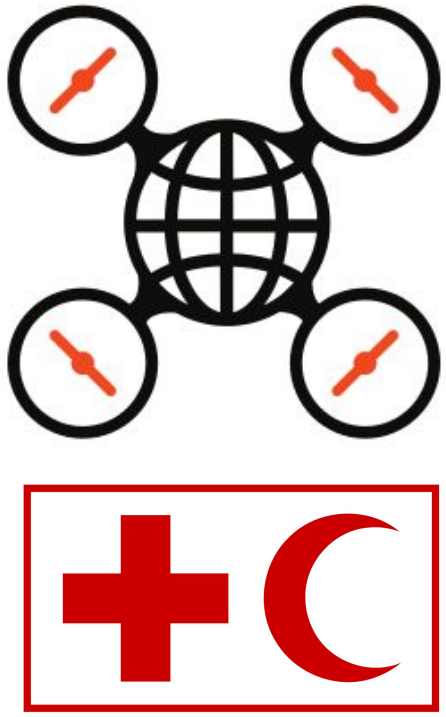


Open-Source Photogrammetry With OpenDroneMap

Stephen Mather, Oberlin College
Corey Snipes, Twomile Heavy Industries Inc

IFRC Drones Group – January 26, 2022

INTRODUCTIONS

Stephen Mather

- Systems Administrator with Focus on Research Support, Oberlin College and Conservatory
- OpenDroneMap Ecosystem cofounder (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)

Corey Snipes

- Aerospace Software Engineer
  - *Focus: Air Traffic Management, Cybersecurity*
- Part 107 Commercial UAS Pilot
  - *Focus: Mapping and Modeling in Urban and Coastal Contexts*
- Board President, North Coast Drone Alliance
- Based in Cleveland, Ohio

AGENDA

Agenda

- What is ODM?
- Benefits
- Capabilities
- Use Cases
- Getting Started
- Learning More
- Getting Involved

WHAT IS ODM?

Overview

Animation via webodm.net

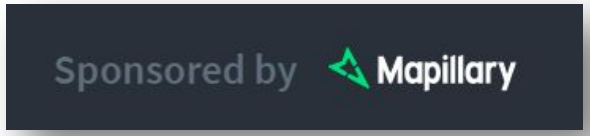
- Open-source toolkit for photogrammetry from UAS imagery and sensor data
- Used globally across all sectors
  - *Government*
    - Cleveland Metroparks
    - Korea National Park Service
    - US Department of Interior
  - *NGO*
    - Used by the Red Cross, World Bank, United Nations
  - *Private sector*
    - 10s of thousands of users
  - *Hobbiest*

- Begun in 2014, significant improvements 2018-2021
  - *Output Quality*
  - *Features*
  - *Usability*

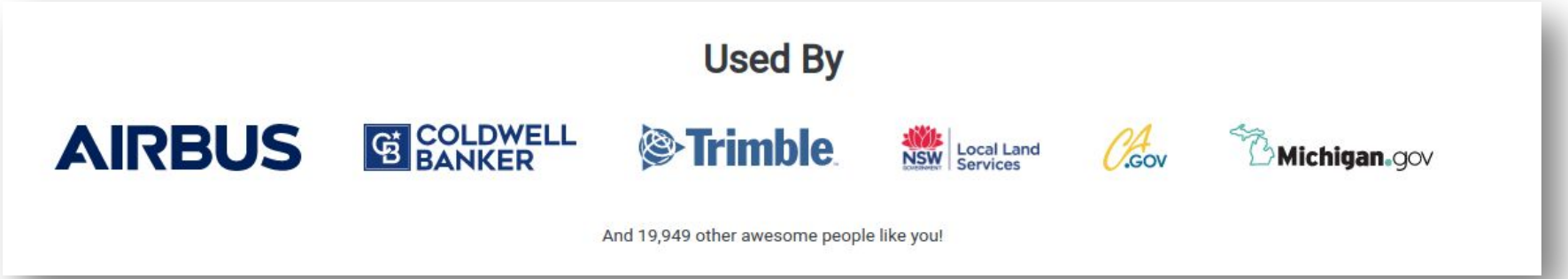
OpenDroneMap Goals

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

OpenDroneMap Funding



- Community Contributions
- Cleveland Metroparks
- ELHRA's Humanitarian Innovation Fund
- World Bank Tanzania and Global Facility for Disaster Reduction and Recovery
- American Red Cross
- Korea National Park Service
  - Via associated projects, e.g. OpenSfM and OpenMVS
  - Via commercial funding via WebODM.net:



BENEFITS

Why Open Source

Shared Costs

- Accessible to orgs and programs with limited budgets
  - *Pix4D is $292-$350/mo -OR- $4,990 one-time*
  - ***ODM is $0* (free as in freedom forever)***

But equally important:

- **Control** over your toolchain (change if you want)
- Shoulders of giants: many contributors, **collective wisdom**
- **Transparency** leads to greater
  - ***Quality***
  - ***Security***
- Standards Based
- Public Good

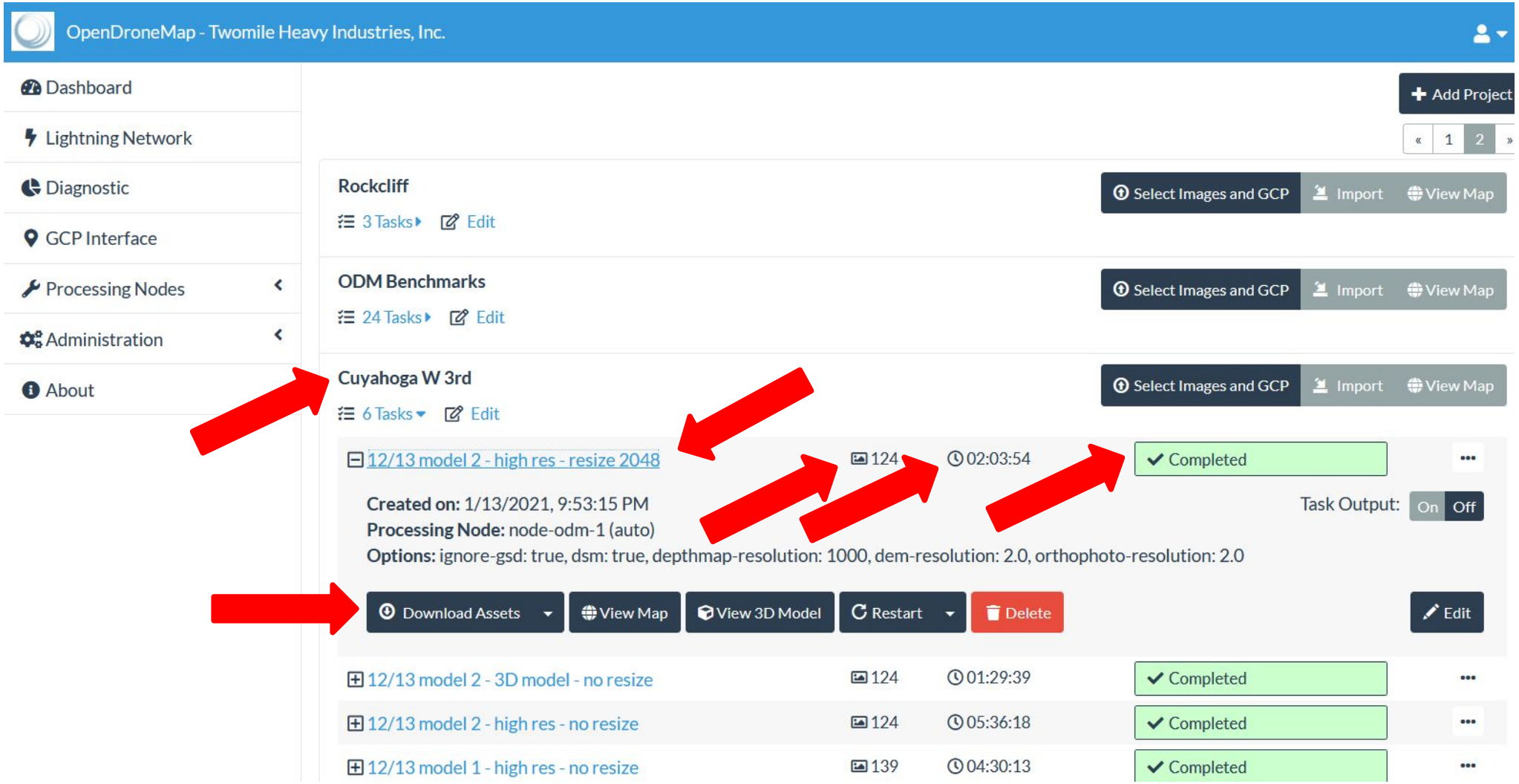
https://www.newelementary.com/2020/06/lego-part-65581-lantern-techniques-3.html

- Use of Proprietary Software in the Aid Sector Perpetuates Racial Injustice
  - *https://ivangayton.net/*

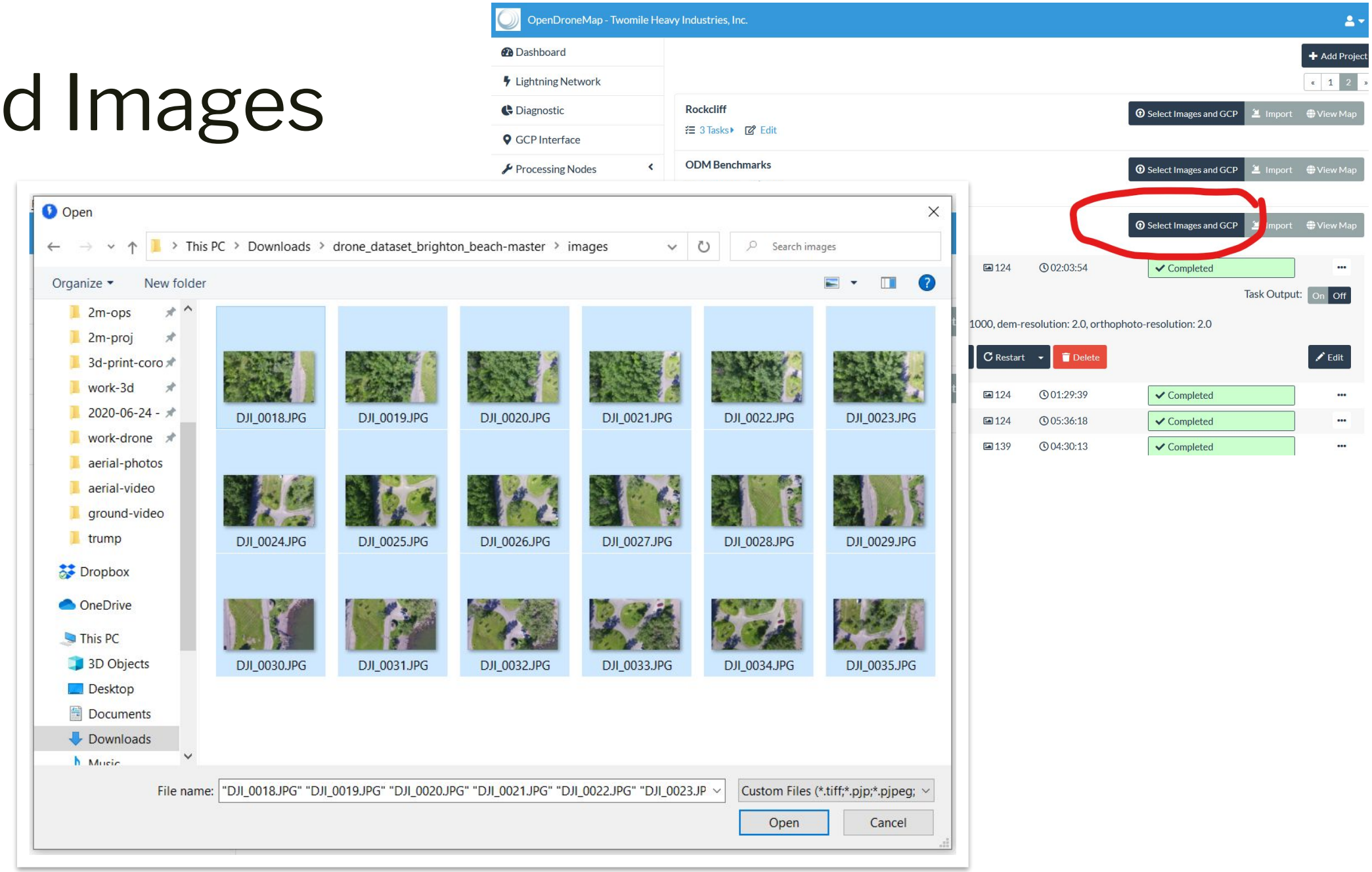
**You can pay for certain parts, but not required.*

CAPABILITIES

Dashboard


OpenDroneMap - Twomile Heavy Industries, Inc.
Dashboard
Lightning Network
Diagnostic
GCP Interface
Processing Nodes
Administration
About
Add Project
« 1 2 »
Rockcliff
3 Tasks
Edit
Select Images and GCP
Import
View Map
ODM Benchmarks
24 Tasks
Edit
Select Images and GCP
Import
View Map
Cuyahoga W 3rd
6 Tasks
Edit
Select Images and GCP
Import
View Map
12/13 model 2 - high res - resize 2048
124
02:03:54
Completed
Created on: 1/13/2021, 9:53:15 PM
Processing Node: node-odm-1 (auto)
Options: ignore-gsd: true, dsm: true, depthmap-resolution: 1000, dem-resolution: 2.0, orthophoto-resolution: 2.0
Task Output:
On
Off
Download Assets
View Map
View 3D Model
Restart
Delete
Edit
12/13 model 2 - 3D model - no resize
124
01:29:39
Completed
12/13 model 2 - high res - no resize
124
05:36:18
Completed
12/13 model 1 - high res - no resize
139
04:30:13
Completed

