
B. Right click+drag = move model
C. Scroll wheel = zoom in/out
D. Top left (3 bars) button = collapse tools
E. Top left (map) button = show model location
F. Tools
    A. Measure
    B. Navigation
G. Appearance
H. Scene

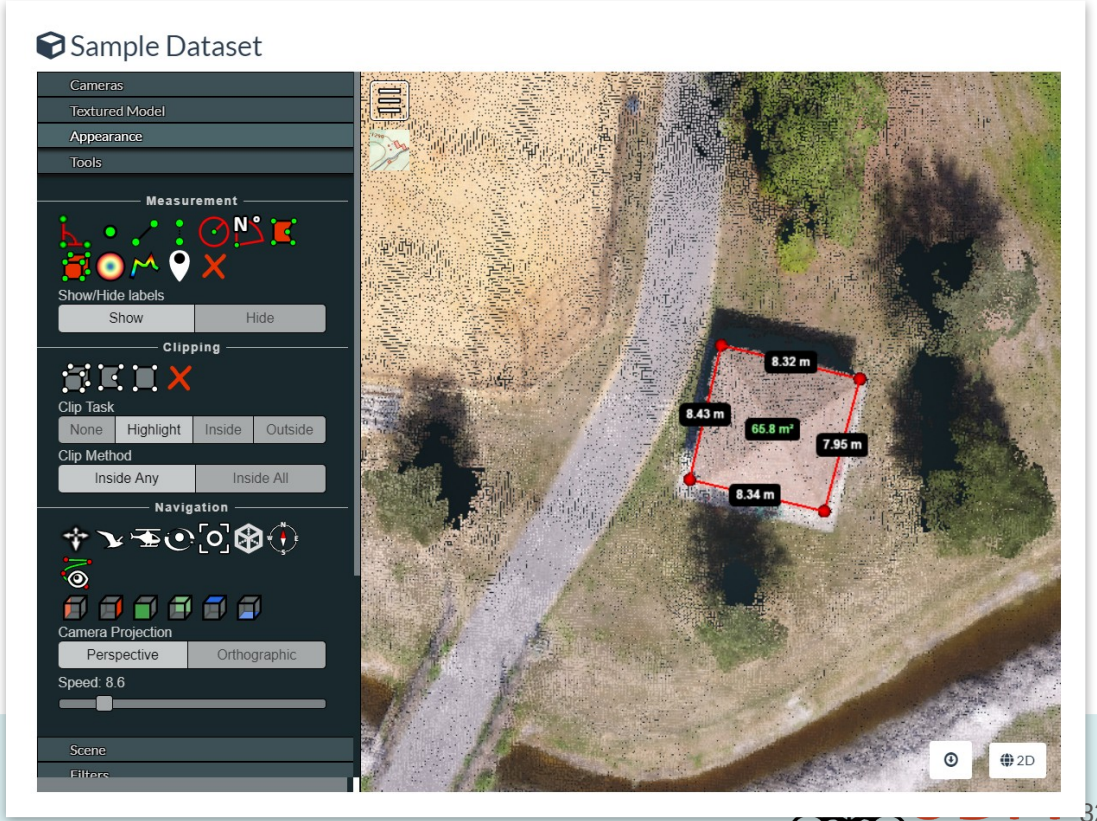


#7 – 3D Model – Measure (Linear)

A. Adjust the model so you can see
B. Click 3rd Measurement tool (angled line)
C. LEFT click 2 points on the map
D. Now RIGHT click the last point to finish
E. View measured distance (m)
F. Click red “X” in measurement tools, to delete

