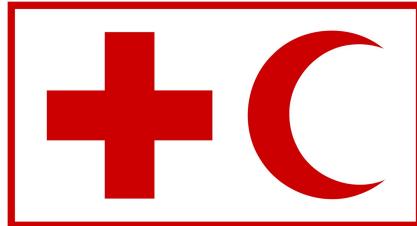


Open-Source Photogrammetry With **OpenDroneMap**

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

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



Animation via webodm.net

OpenDroneMap Goals

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



OpenDroneMap Funding

Sponsored by 



- 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:

Used By



And 19,949 other awesome people like you!

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



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

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

CAPABILITIES



Dashboard

The screenshot shows the OpenDroneMap dashboard interface. On the left, a sidebar lists navigation items: Dashboard, Lightning Network, Diagnostic, GCP Interface, Processing Nodes, Administration, and About. The main area displays two projects: 'Rockcliff' and 'Cuyahoga W 3rd'. The 'Cuyahoga W 3rd' project is currently selected, showing its task list. A specific task, '12/13 model 2 - high res - resize 2048', is highlighted with a red arrow pointing to its details. This task was created on 1/13/2021 at 9:53:15 PM, processed by node-odm-1 (auto), and has options: ignore-gsd: true, dsm: true, depthmap-resolution: 1000, dem-resolution: 2.0, orthophoto-resolution: 2.0. It has a file count of 124, a duration of 02:03:54, and a status of 'Completed' (indicated by a green bar). Below this task, there are three other completed tasks: '12/13 model 2 - 3D model - no resize', '12/13 model 2 - high res - no resize', and '12/13 model 1 - high res - no resize'. At the bottom of the task list are buttons for 'Download Assets', 'View Map', 'View 3D Model', 'Restart', 'Delete', and 'Edit'. Red arrows also point to the 'Edit' button and the 'Download Assets' button.

OpenDroneMap - Twomile Heavy Industries, Inc.

Dashboard Add Project

Lightning Network 1 2

Diagnostic Select Images and GCP Import View Map

GCP Interface

Processing Nodes

Administration

About

Rockcliff
3 Tasks ▾ Edit

Cuyahoga W 3rd
6 Tasks ▾ Edit

12/13 model 2 - high res - resize 2048
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

124 02:03:54 Completed

Task Output: On Off

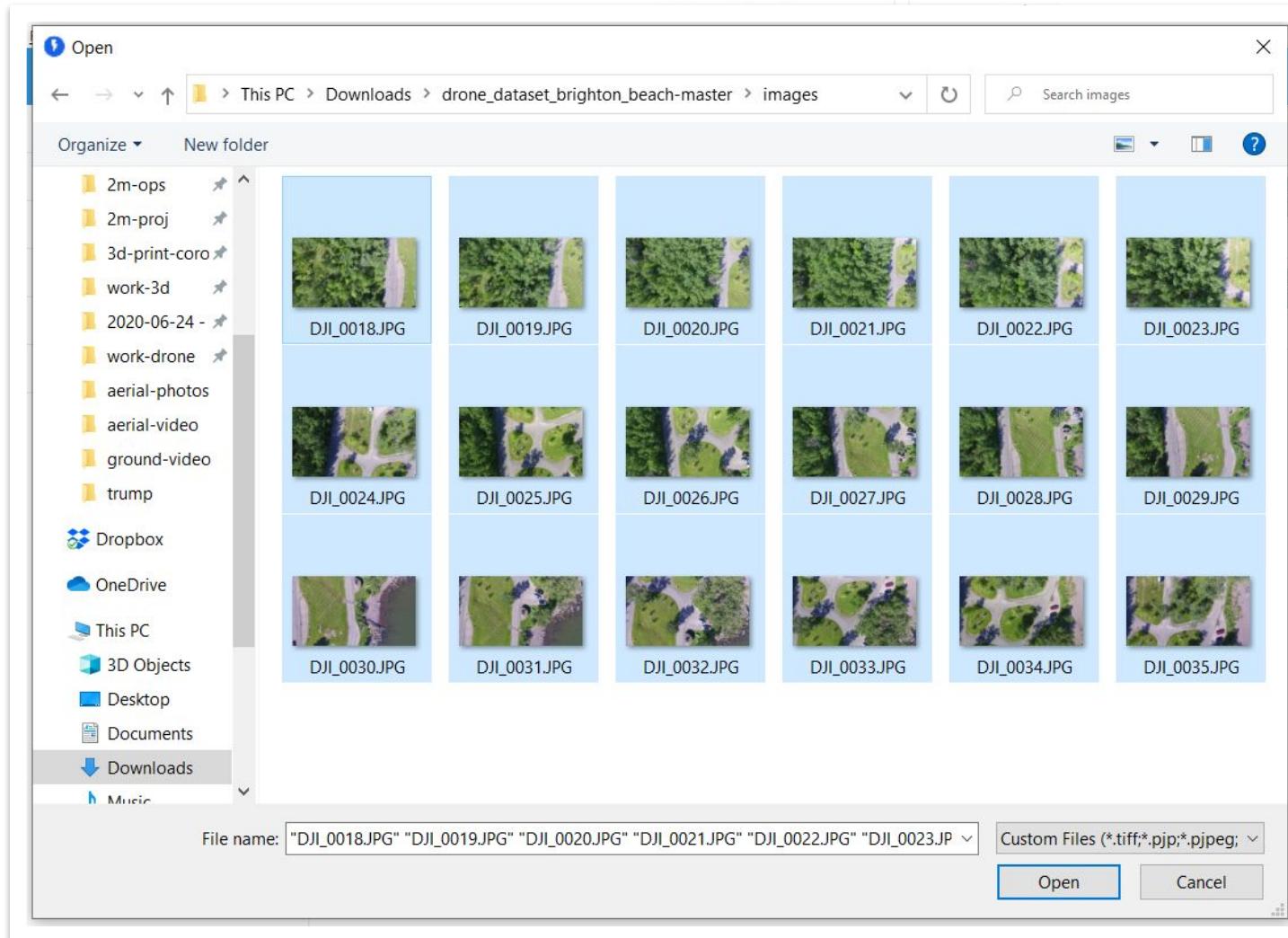
Download Assets View Map View 3D Model Restart Delete Edit

12/13 model 2 - 3D model - no resize 124 01:29:39 Completed

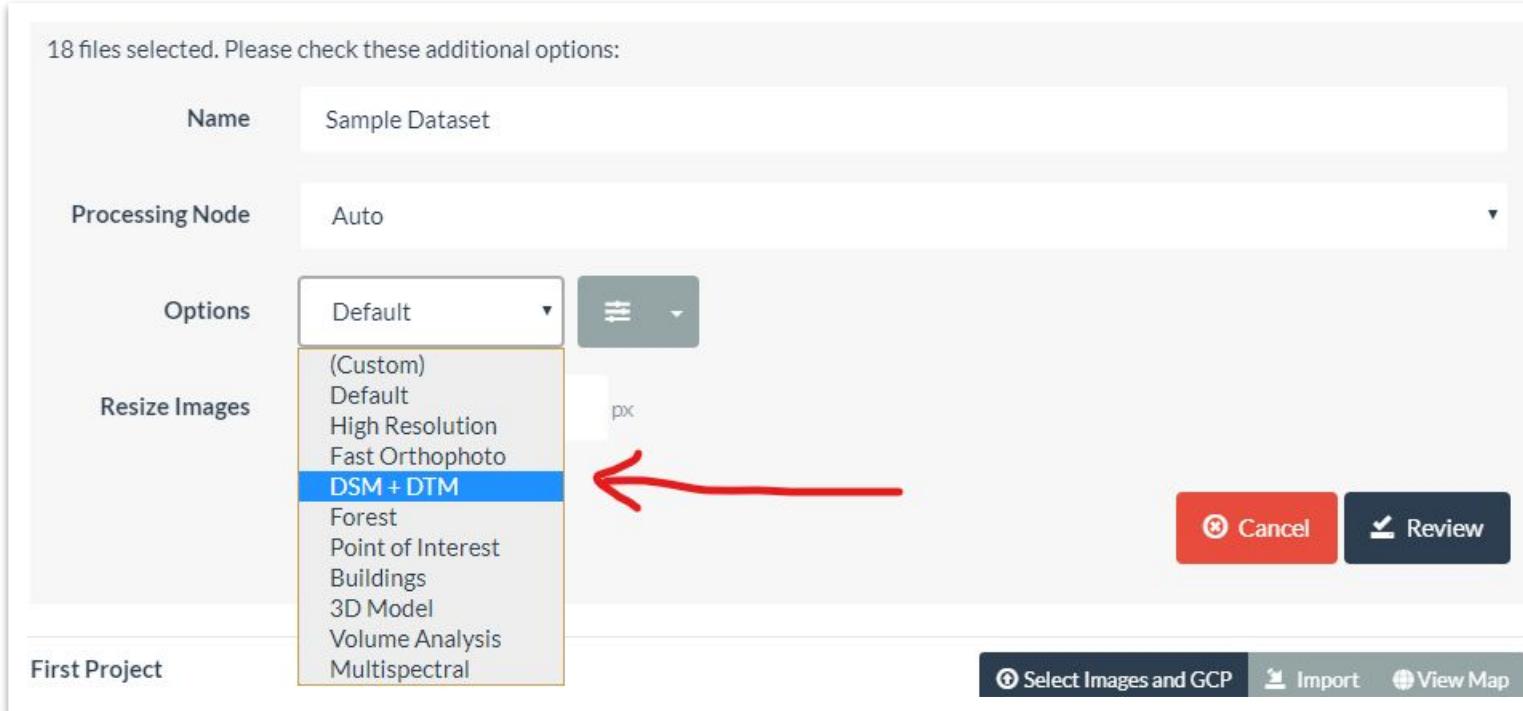
12/13 model 2 - high res - no resize 124 05:36:18 Completed