Add Images


OpenDroneMap - Twomile Heavy Industries, Inc.
Dashboard
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GCP Interface
Processing Nodes
Add Project
Rockcliff
3 Tasks
Edit
Select Images and GCP
Import
View Map
ODM Benchmarks
Select Images and GCP
Import
View Map
Select Images and GCP
Import
View Map
124
02:03:54
Completed
Task Output:
On
Off
1000, dem-resolution: 2.0, orthophoto-resolution: 2.0
Restart
Delete
Edit
124
01:29:39
Completed
124
05:36:18
Completed
139
04:30:13
Completed
Open
This PC
Downloads
drone_dataset_brighton_beach-master
images
Search images
Organize
New folder
2m-ops
2m-proj
3d-print-coro
work-3d
2020-06-24 -
work-drone
aerial-photos
aerial-video
ground-video
trump
Dropbox
OneDrive
This PC
3D Objects
Desktop
Documents
Downloads
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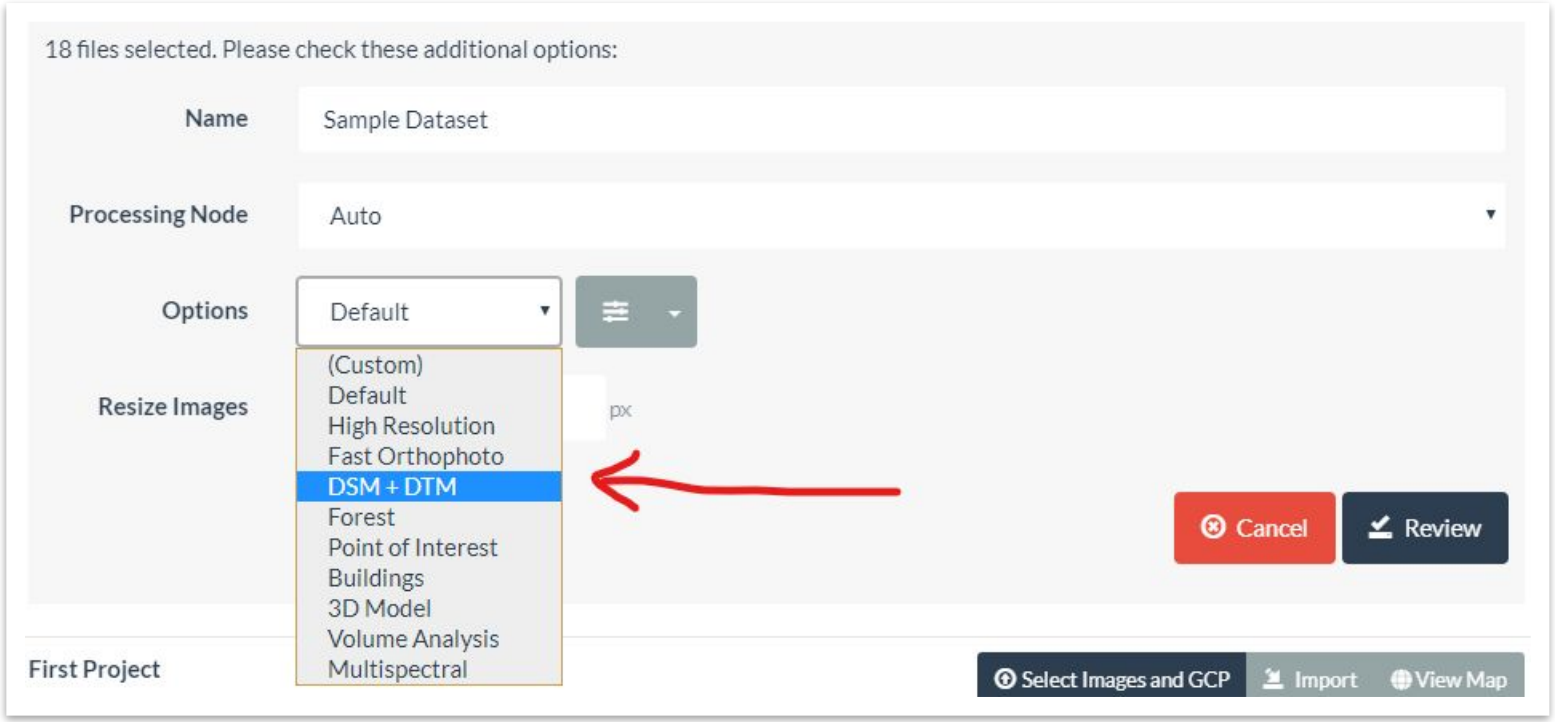
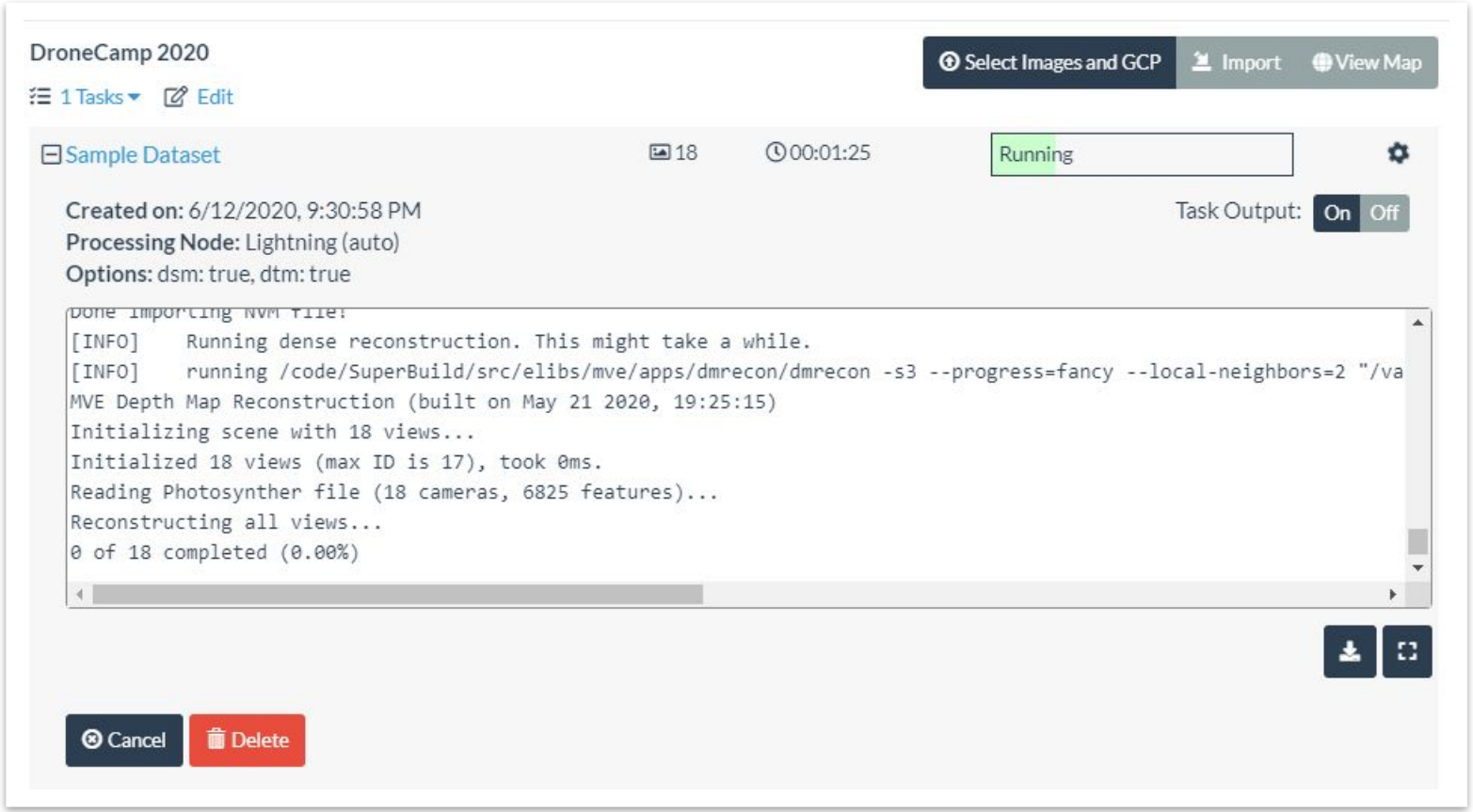
DJI_0030.JPG
DJI_0031.JPG
DJI_0032.JPG
DJI_0033.JPG
DJI_0034.JPG
DJI_0035.JPG
File name:
"DJI_0018.JPG" "DJI_0019.JPG" "DJI_0020.JPG" "DJI_0021.JPG" "DJI_0022.JPG" "DJI_0023.JP
Custom Files (*.tiff;*.pjp;*.pjpeg;
Open
Cancel

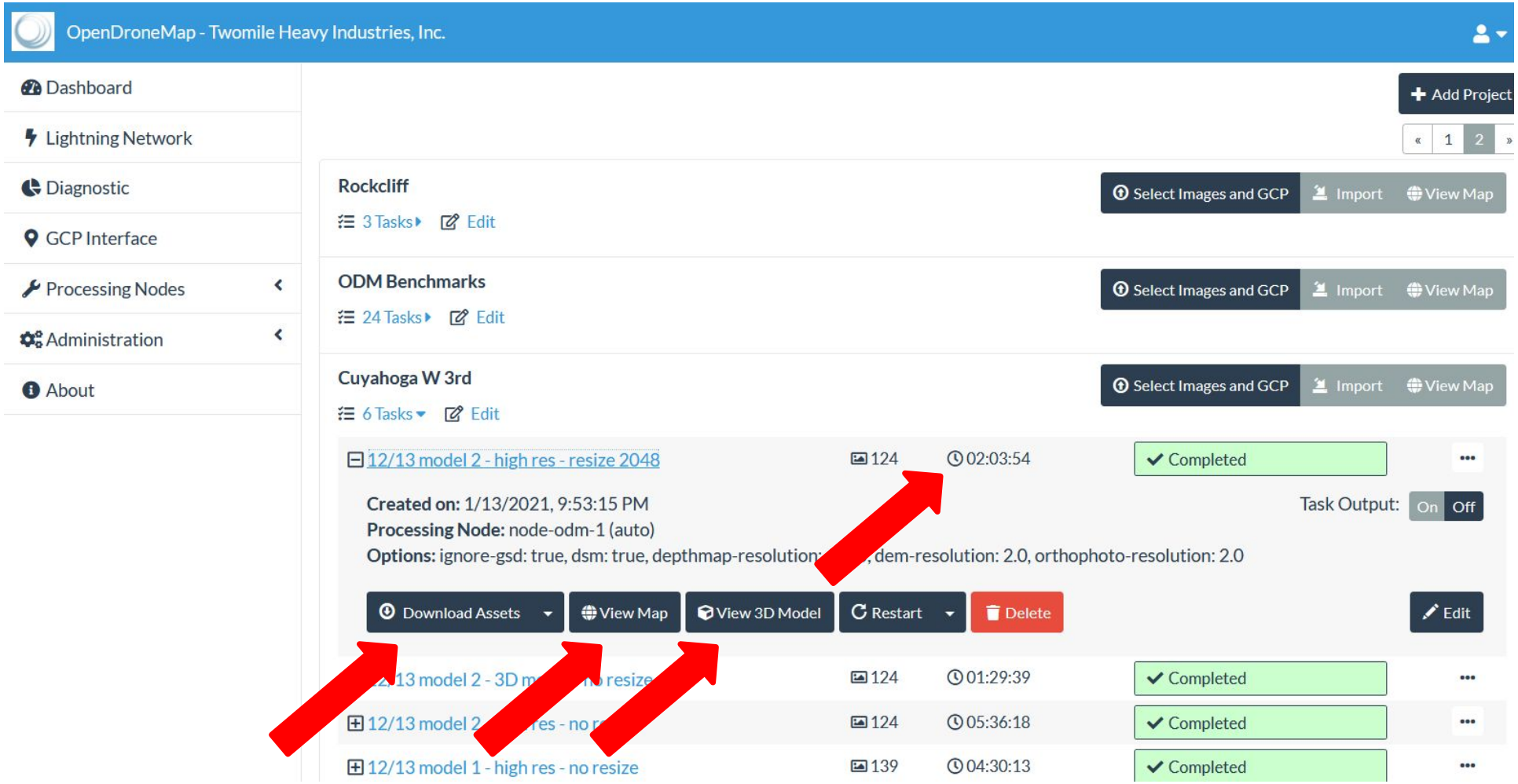
Set Configuration



Processing


DroneCamp 2020
Select Images and GCP
Import
View Map
1 Tasks
Edit
Sample Dataset
18
00:01:25
Running
Created on: 6/12/2020, 9:30:58 PM
Processing Node: Lightning (auto)
Options: dsm: true, dtm: true
Task Output:
On
Off
Done importing NVM file!
[INFO] Running dense reconstruction. This might take a while.
[INFO] running /code/SuperBuild/src/elibs/mve/apps/dmrecon/dmrecon -s3 --progress=fancy --local-neighbors=2 "/va
MVE Depth Map Reconstruction (built on May 21 2020, 19:25:15)
Initializing scene with 18 views...
Initialized 18 views (max ID is 17), took 0ms.
Reading Photosynther file (18 cameras, 6825 features)...
Reconstructing all views...
0 of 18 completed (0.00%)
Cancel
Delete