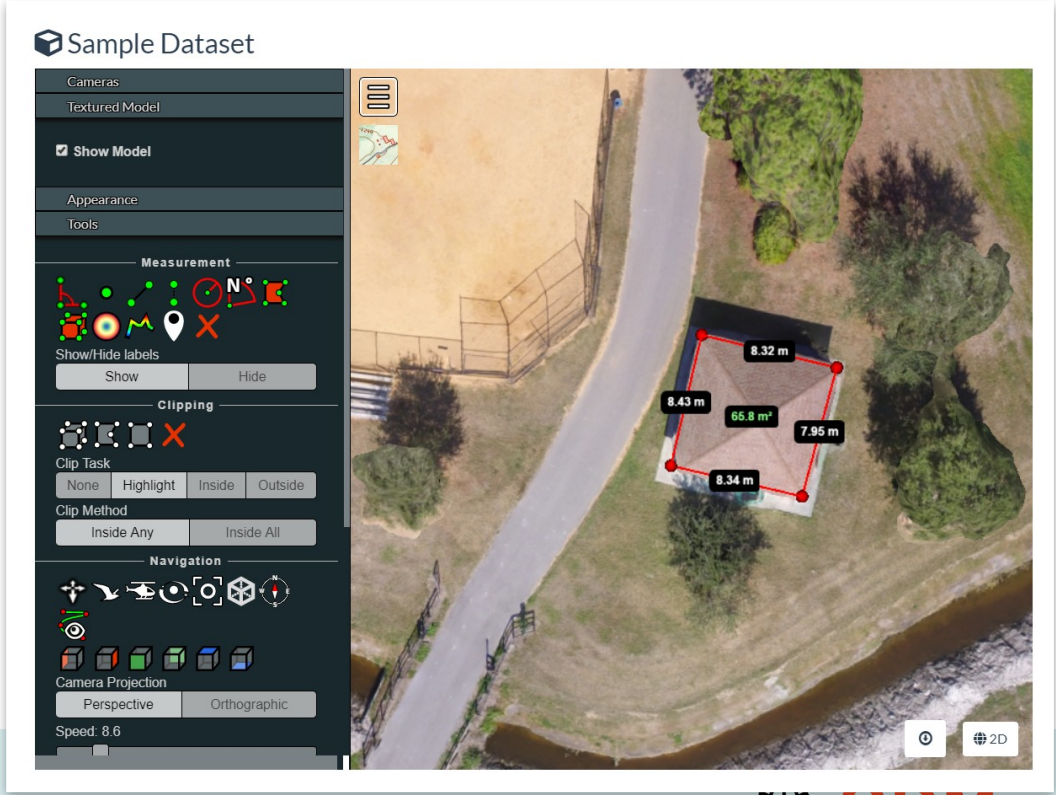
#8 – 3D Model – Measure (Area)

A. Adjust the model so you can see
B. Click top right Measurement tool (red box)
C. LEFT click 4 points on the map
D. Now RIGHT click the last point to finish
E. View measured distances (white)
F. View measured area (green)