12/13 model 1 - high res - no resize 139 04:30:13 Completed

Add Images



Set Configuration



Processing

DroneCamp 2020

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

```
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

The screenshot shows the OpenDroneMap web application interface. The left sidebar includes links for Dashboard, Lightning Network, Diagnostic, GCP Interface, Processing Nodes, Administration, and About. The main content area displays three projects: Rockcliff, ODM Benchmarks, and Cuyahoga W 3rd. Each project section has a 'Select Images and GCP' button, an 'Import' button, and a 'View Map' button. The Rockcliff section shows 3 Tasks, with one task listed: "12/13 model 2 - high res - resize 2048". This task was created on 1/13/2021 at 9:53:15 PM, processed by node.odm-1 (auto), and has options: ignore-gsd: true, dsm: true, depthmap-resolution: 2.0, dem-resolution: 2.0, orthophoto-resolution: 2.0. It is marked as Completed with a green bar and a timestamp of 02:03:54. The Cuyahoga W 3rd section shows 6 Tasks, with three listed: "12/13 model 2 - high res - resize 2048", "12/13 model 2 - 3D model - no resize", and "12/13 model 2 - high res - no resize". These tasks are also marked as Completed with green bars and timestamps of 01:29:39, 05:36:18, and 04:30:13 respectively. The bottom navigation bar includes buttons for Download Assets, View Map, View 3D Model, Restart, Delete, and Edit.

Project	Task Description	Created On	Processing Node	Options	Status	Last Update	Task Output
Rockcliff	12/13 model 2 - high res - resize 2048	1/13/2021, 9:53:15 PM	node.odm-1 (auto)	ignore-gsd: true, dsm: true, depthmap-resolution: 2.0, dem-resolution: 2.0, orthophoto-resolution: 2.0	Completed	02:03:54	On
	12/13 model 2 - 3D model - no resize				Completed	01:29:39	On
	12/13 model 2 - high res - no resize				Completed	05:36:18	On