Finished


OpenDroneMap - Twomile Heavy Industries, Inc.
Dashboard
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Processing Node: node-odm-1 (auto)
Options: ignore-gsd: true, dsm: true, depthmap-resolution:
dem-resolution: 2.0, orthophoto-resolution: 2.0
Task Output:
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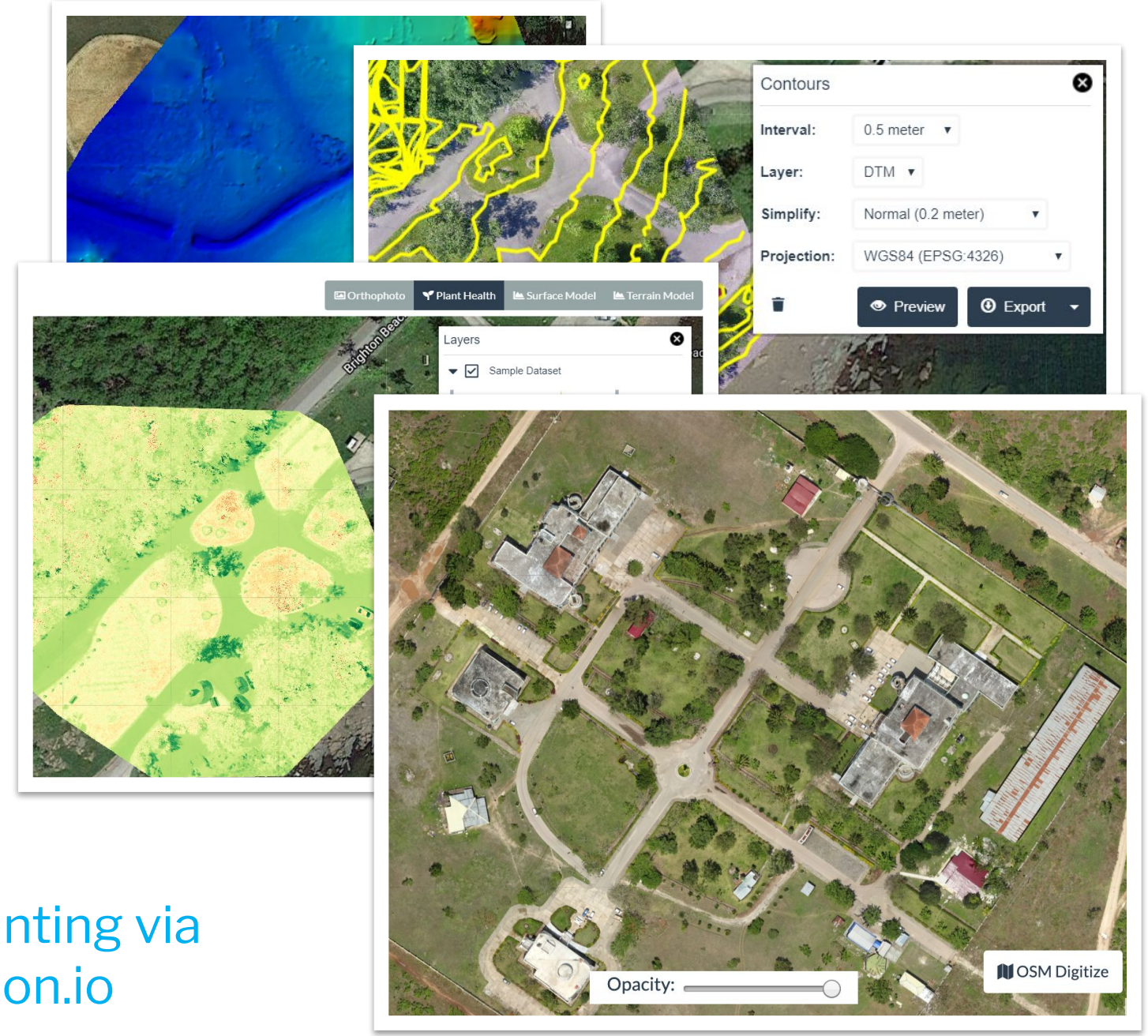
Off
Download Assets
View Map
View 3D Model
Restart
Delete
Edit
124
01:29:39
Completed
124
05:36:18
Completed
12/13 model 1 - high res - no resize
139
04:30:13
Completed

2D Outputs

- DSM / DTM / Contours
- Plant Health
- Orthophoto (GeoTIFF)



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

Photo Credit: opendronemap.org

3D Outputs

Dense Point Cloud (.las/.laz)

- CloudCompare, etc for analysis

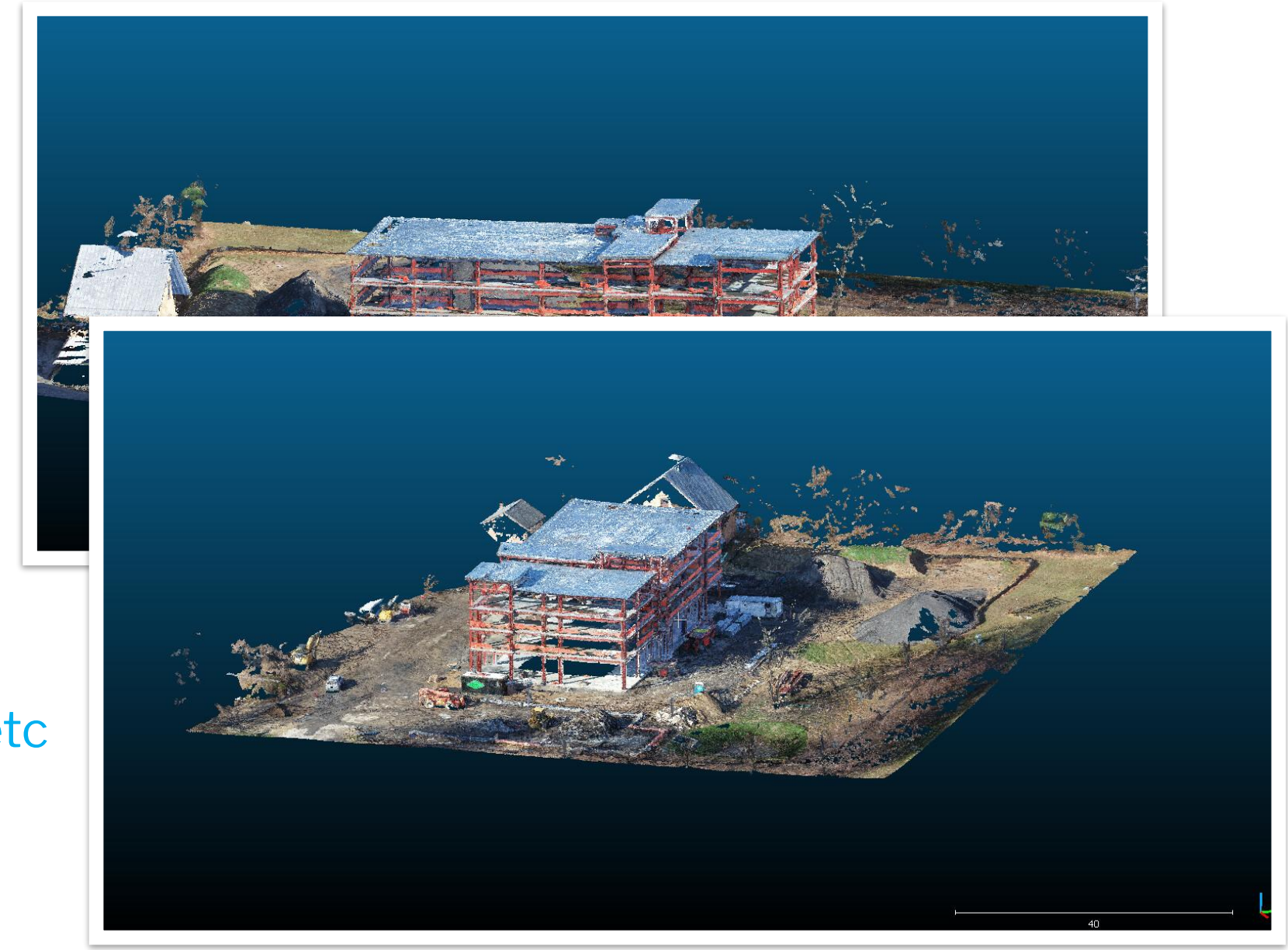
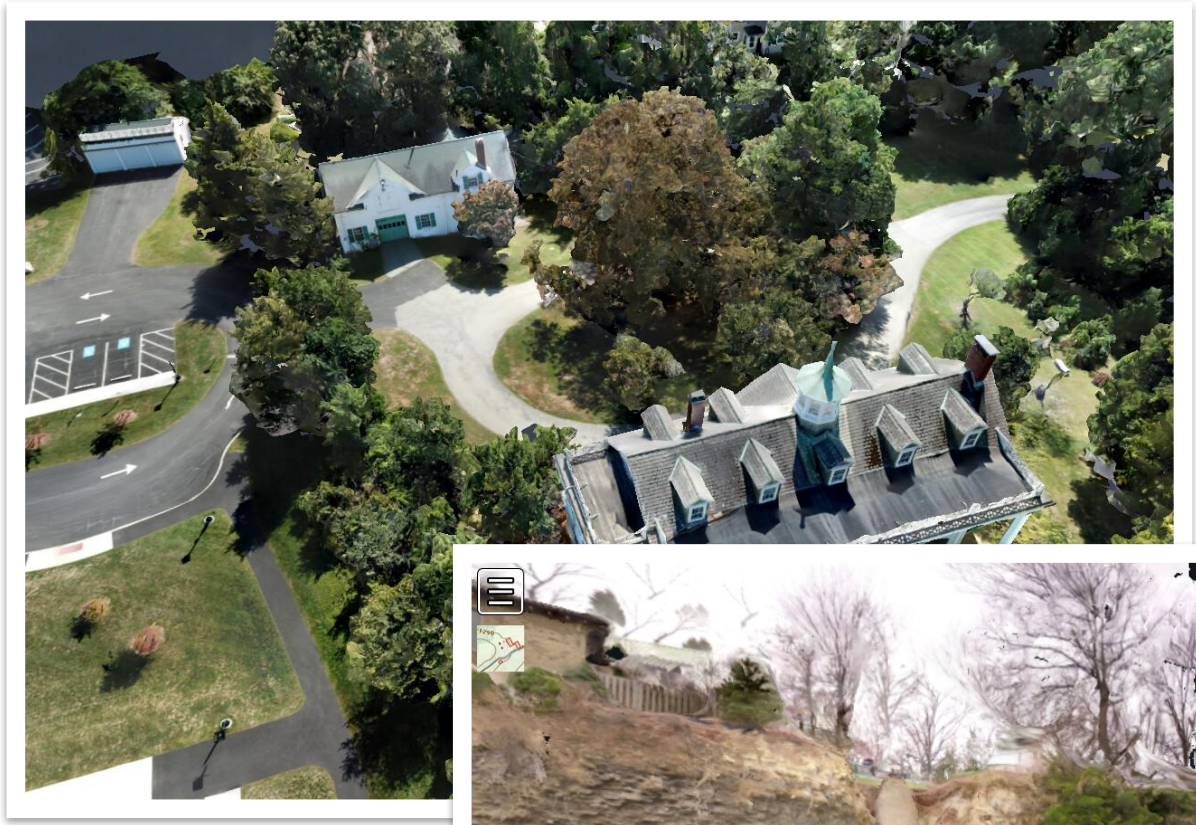


Photo Credit: Joseph Fazioli

3D Outputs

Textured 3D Model (.obj)