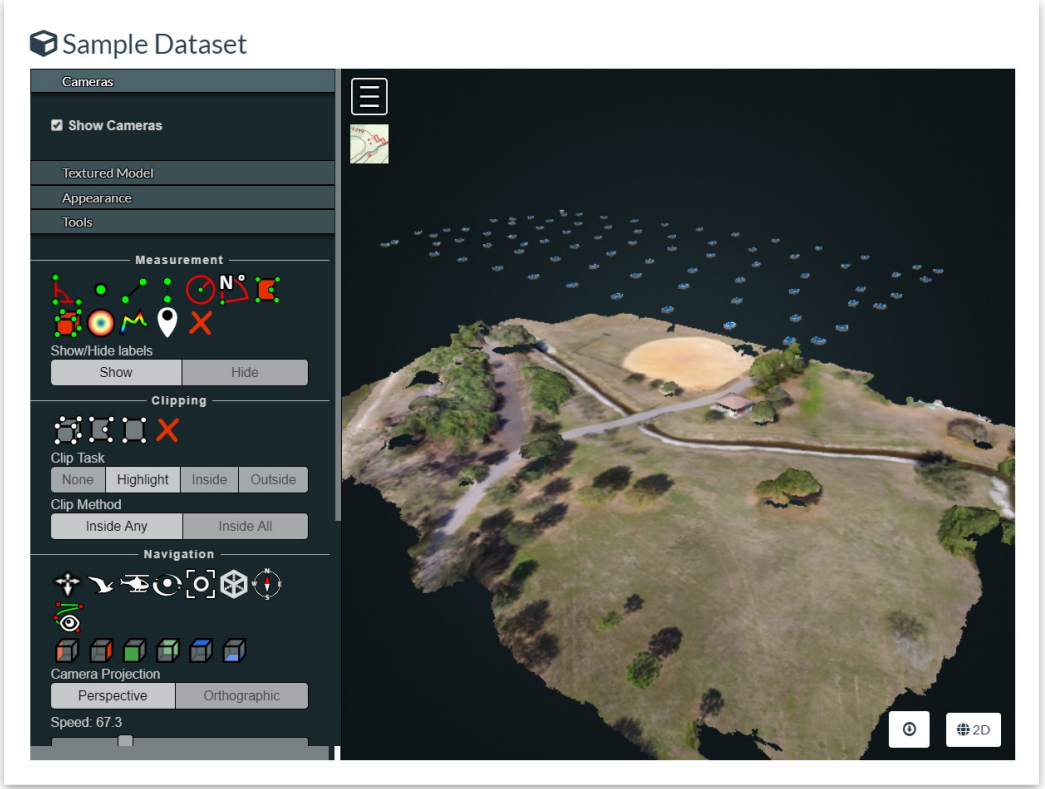
#9 – View Textured Model

A. Find “Textured Model” near the top of the tool menu
B. Click to expand, then click “Show Model”
C. Wait a few seconds
D. View how the scene becomes more detailed, holes are filled
E. Uncheck and check the box to turn off, and on
F. Move the model around to view other parts
G. Edges of model = lots of error
   Interior of model = better precision