Cuyahoga W 3rd	12/13 model 2 - high res - resize 2048				Completed	04:30:13	On
	12/13 model 1 - high res - no resize				Completed		Off

2D Outputs

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

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

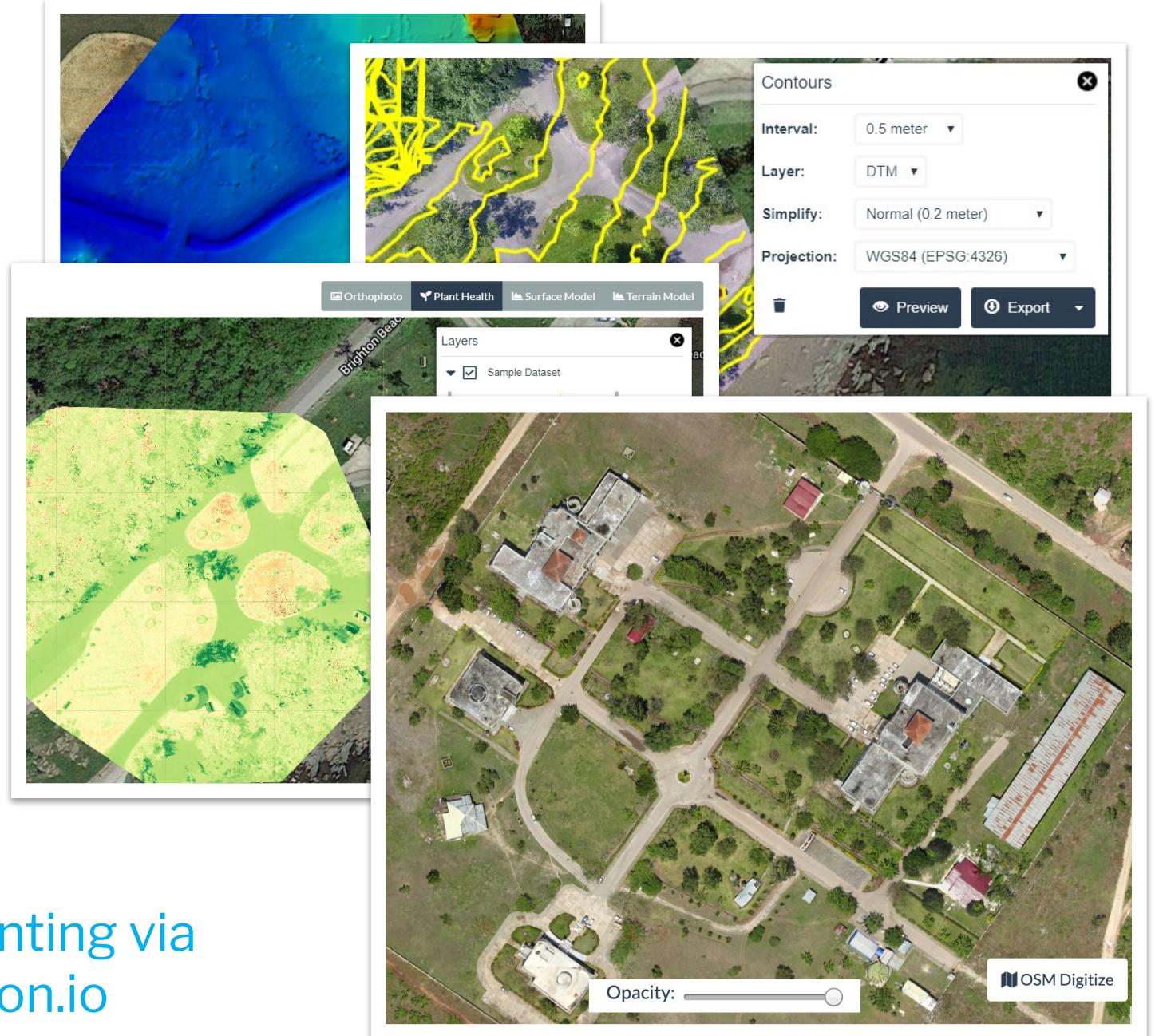


Photo Credit:
opendronemap.org

3D Outputs

Dense Point Cloud
(.las/.laz)

- CloudCompare, etc
for analysis

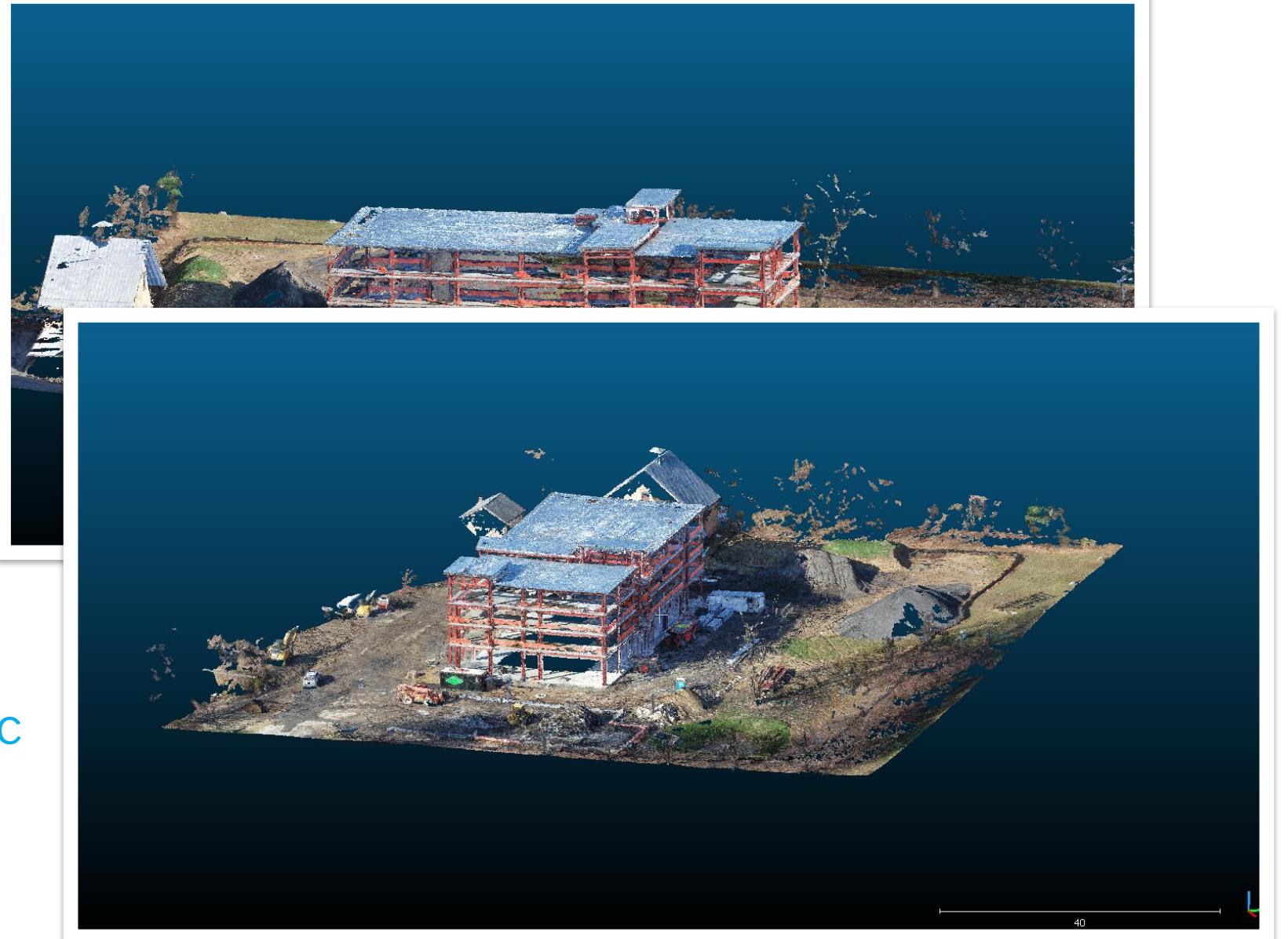
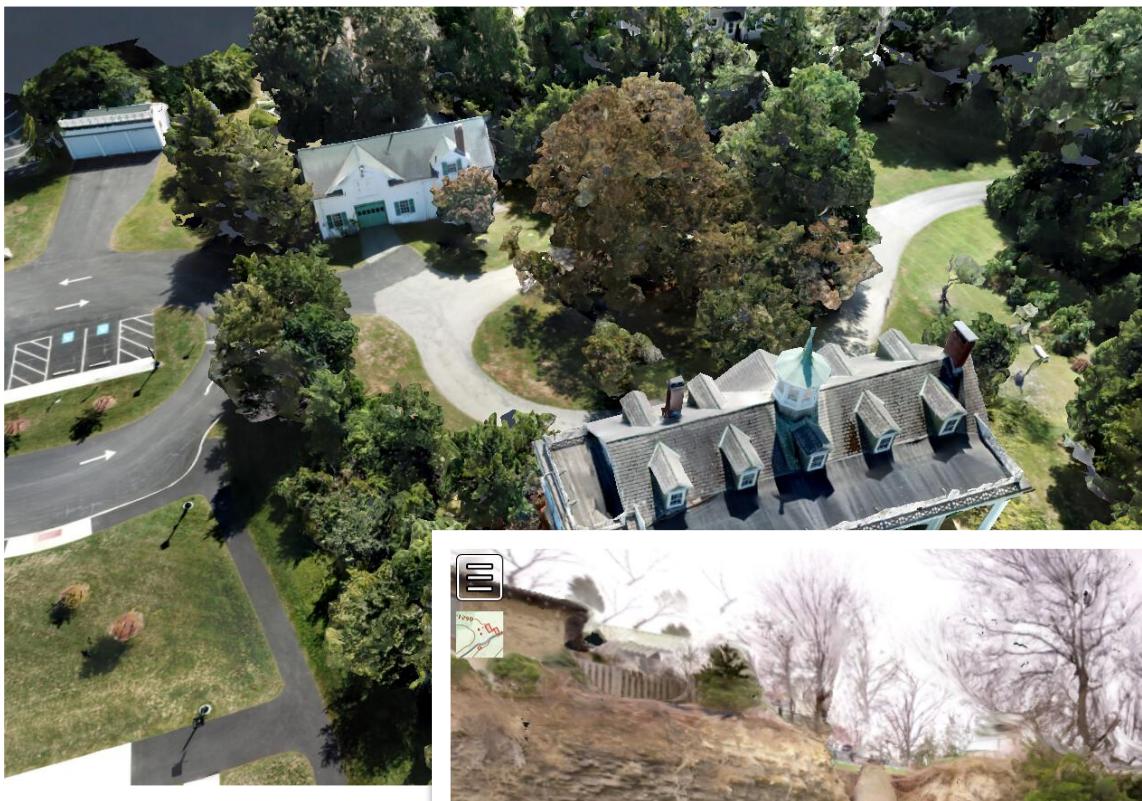


Photo Credit: Joseph
Fazioli

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

Sample Dataset 1.4.1