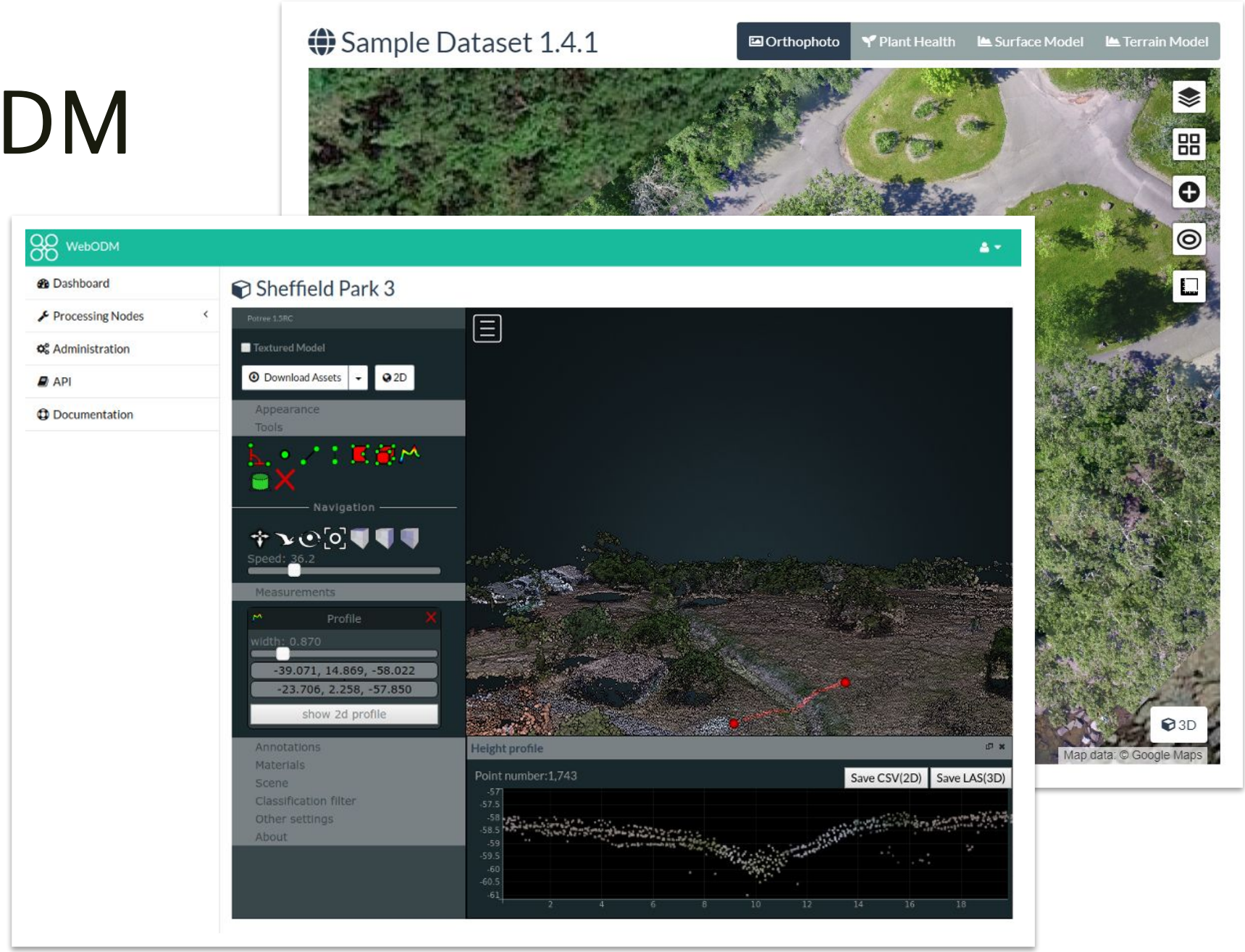


- Sketchfab, et al for sharing
- CAD, Blender
- 3D print

Photo Credit: Jamie Portolese, Corey Snipes

Within ODM

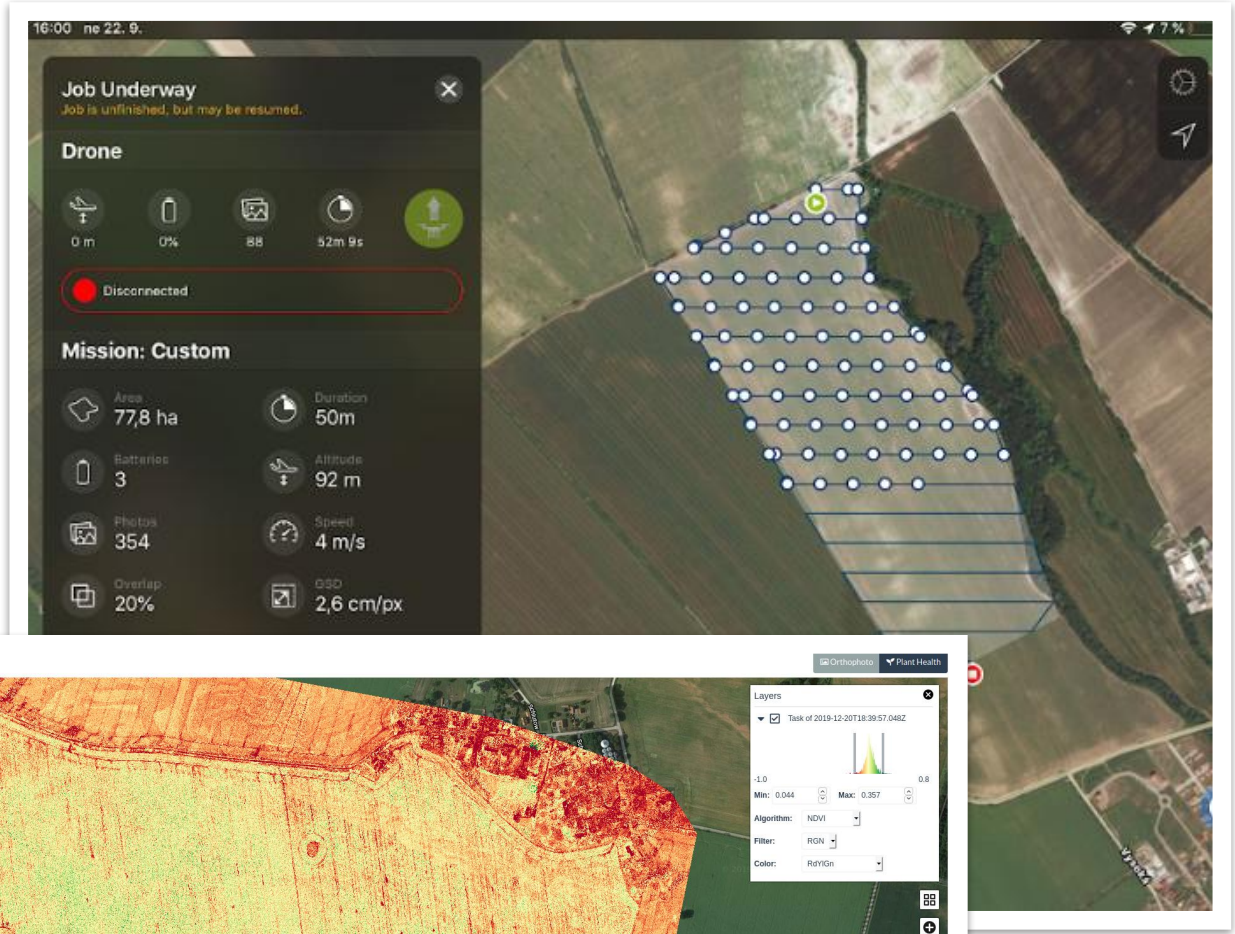
- Measurement
- Analysis



USE CASES

Agriculture

- Drone with multispectral camera
- Capture biweekly images of a large field
- Use ODM plant health algorithms
- Visually monitor crop health
- Highlight areas of plant stress, for focused attention



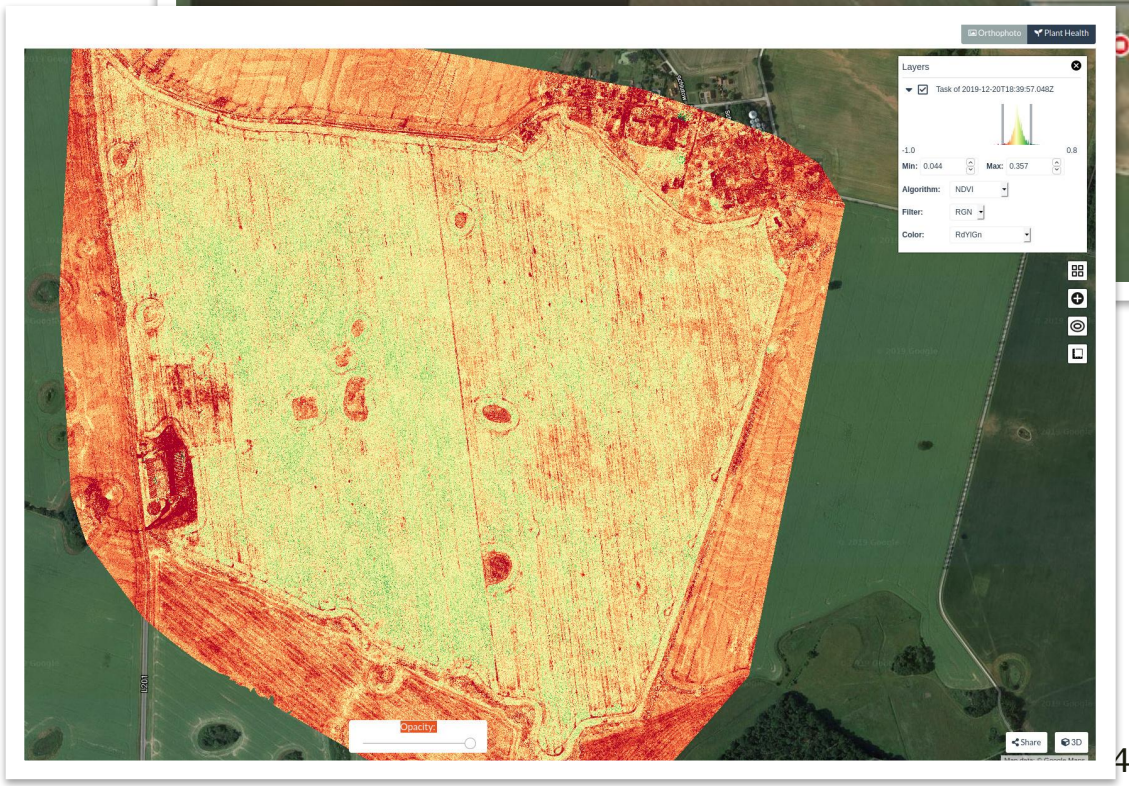


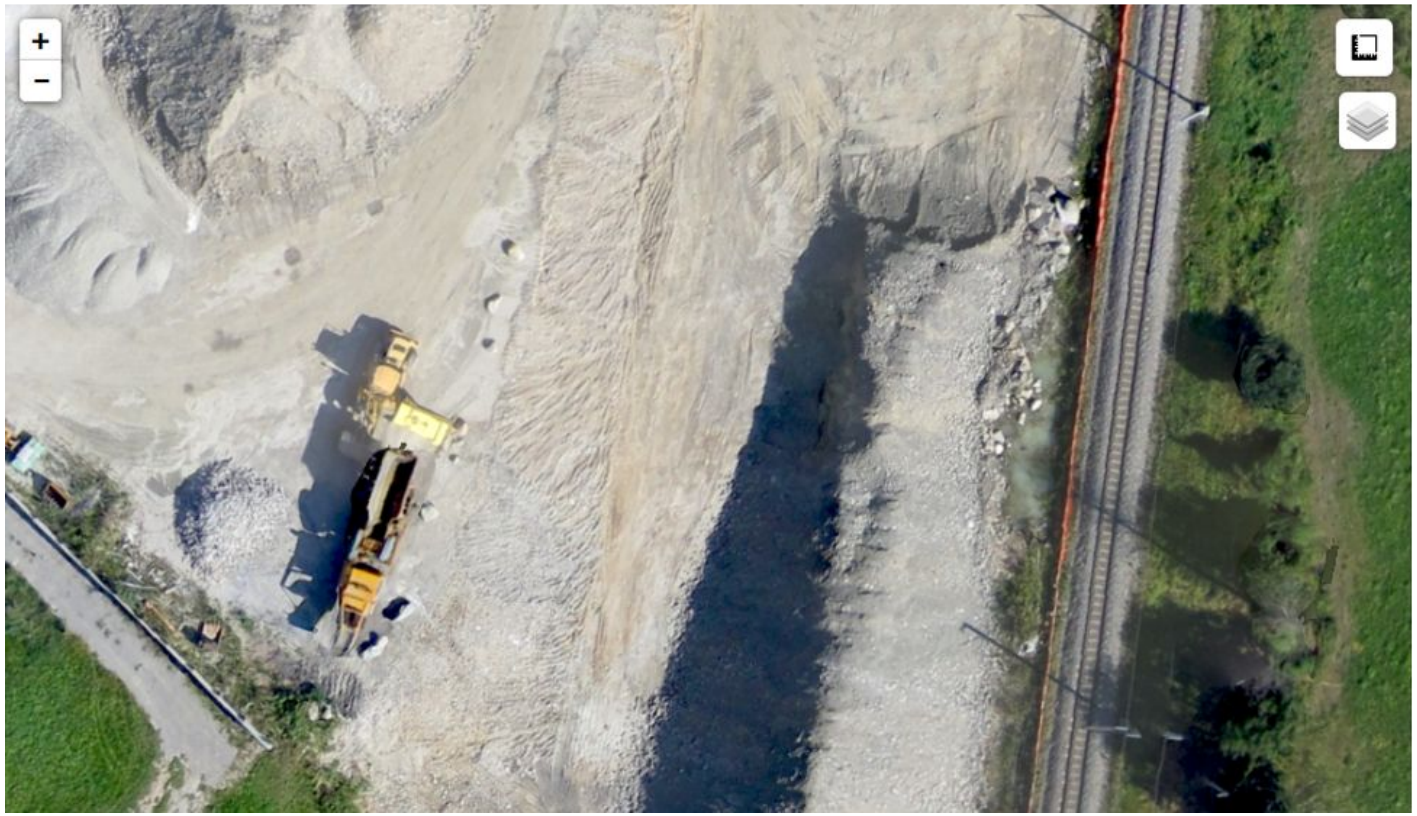
Image: community.opendronemap.org

Emergency Management

- Drone with standard camera
- Quickly map a tornado zone
- Use ODM to identify and quantify damage areas
- Prioritize resources, work
- Estimate re-planting costs/effort
- Repeat flights to monitor progress

Image: opendronemap.org

Construction



- Drone with a standard (RGB) camera
- Capture weekly images of construction site
- Use ODM to generate orthophoto, 3D model
- Use ODM linear, area, and volume measurements
- Monitor as-built progress against plans
- Visual updates for project stakeholders