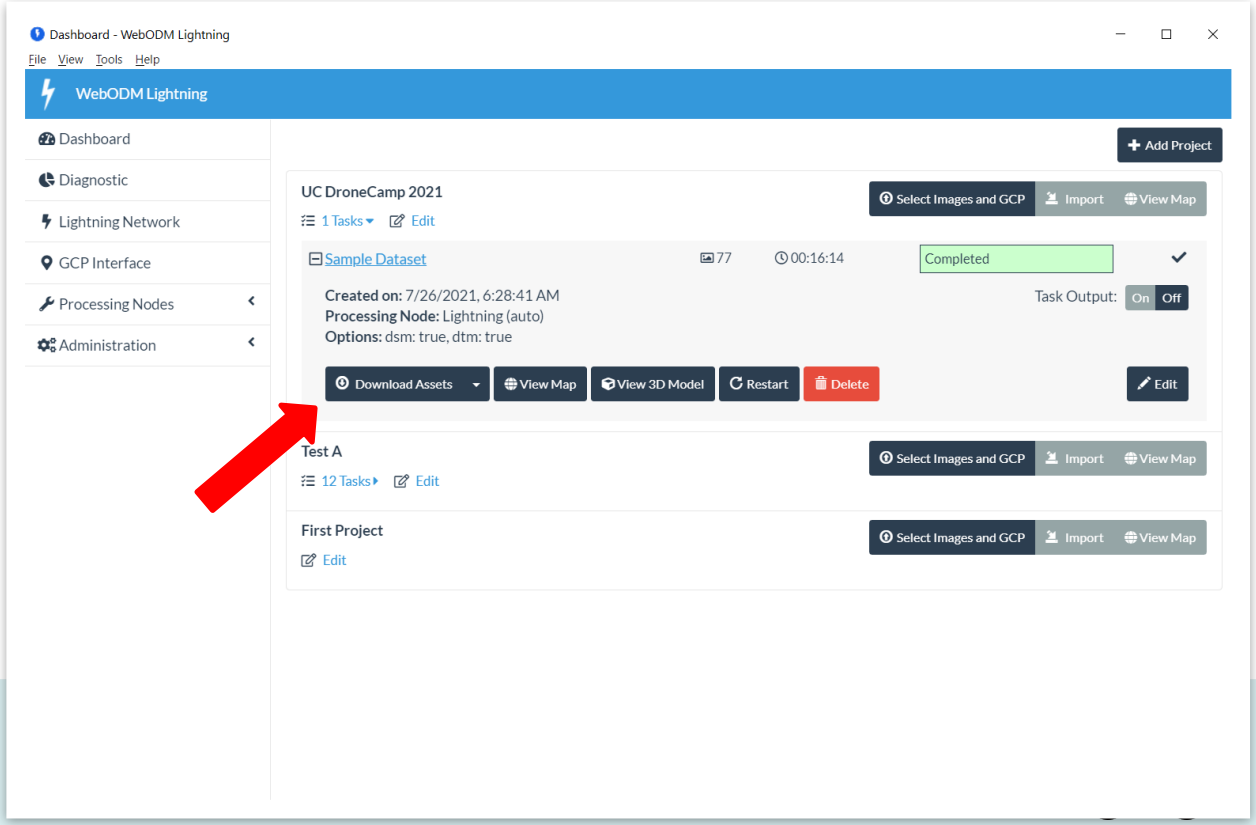


#10 – View Cameras

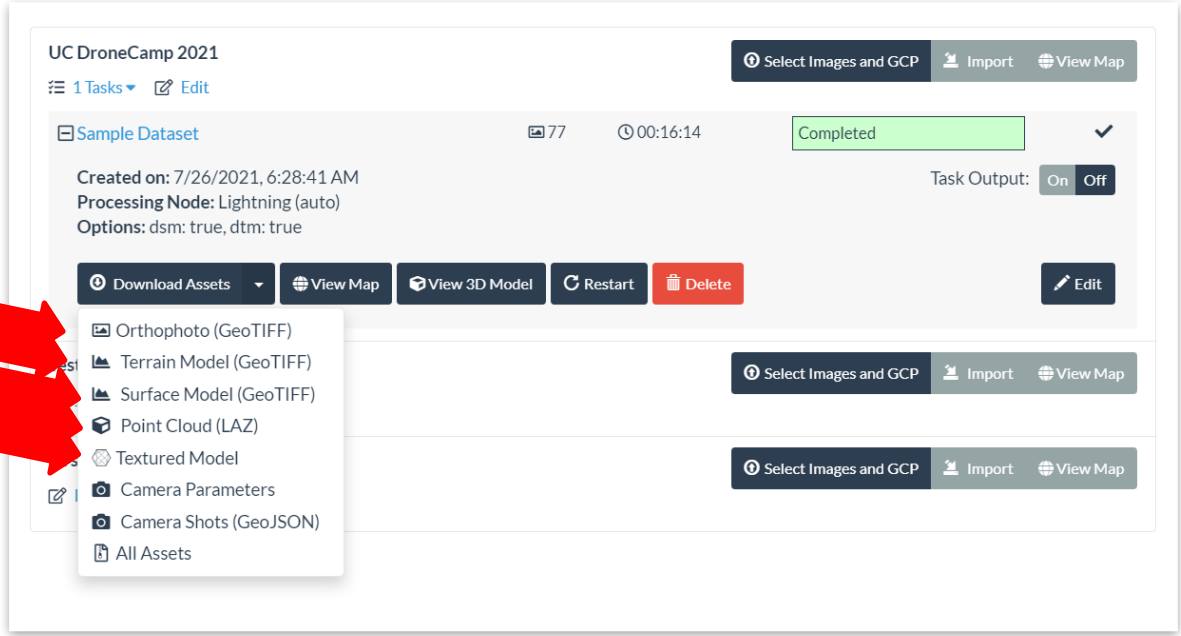
A. Find “Cameras” near the top of the tool menu
B. Click to expand, then click “Show Cameras”
C. Zoom out (scroll) until you see the blue squares floating above the scene
D. Note positions, angles of cameras
E. Click one camera to see the photo from that position