Orthophoto Plant Health Surface Model Terrain Model

WebODM

Dashboard Processing Nodes Administration API Documentation

Sheffield Park 3

Potree 1.5RC

Textured Model

Download Assets 2D

Appearance Tools

Navigation

Speed: 36.2

Measurements

Profile width: 0.870

-39.071, 14.869, -58.022
-23.706, 2.258, -57.850

Annotations Materials Scene Classification filter Other settings About

Height profile

Point number: 1,743

Save CSV(2D) Save LAS(3D)

Map data: © Google Maps

3D

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

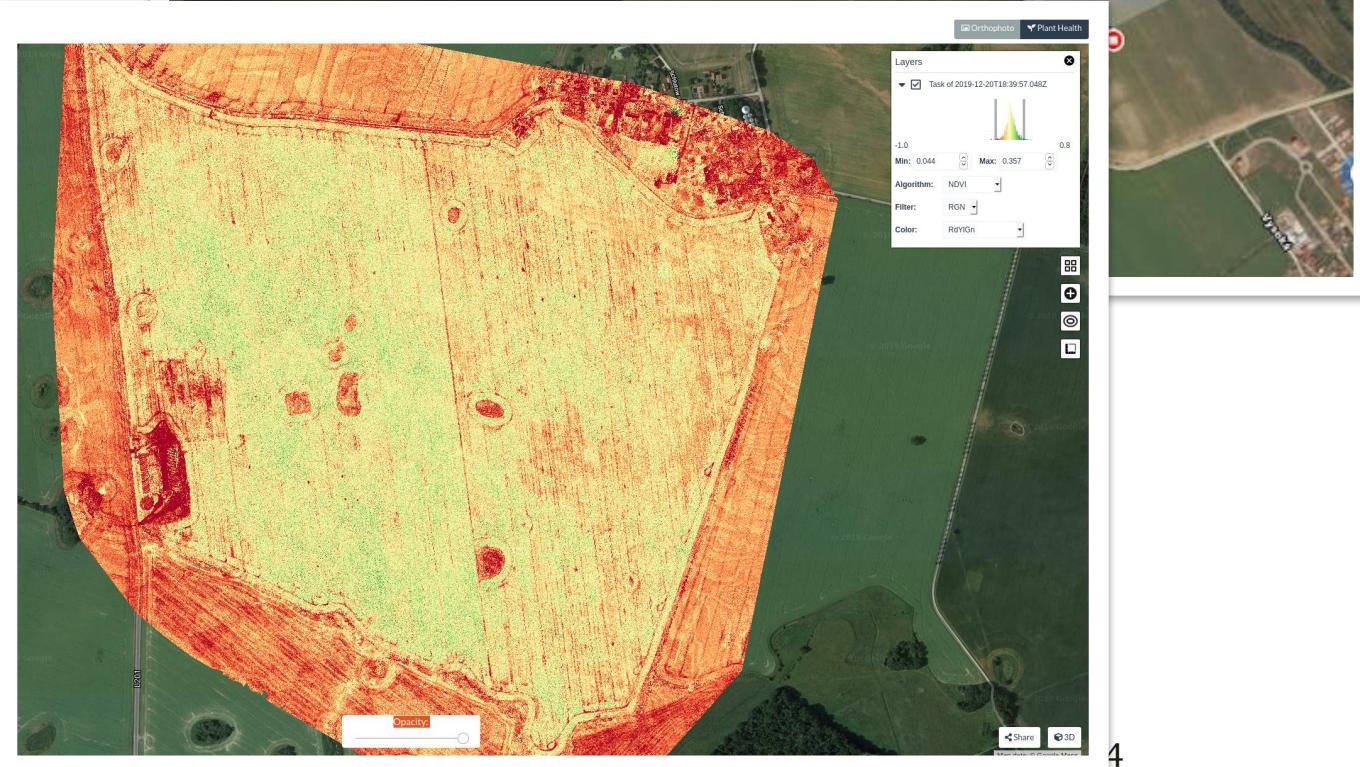
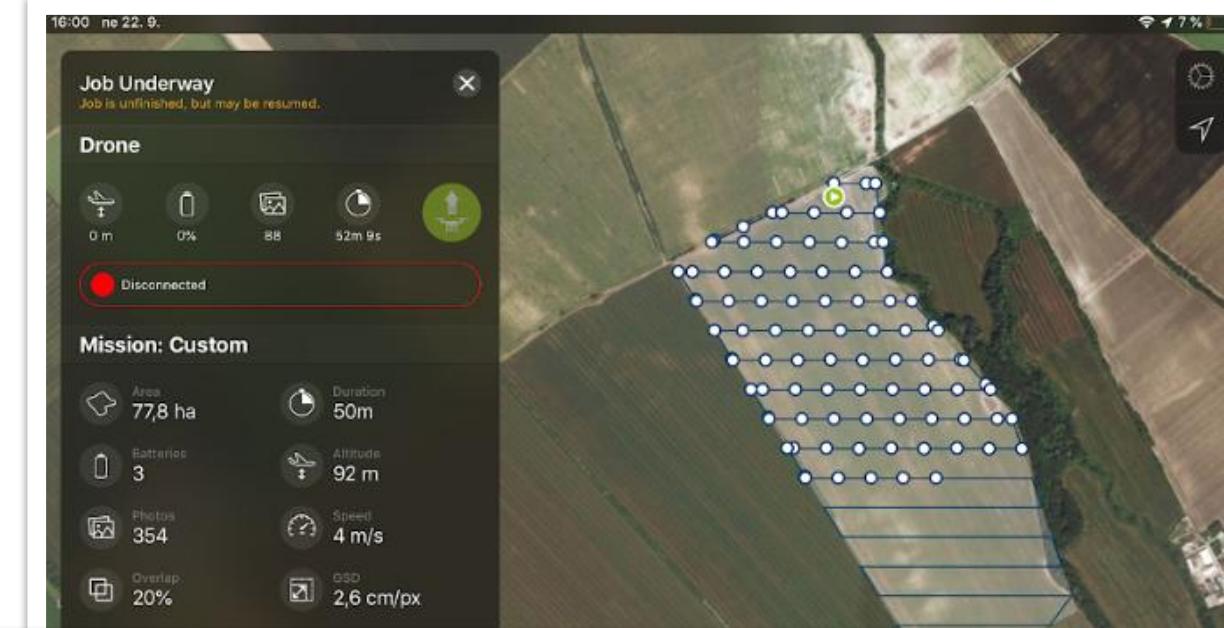