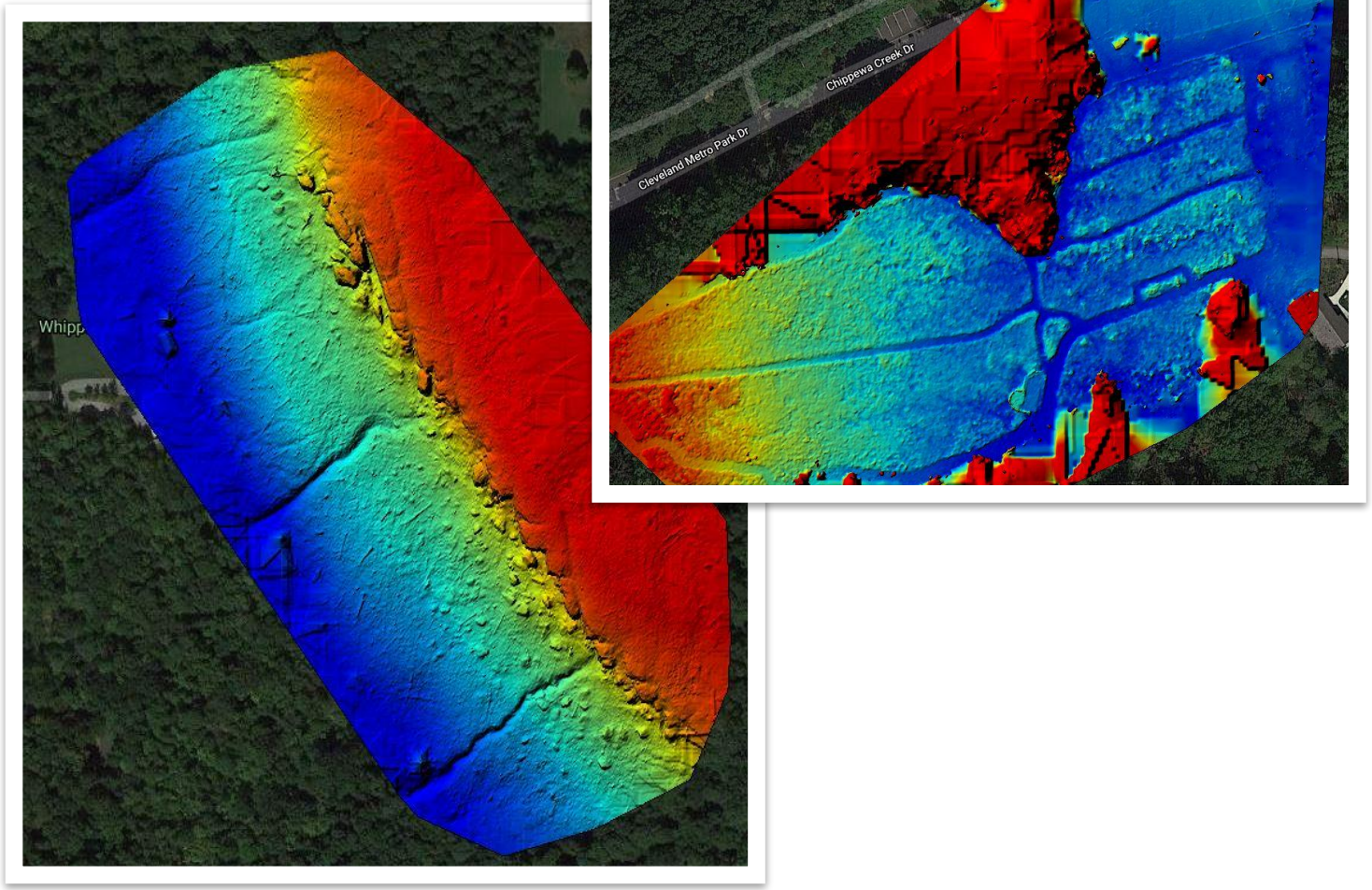
Image: Stephen Mather

Ecological Assessment

- Drone with RGB and NIR camera
- Use ODM plant health algorithms and orthophoto
- Identify areas of plant stress
- Measure riparian area size
- Repeat flights and processing to evaluate restoration efforts

Erosion and Elevation Assessments

- Drone with standard camera
- Use ODM to generate DSM and DTM, respectively
- Repeat flight and processing to monitor erosion over time
- Export DEM for climbing maps

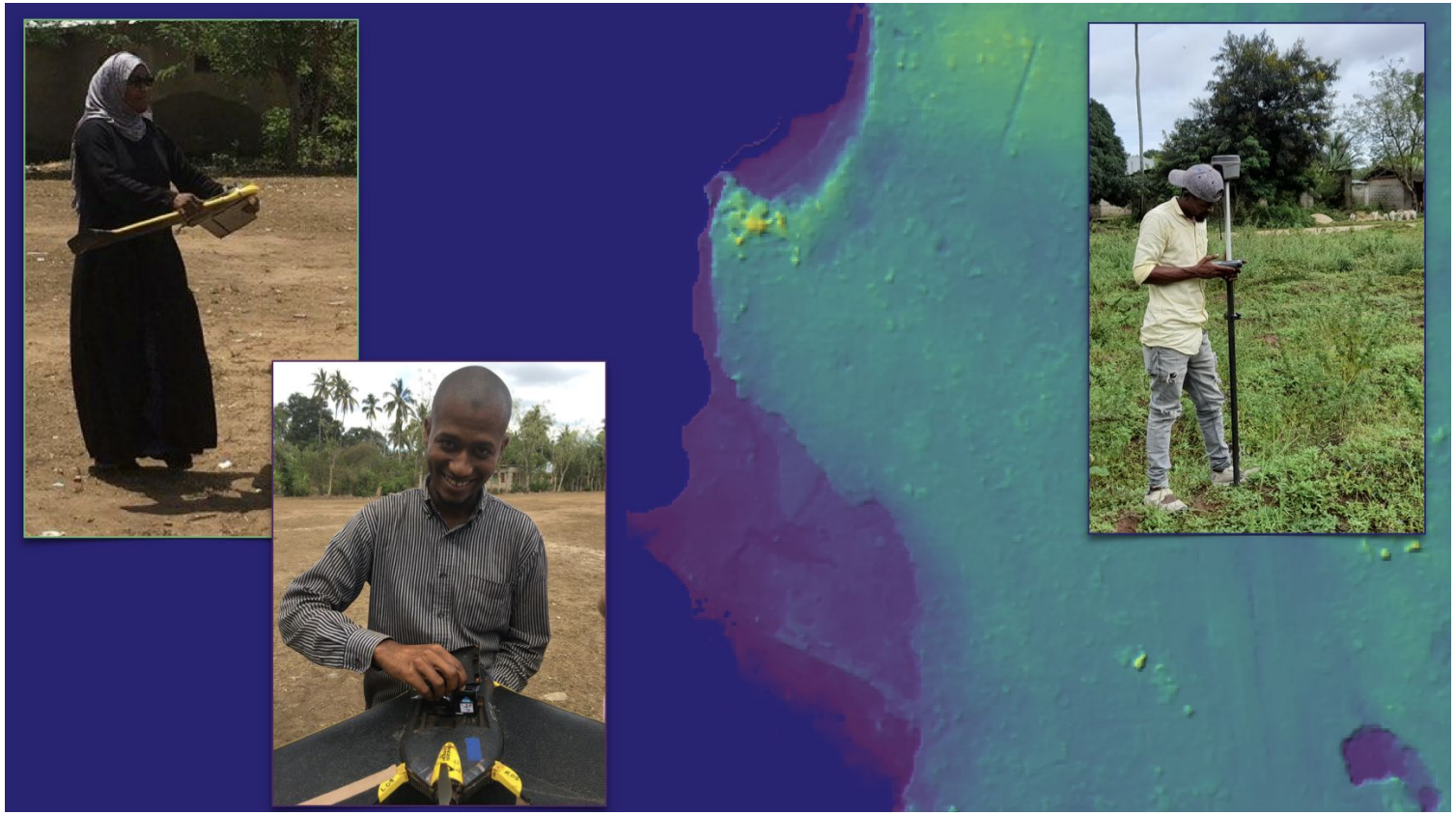


Coastal Monitoring

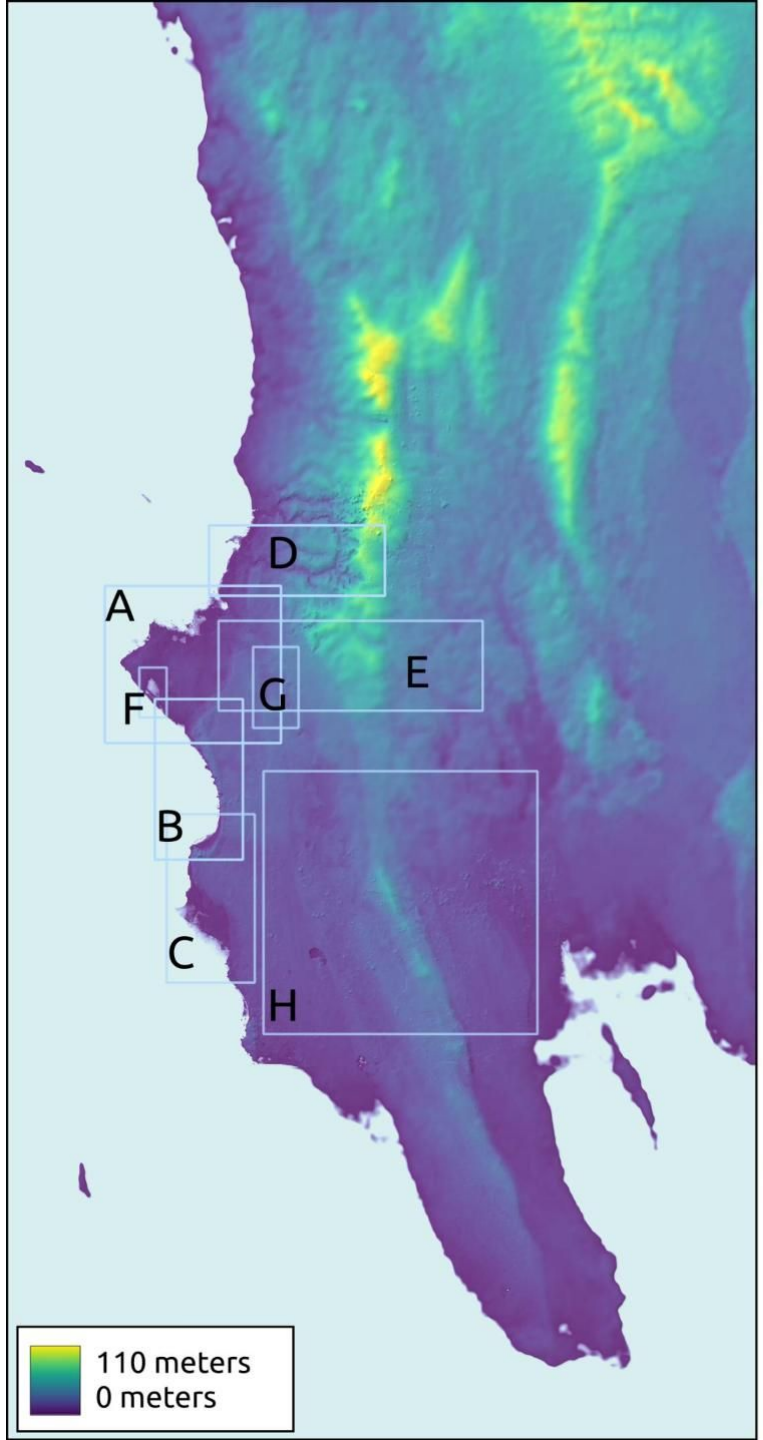
- Drone with standard camera
- Capture photos of a section of coastline
- Use ODM to generate a 3D model
- Repeat every 3 months
- Export 3D models
- Use another tool (e.g., CloudCompare) to assess change over time

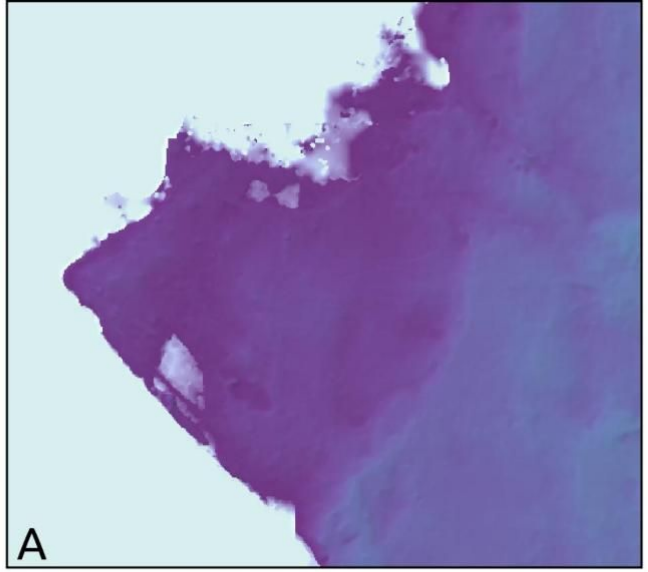
Imagery via Zanzibar Mapping Initiative

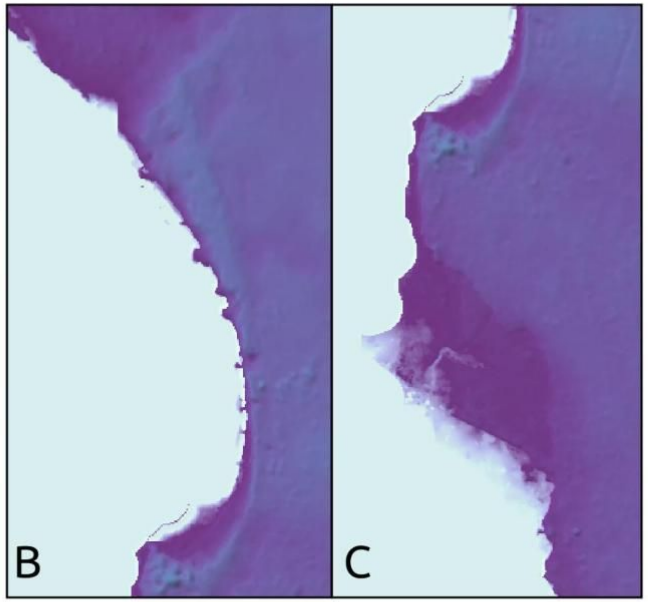
Digital Terrain Models for fluvial, pluvial, and coastal modeling – Zanzibar Mapping initiative