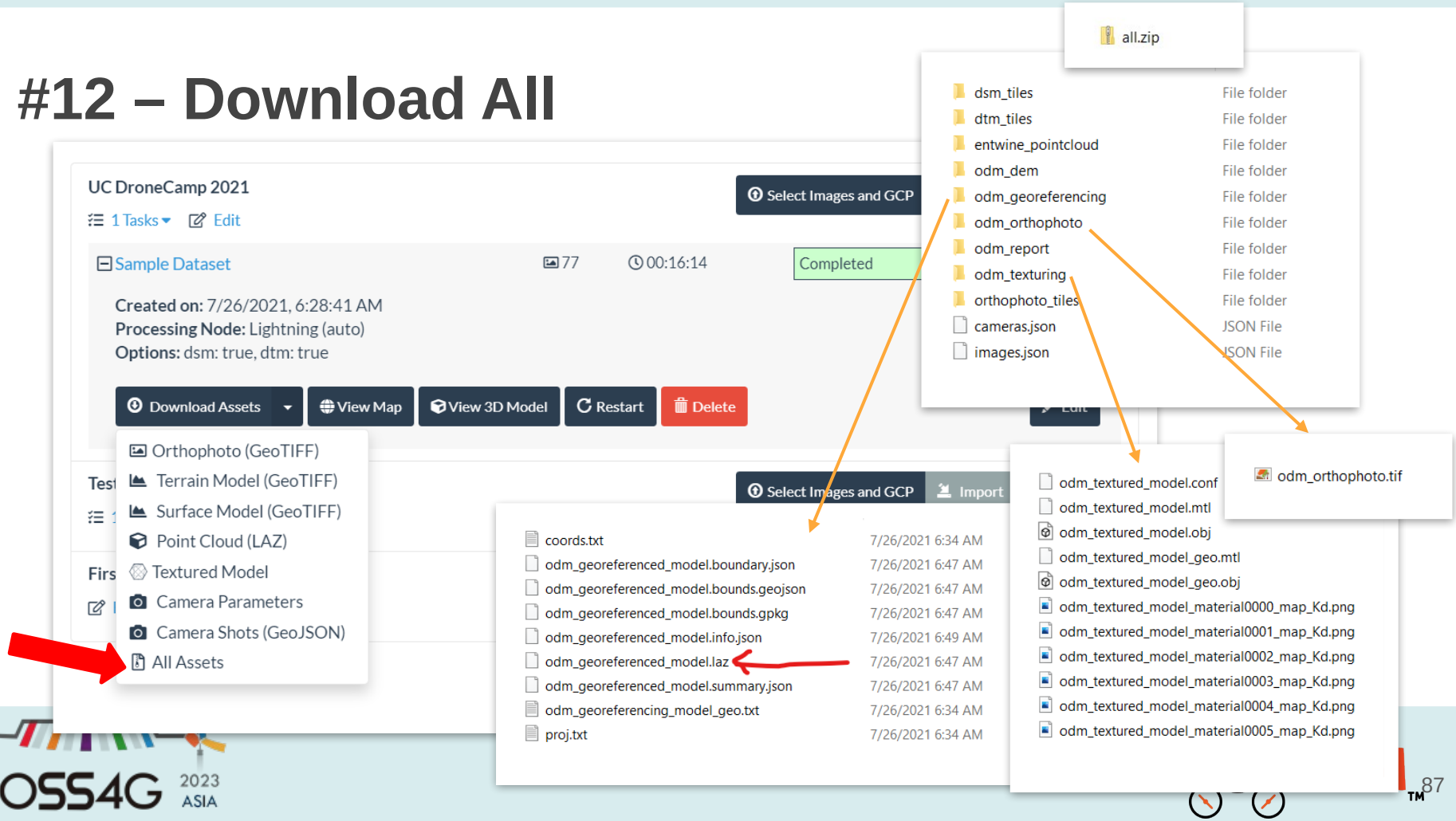
Exercises – Download



#11 – Download Specific Outputs



#12 – Download All



Contact Me

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This material is based on presentations by:

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Piero Toffanin - ODM, UAV4GEO

Screenshots and interface images by Corey Snipes or Stephen Mather, unless otherwise n

https://opendronemap.org

https://github.com/opendronemap/presentations

Coupon for 80% off installer:
https://opendronemap.org/webodm/download/#installer

Then for coupon code, use the email address you used to register for this conference, but:
replace “@” with underscore “_” and dots with dashes “-”

e.g. ***Stephen.Mather@opendronemap.org*** would become
Stephen-Mather_opendronemap-org

Thank You!

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