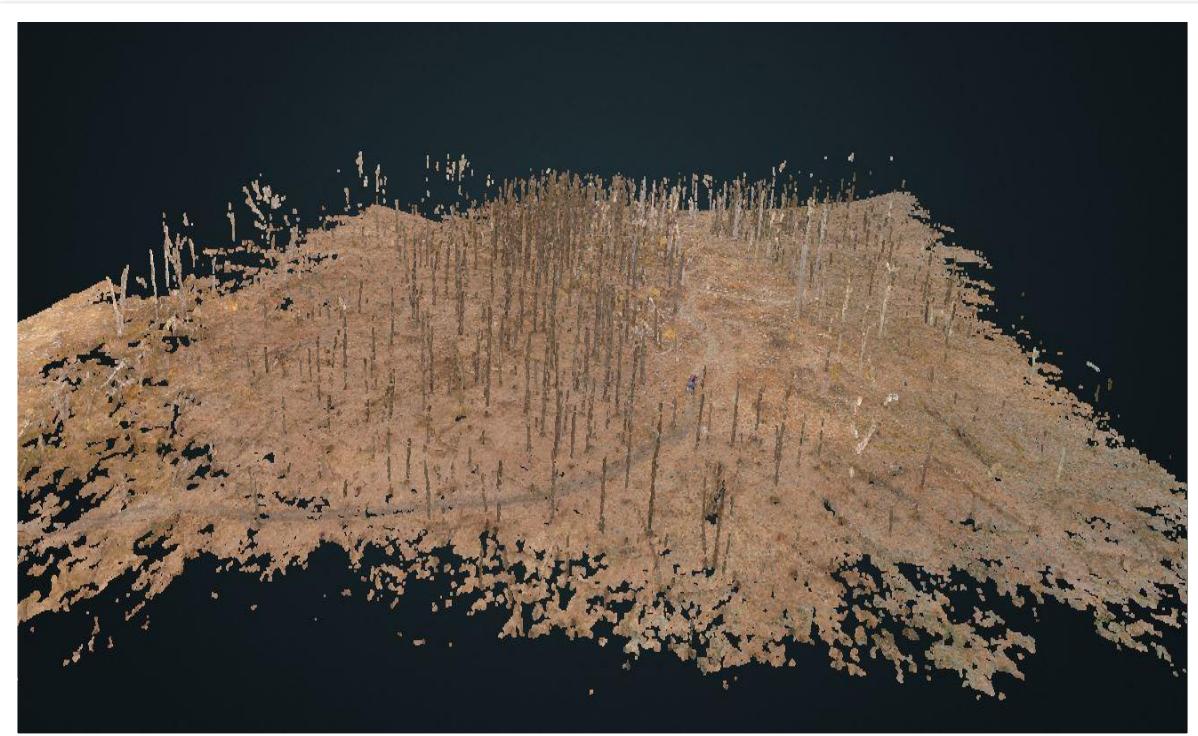


Image: community.opendronemap.org

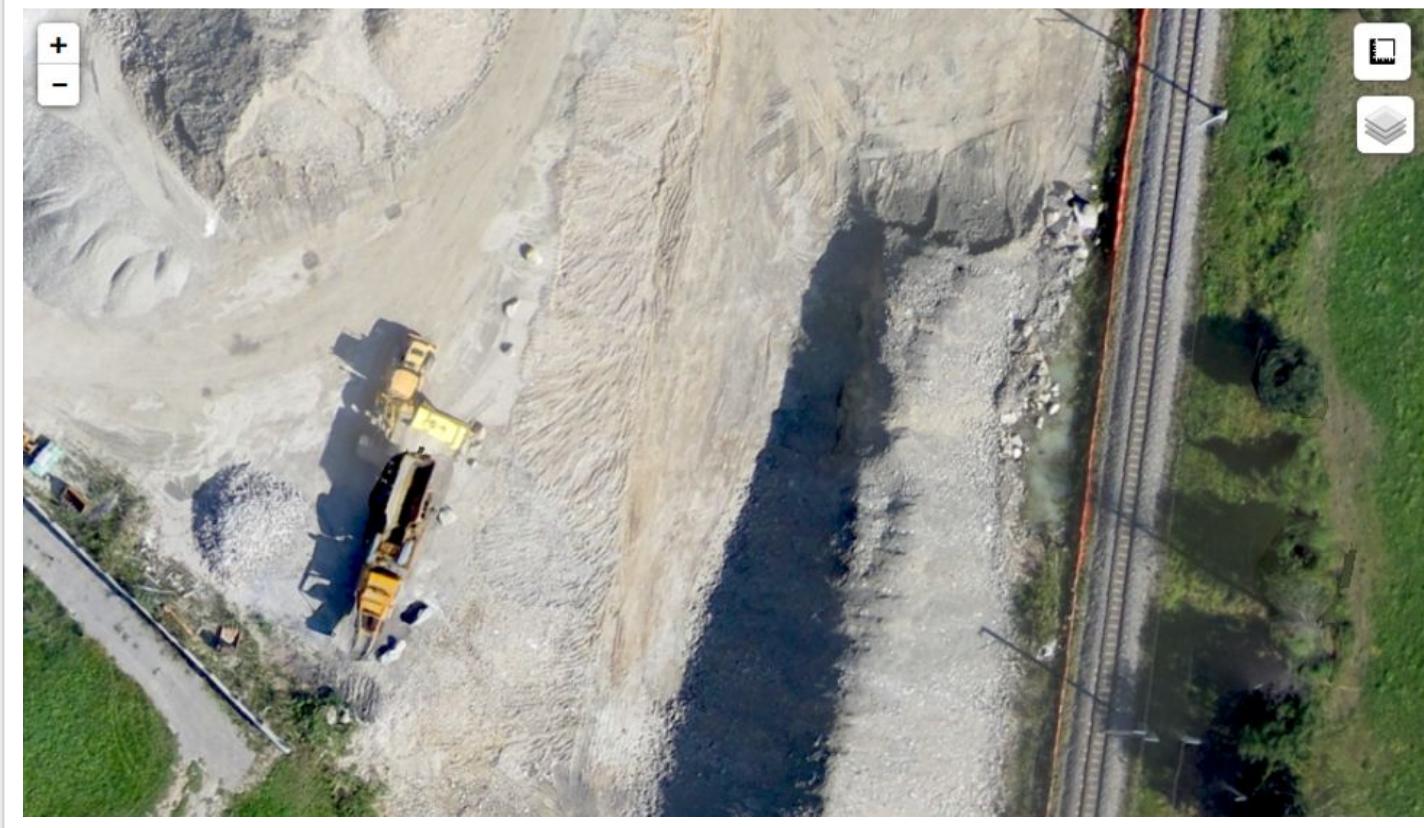
Emergency Management

- 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



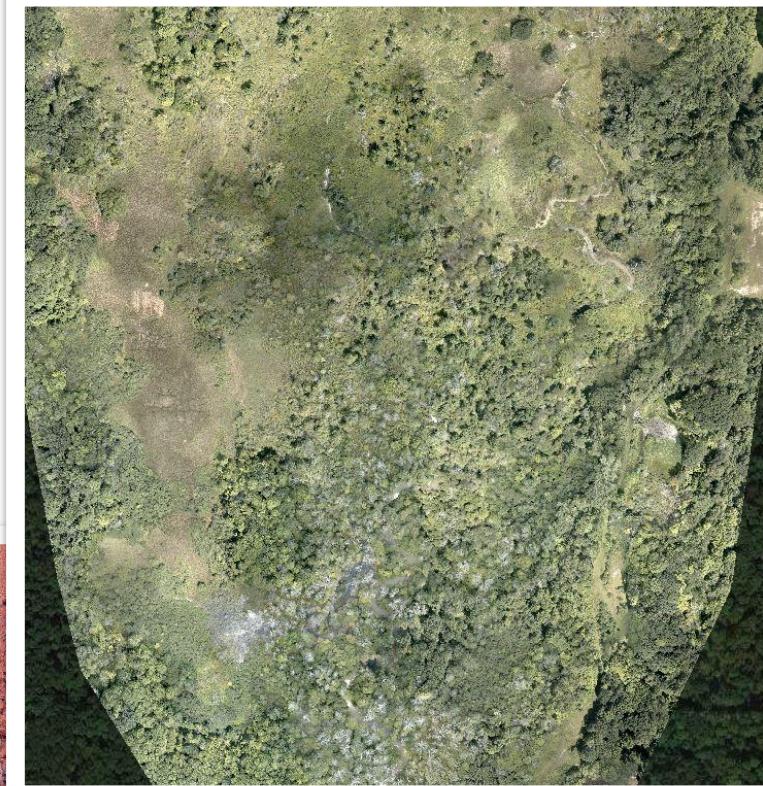
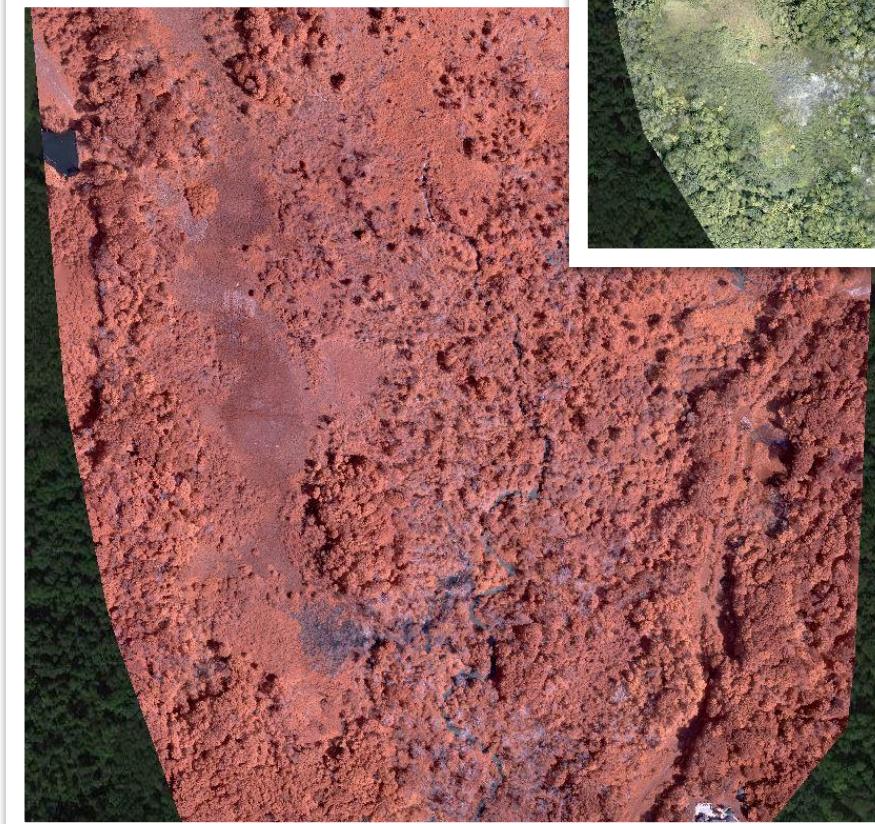
Construction

- 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



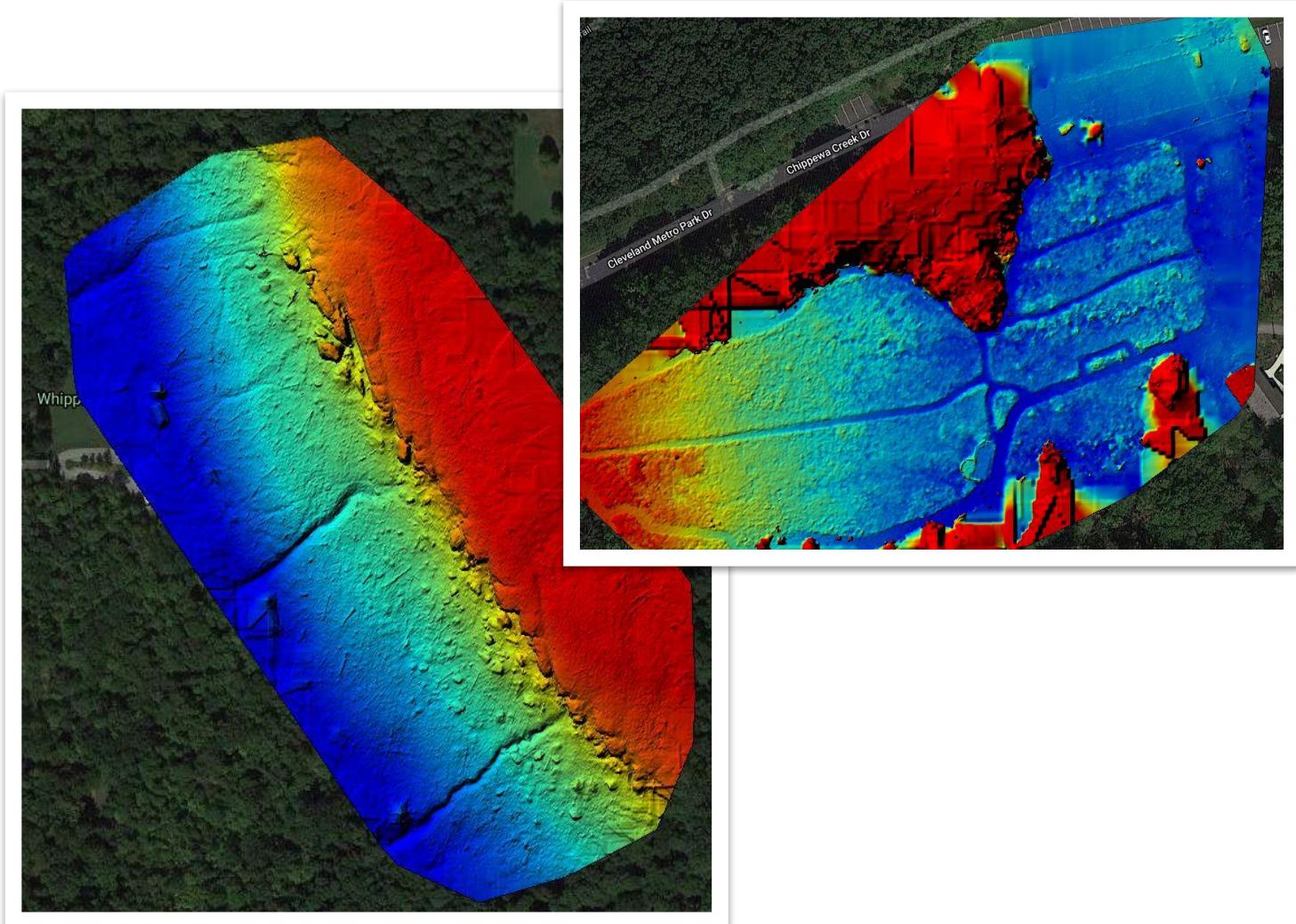
Ecological Assessment

- 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



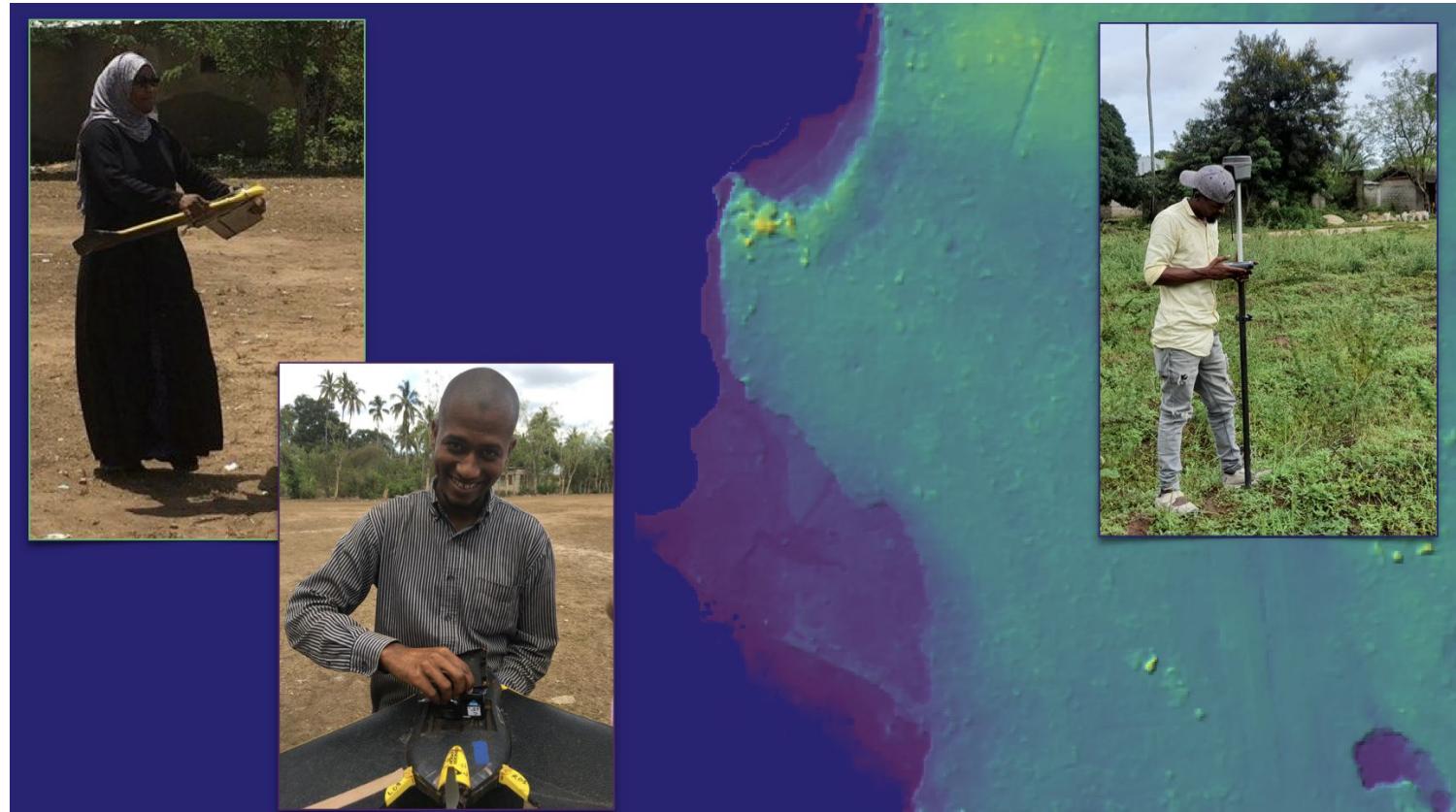
Coastal Monitoring

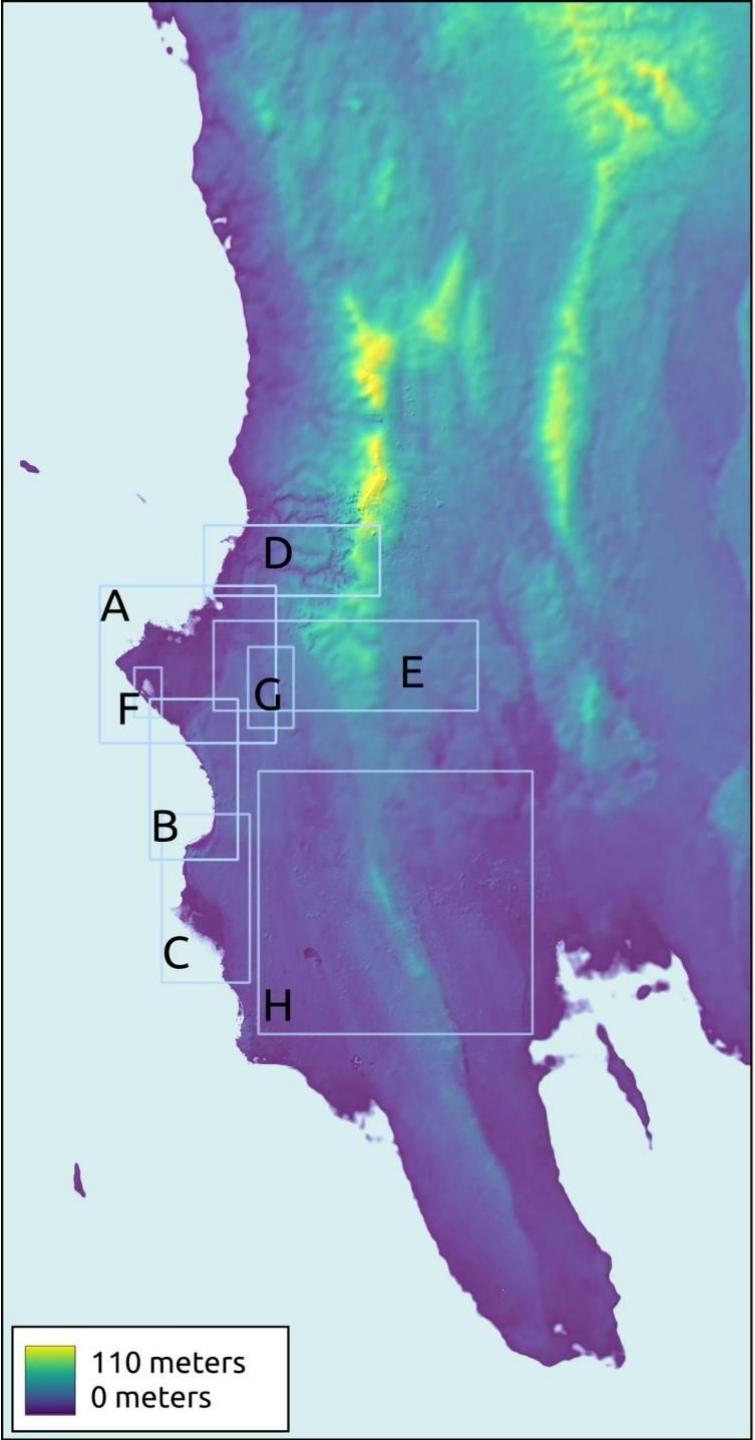
- Drone with standard camera
- Capture photos of a section of coastline