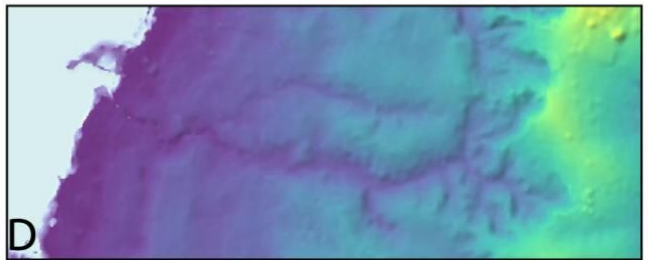


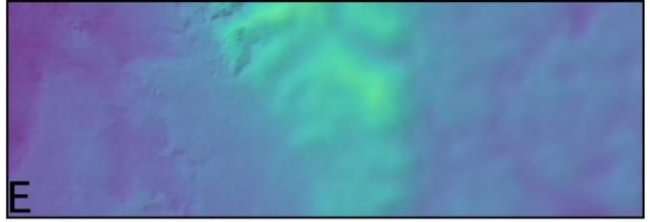
Imagery via Zanzibar Mapping Initiative

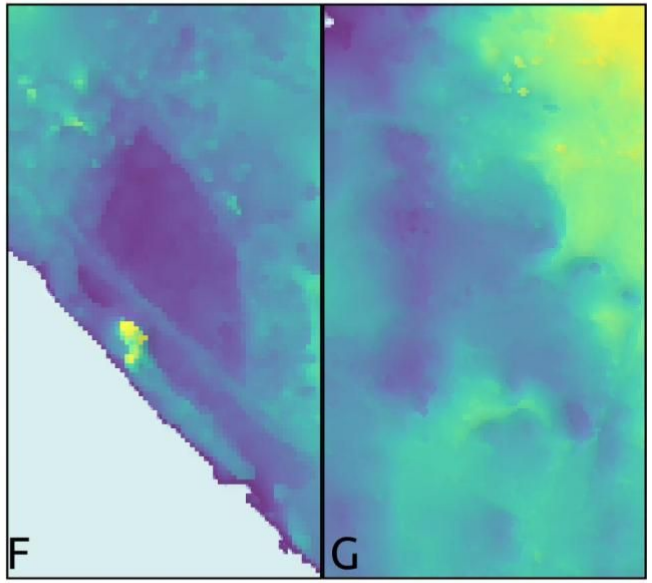


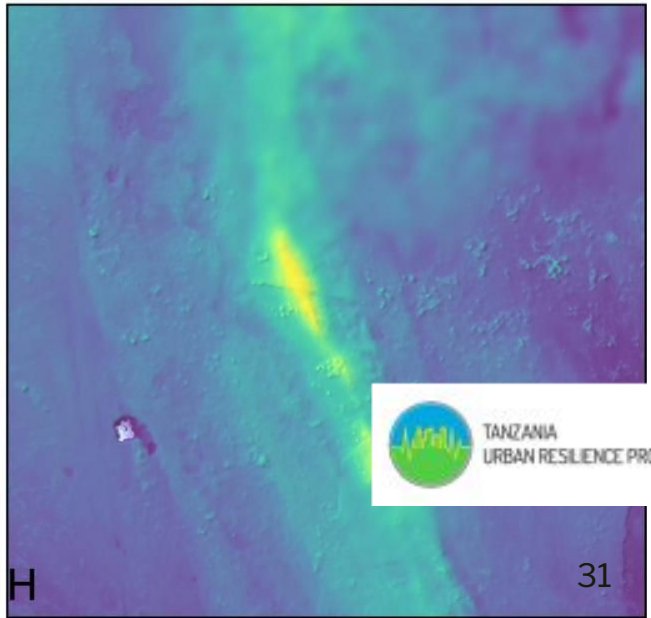




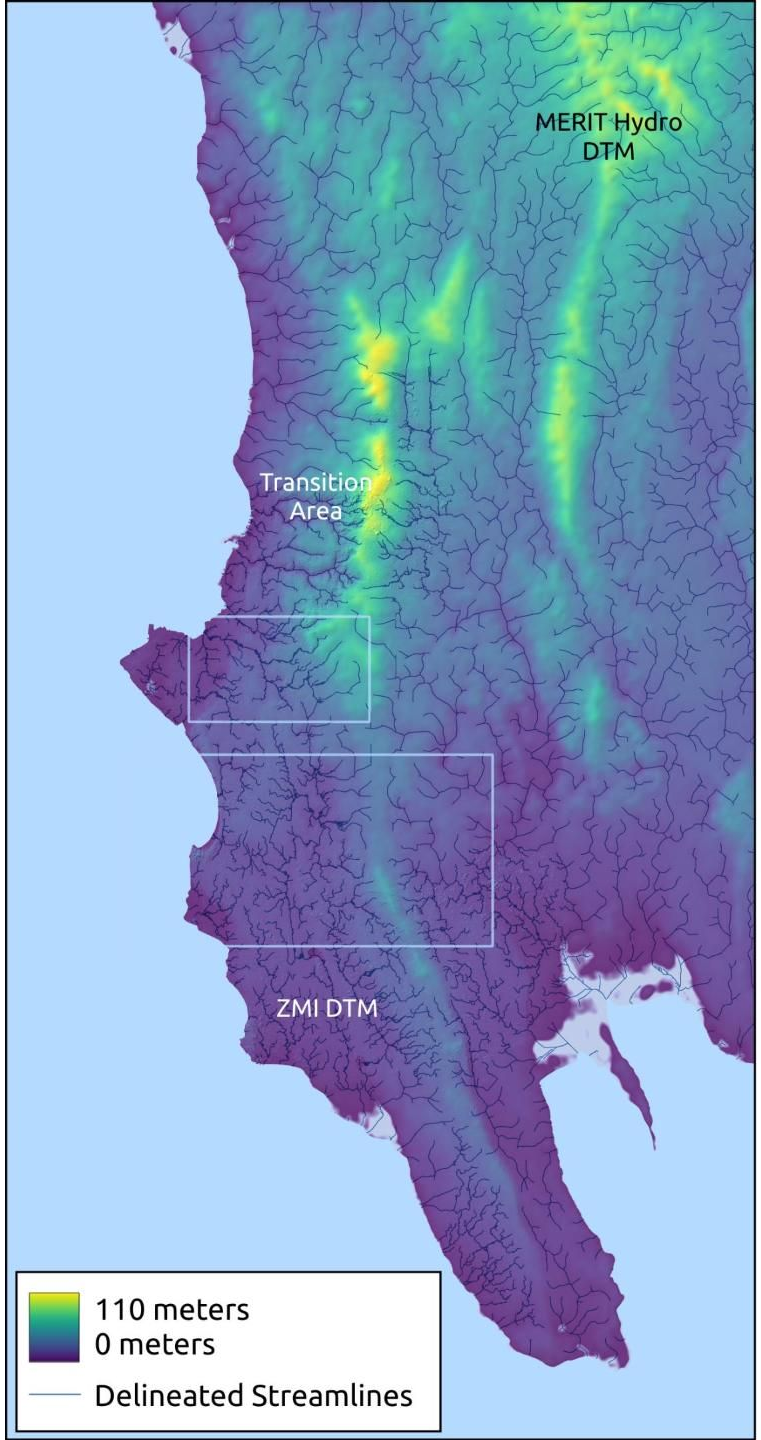


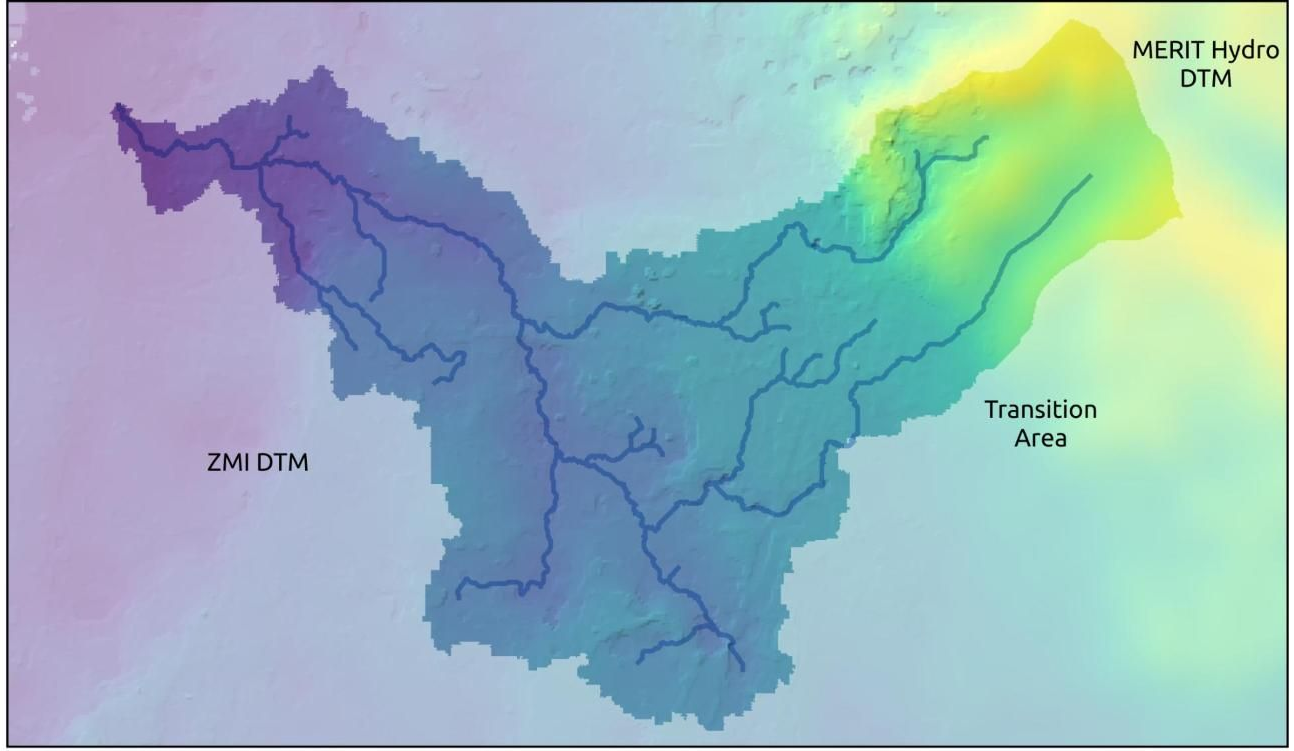


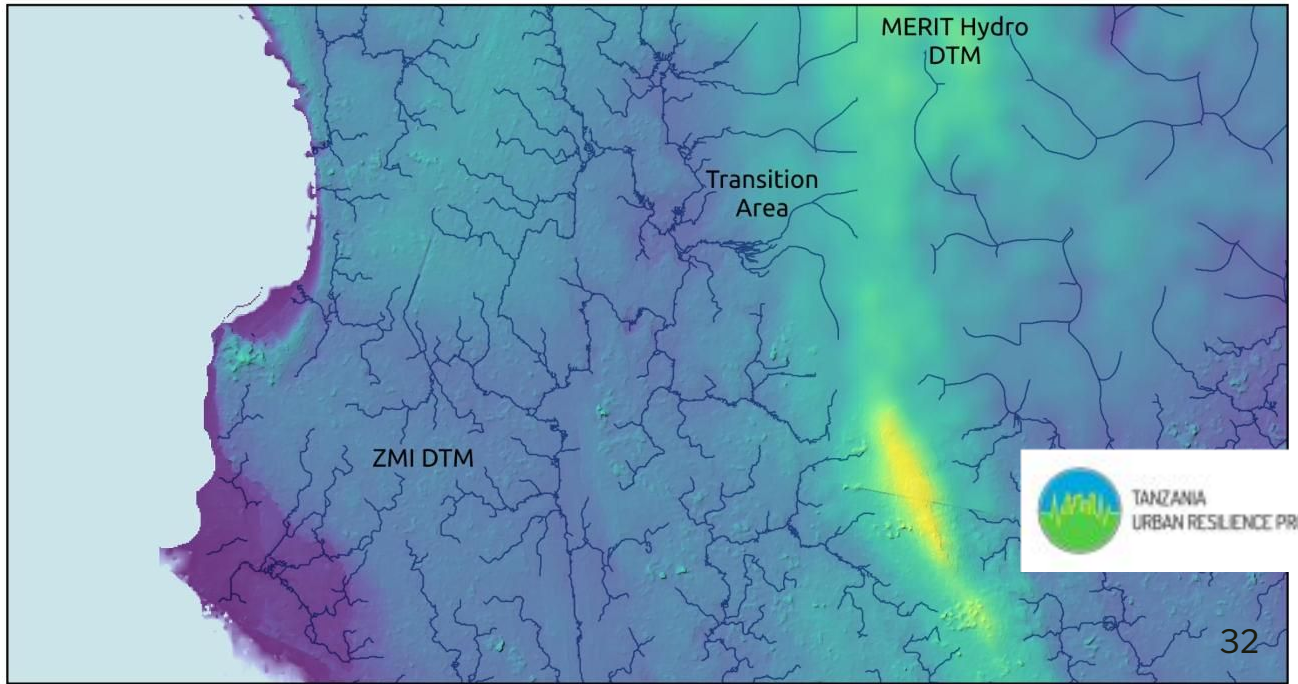




TANZANIA
URBAN RESILIENCE PROGRAMME

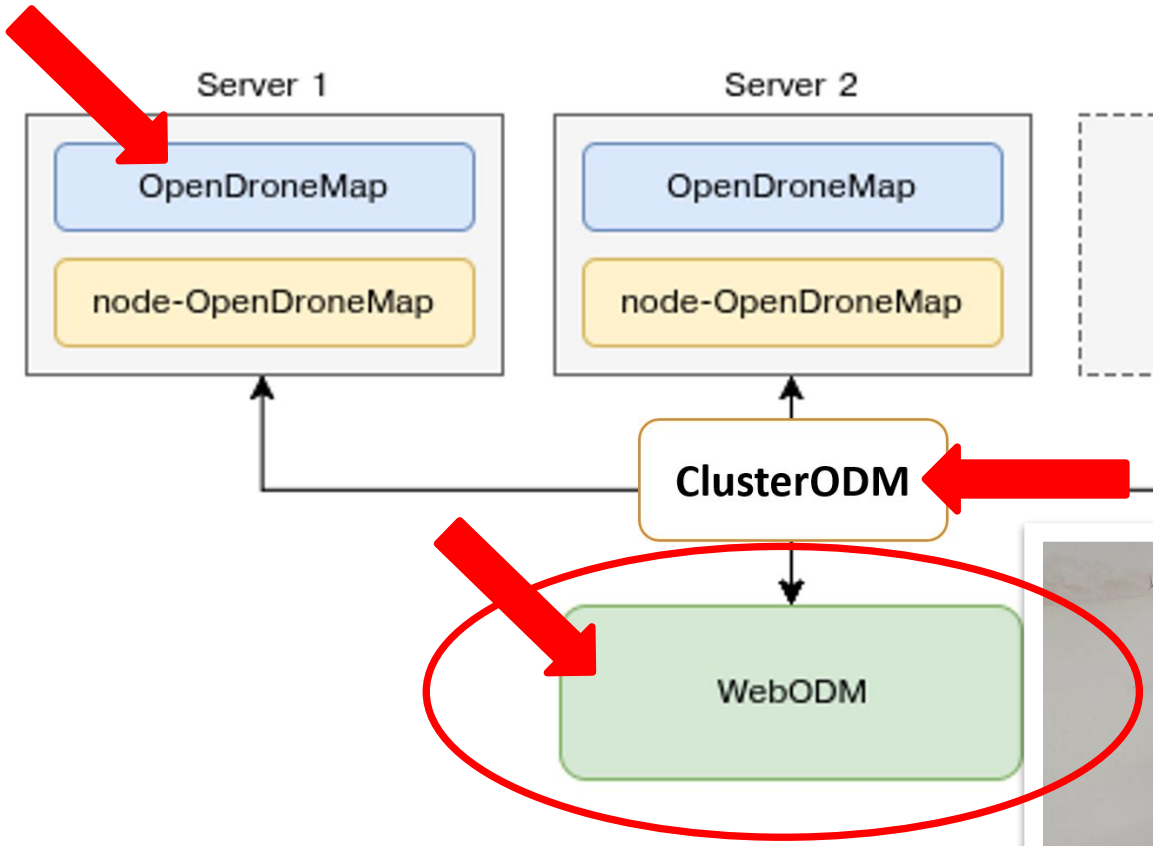

MERIT Hydro
DTM
Transition
Area
ZMI DTM
110 meters
0 meters
Delineated Streamlines

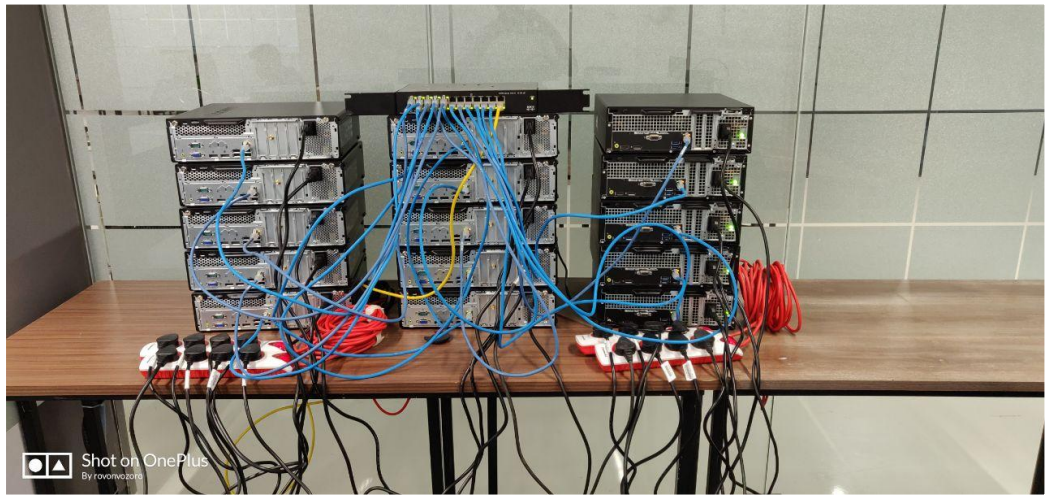

MERIT Hydro
DTM
Transition
Area
ZMI DTM


MERIT Hydro
DTM
Transition
Area
ZMI DTM

GETTING STARTED

Architecture

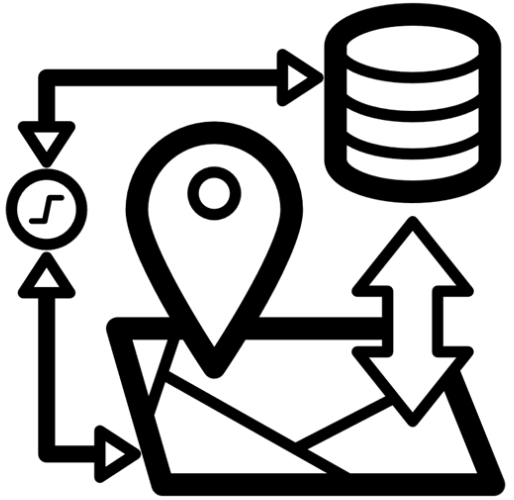




70,000 – 90,000 images

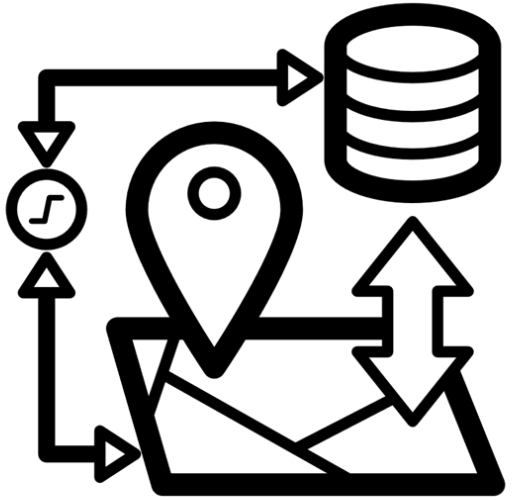
Photo Credit: International Center for Free and Open Source Software, Kerala, India

Supported Systems



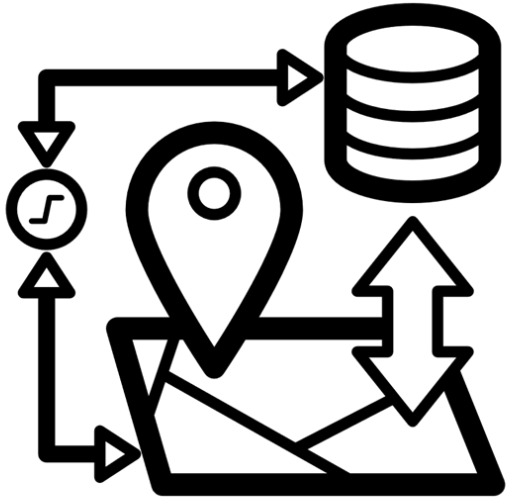
- Windows 10 (native, or Docker)
- Ubuntu Linux (native, or Docker)
- MacOS

System Requirements



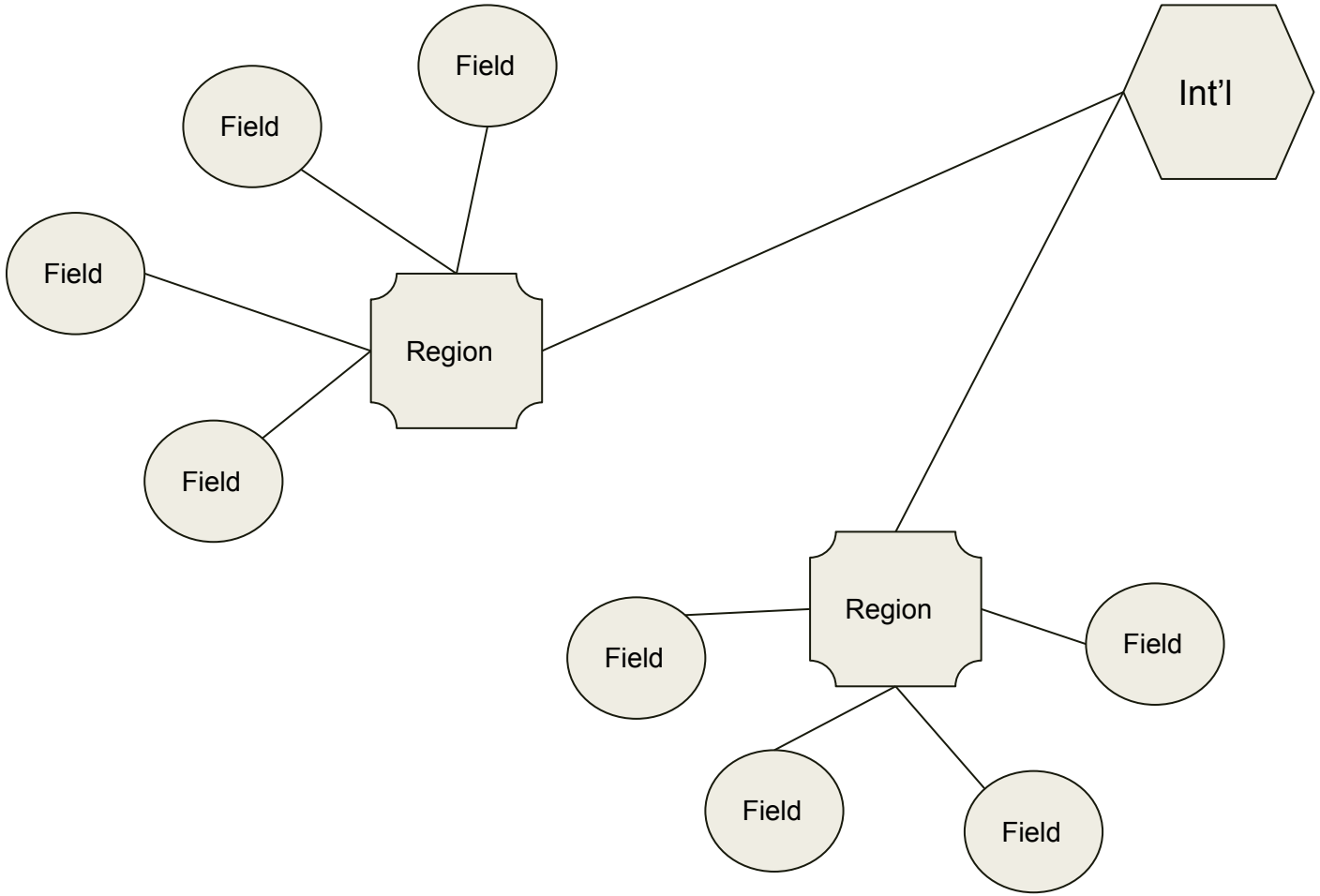
- Microsoft Windows or Linux preferred
- Minimum 16 GB RAM
  - *64+ GB preferred*
- Minimum 50 GB HDD
  - *250+ GB preferred*

Your First Dataset



- Start small (~50 photos)
- Use default settings
- Then:
  - *Increase # photos (250, 1000, 5000)*
  - *Refine configuration*

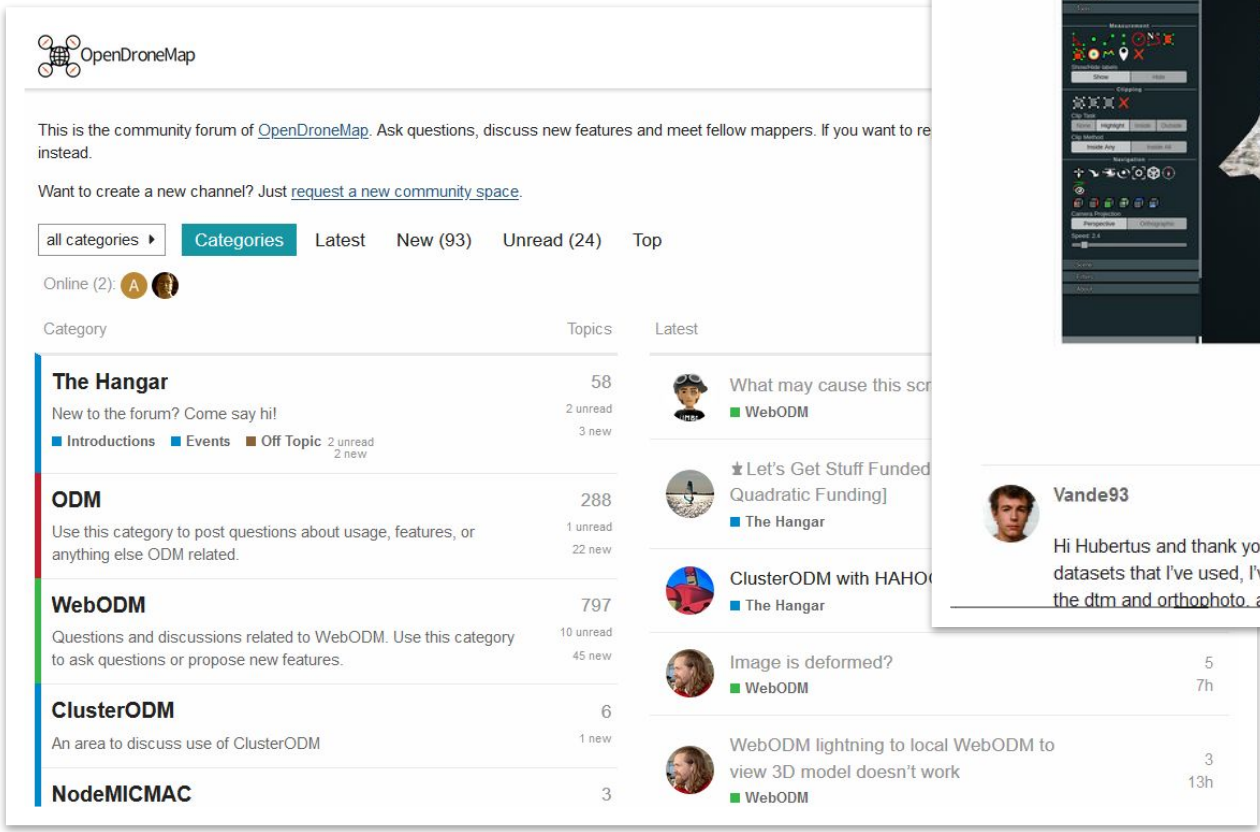
Regional Distribution

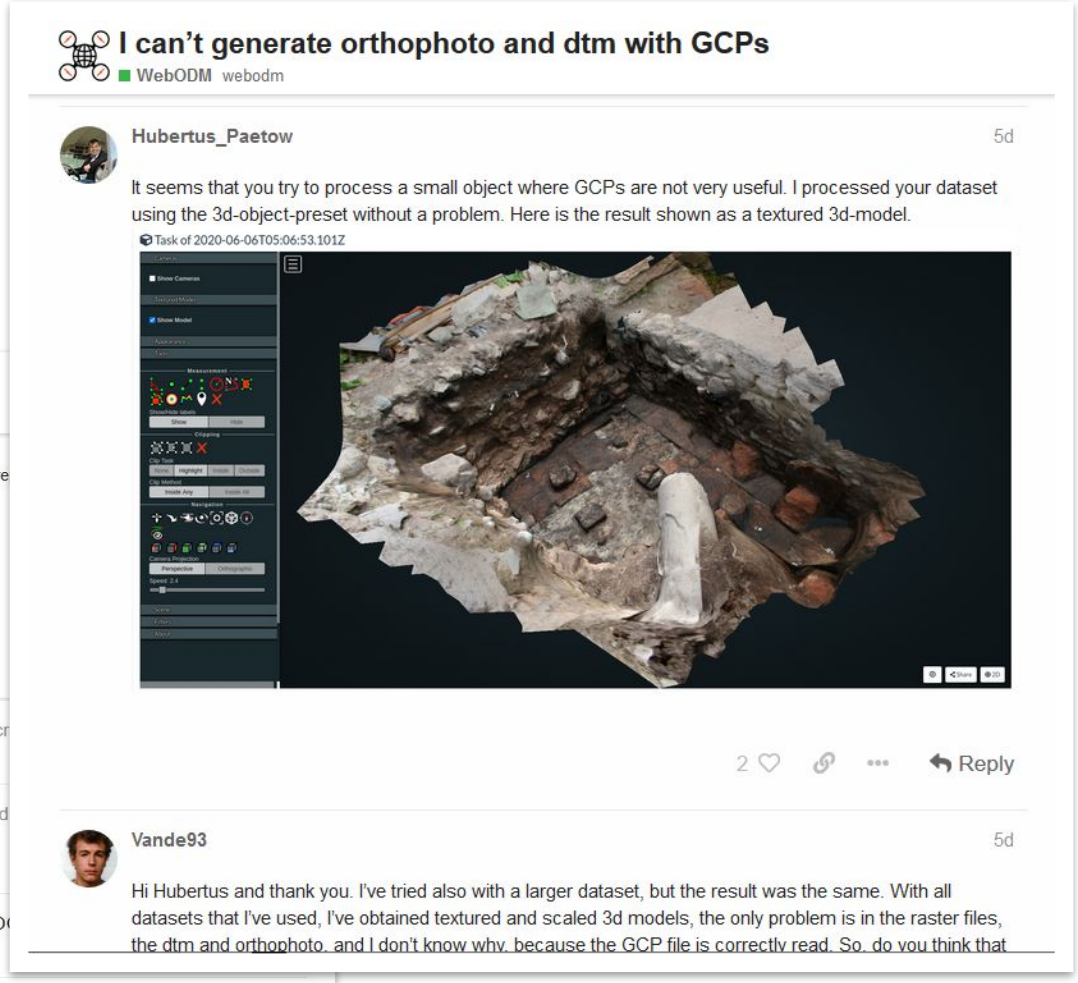


LEARNING MORE

Community Forum

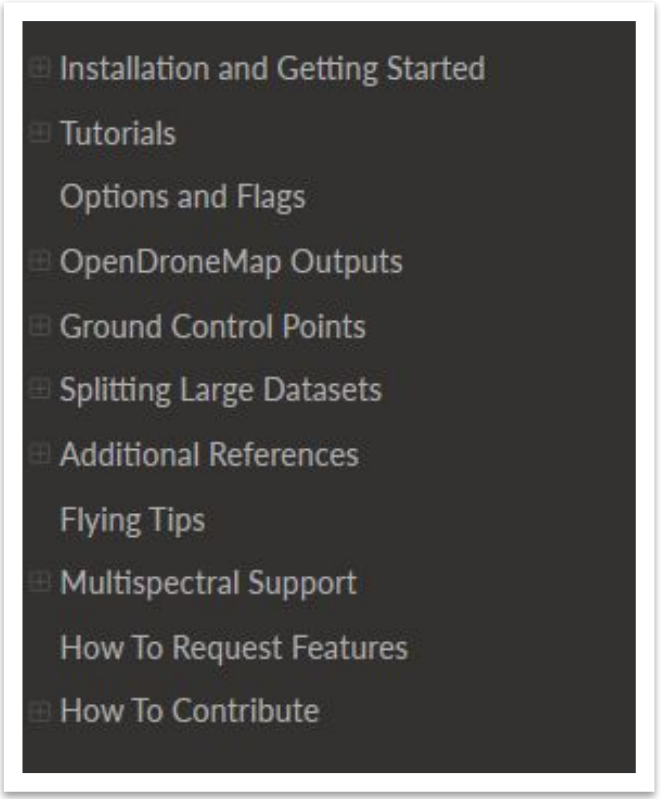
https://community.opendronemap.org





ODM Docs

https://docs.opendronemap.org



ODM Book

https://odmbook.com
$30

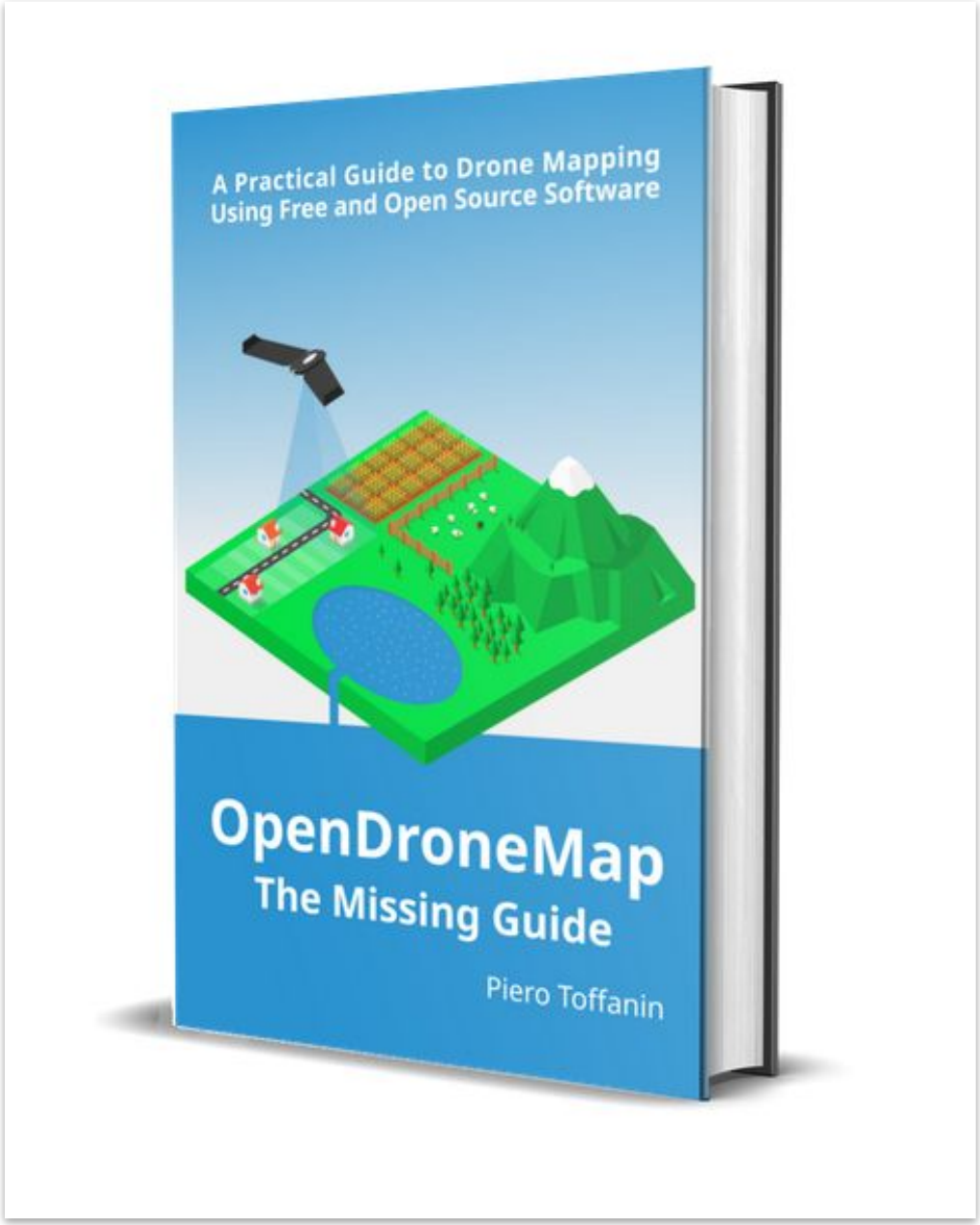
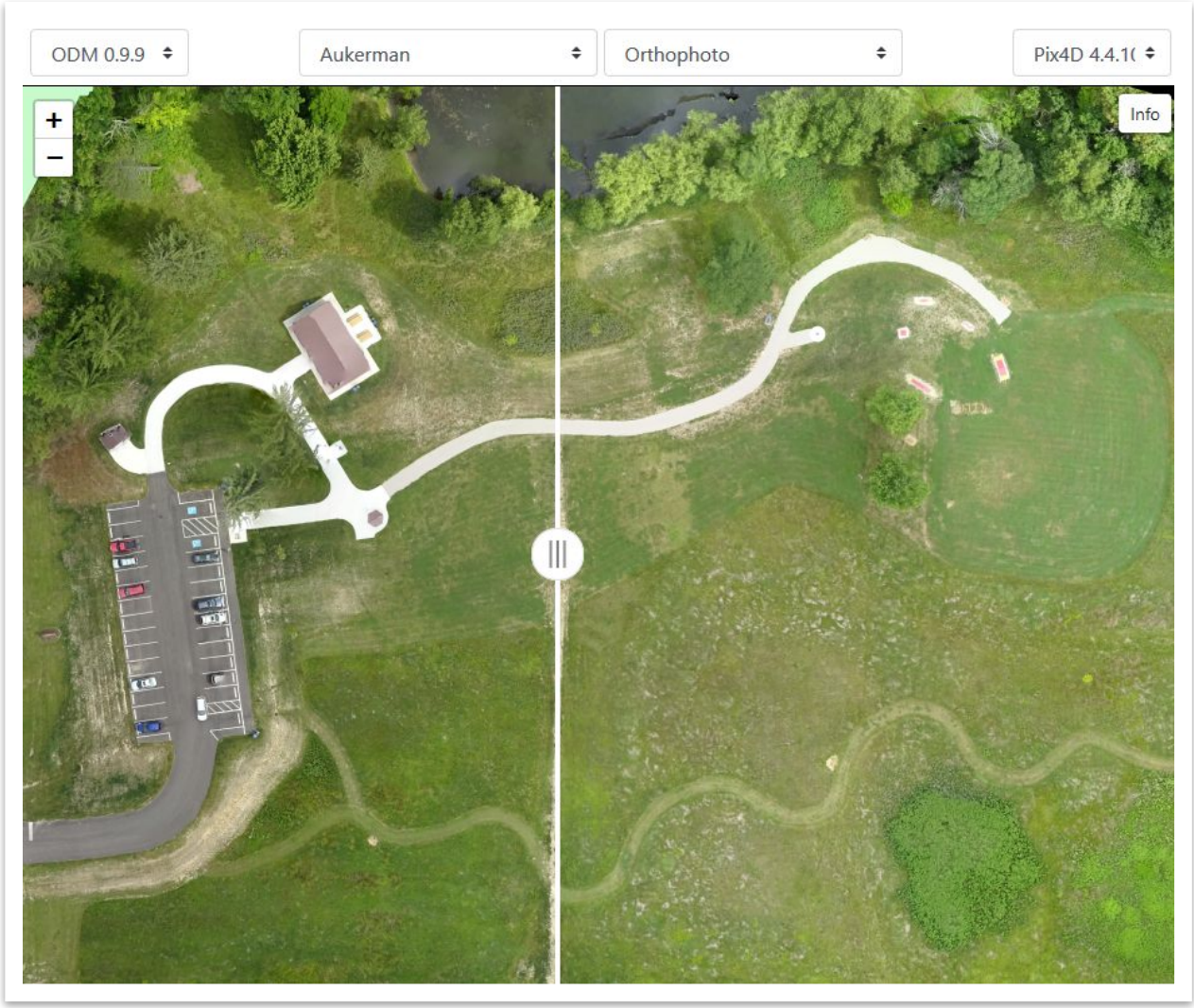


Image: odmbook.com

UAV Arena



- Compare Outputs
  - *ODM*
  - *Pix4D*
  - *DroneDeploy*
  - *Agisoft Metashape*
  - *DroneMapper*
- https://opendronemap.github.io/UAVArena/

Sharing and Training

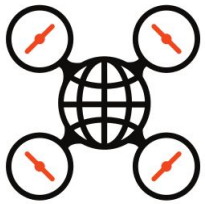
- IFRC Special Interest Group
- In-Depth Training and Workshops

GETTING INVOLVED

Ways to Get Involved

- Community - https://community.opendronemap.org
- Share Data
- Share Code

Questions?



OpenDroneMap
https://opendronemap.org

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Presentation Credits

This presentation builds upon previous work by Piero Toffanin (UAV4GEO), Dakota Benjamin (Cleveland Metroparks), India Johnson (Cleveland Metroparks) and the presenters.

Screenshots and interface images by the presenters unless otherwise noted.

Some icons sourced from thenounproject.com

https://community.opendronemap.org