- Use ODM to generate a 3D model
- Repeat every 3 months
- Export 3D models
- Use another tool (e.g., CloudCompare) to assess change over time



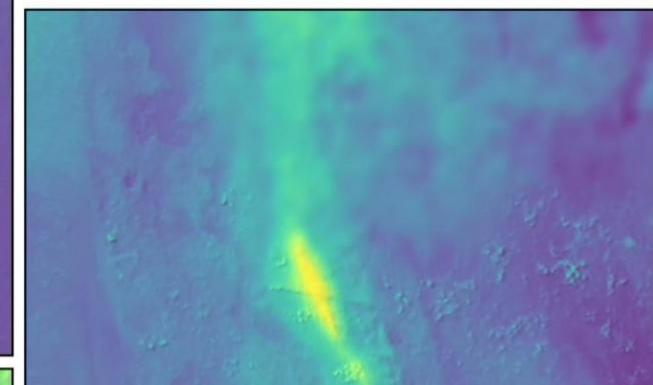
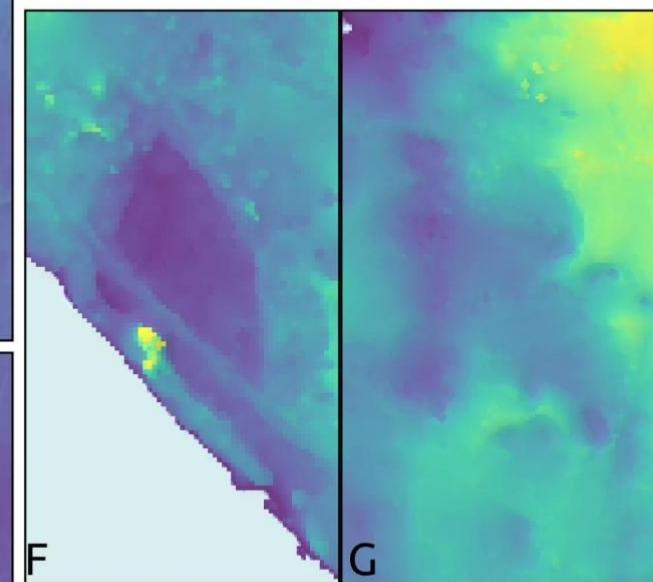
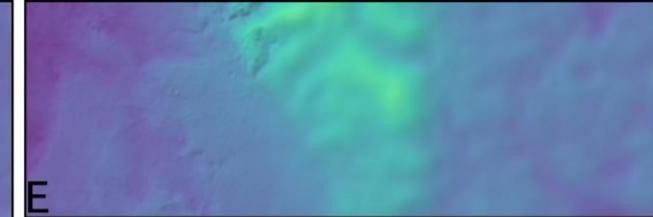
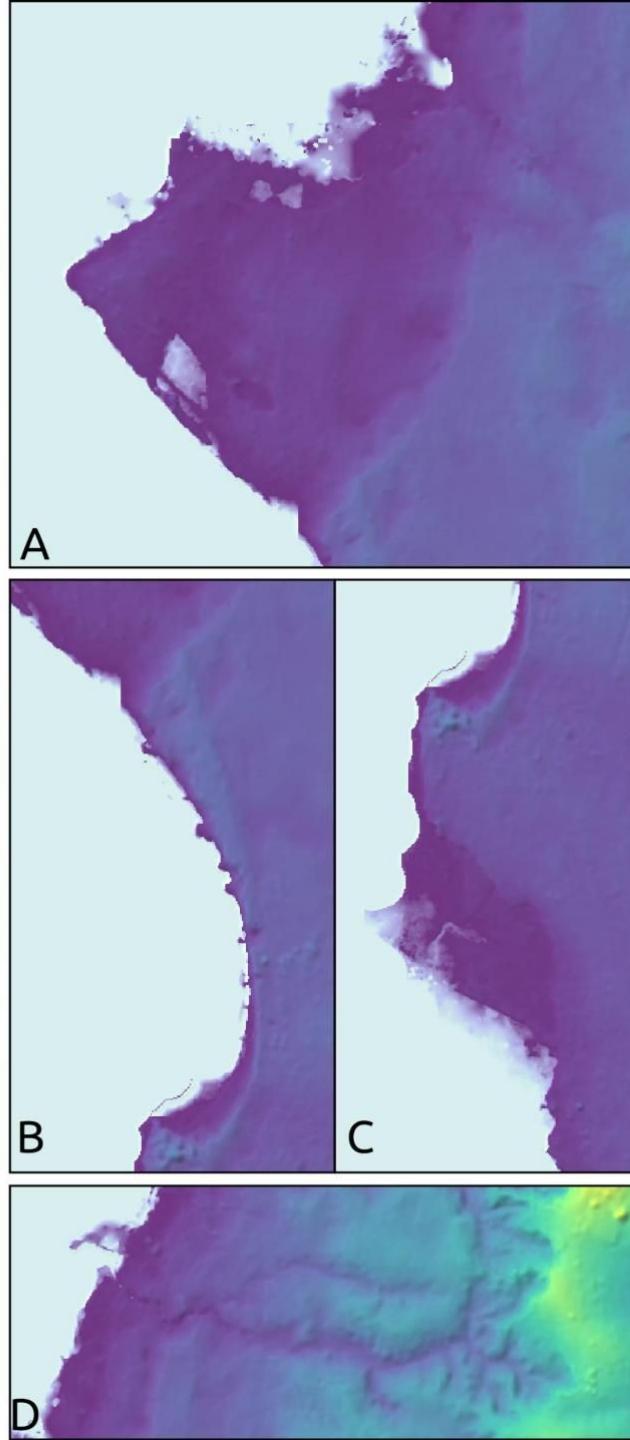


Digital Terrain Models for fluvial, pluvial, and coastal modeling – Zanzibar Mapping initiative

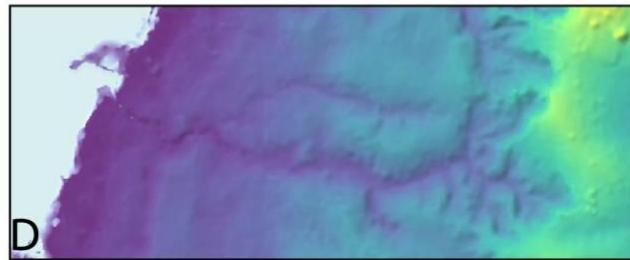


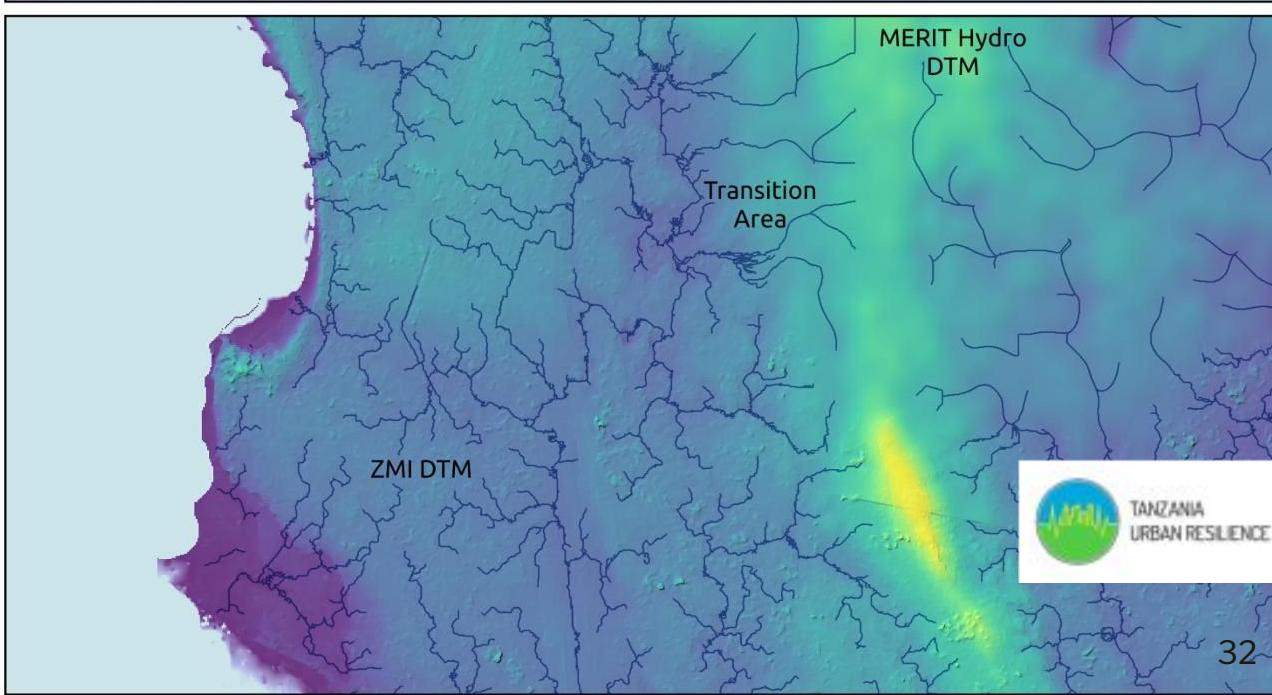
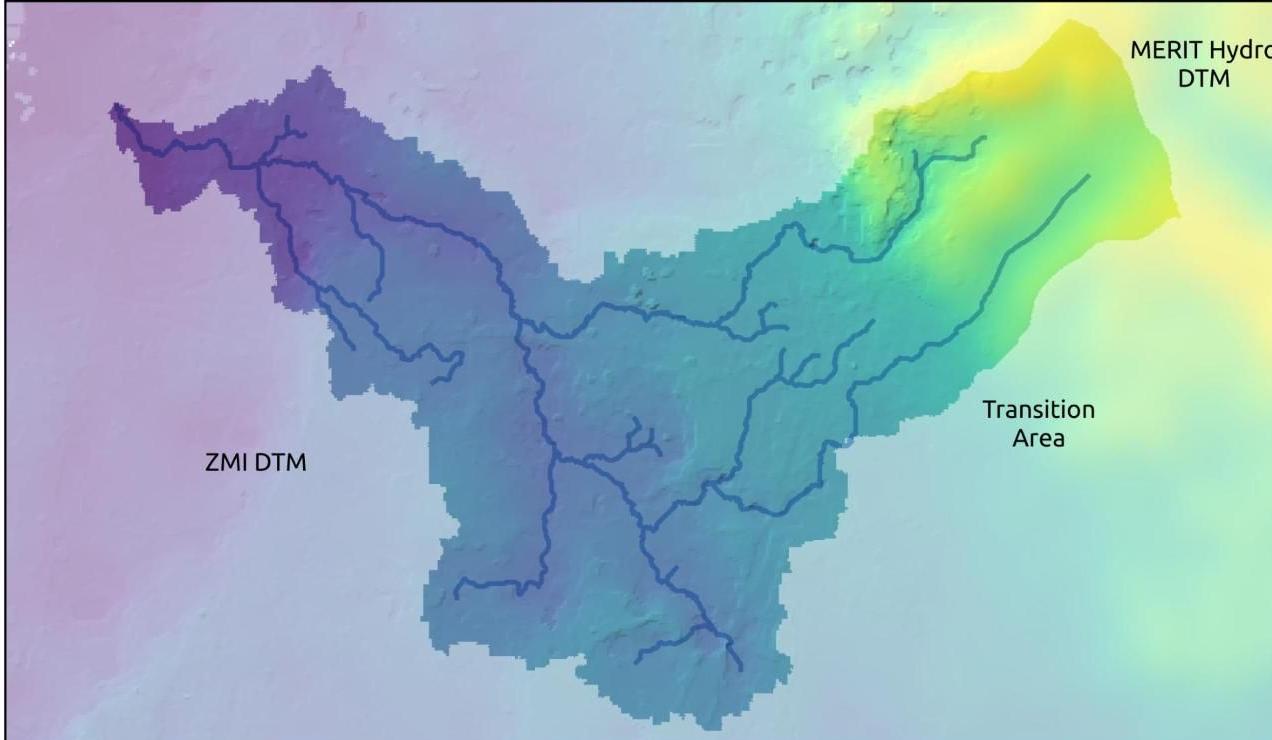
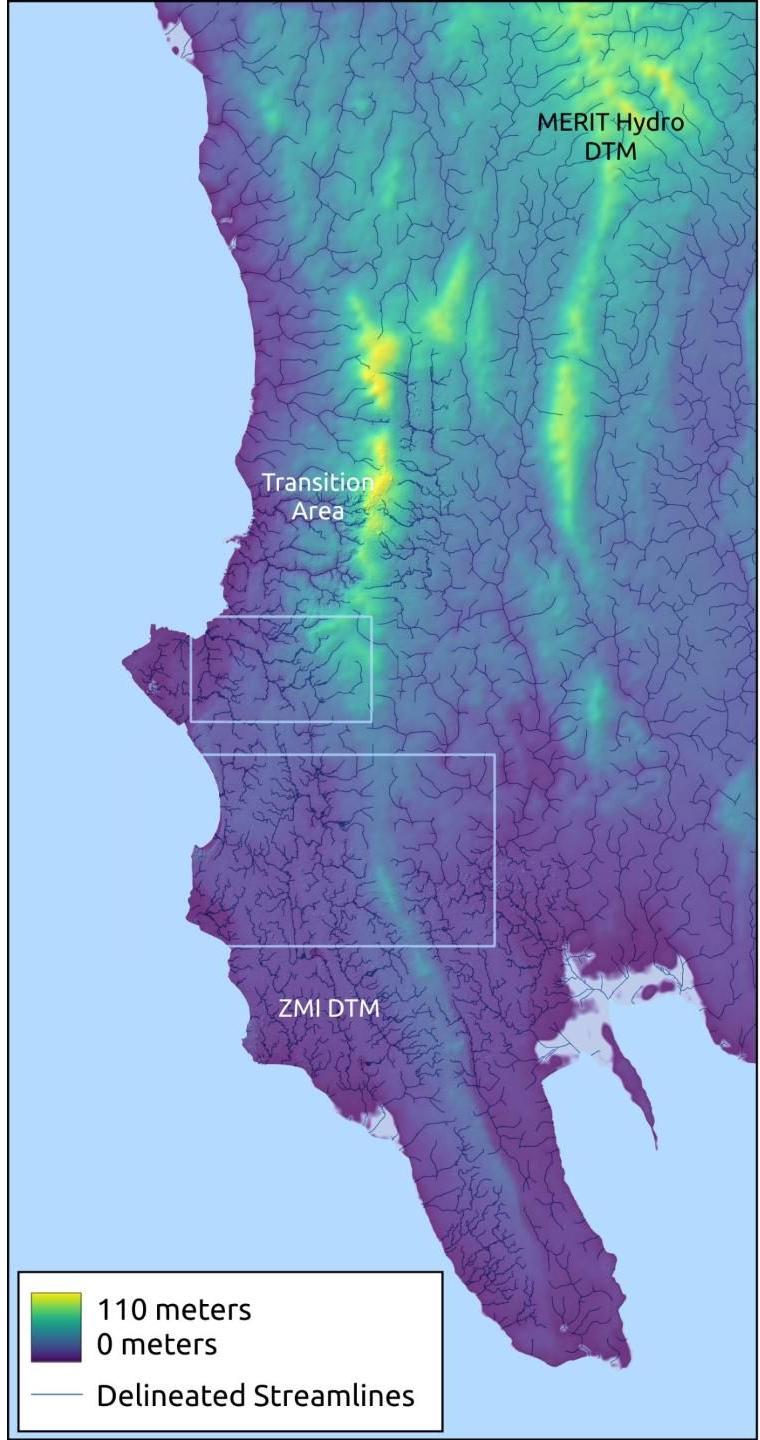


110 meters
0 meters



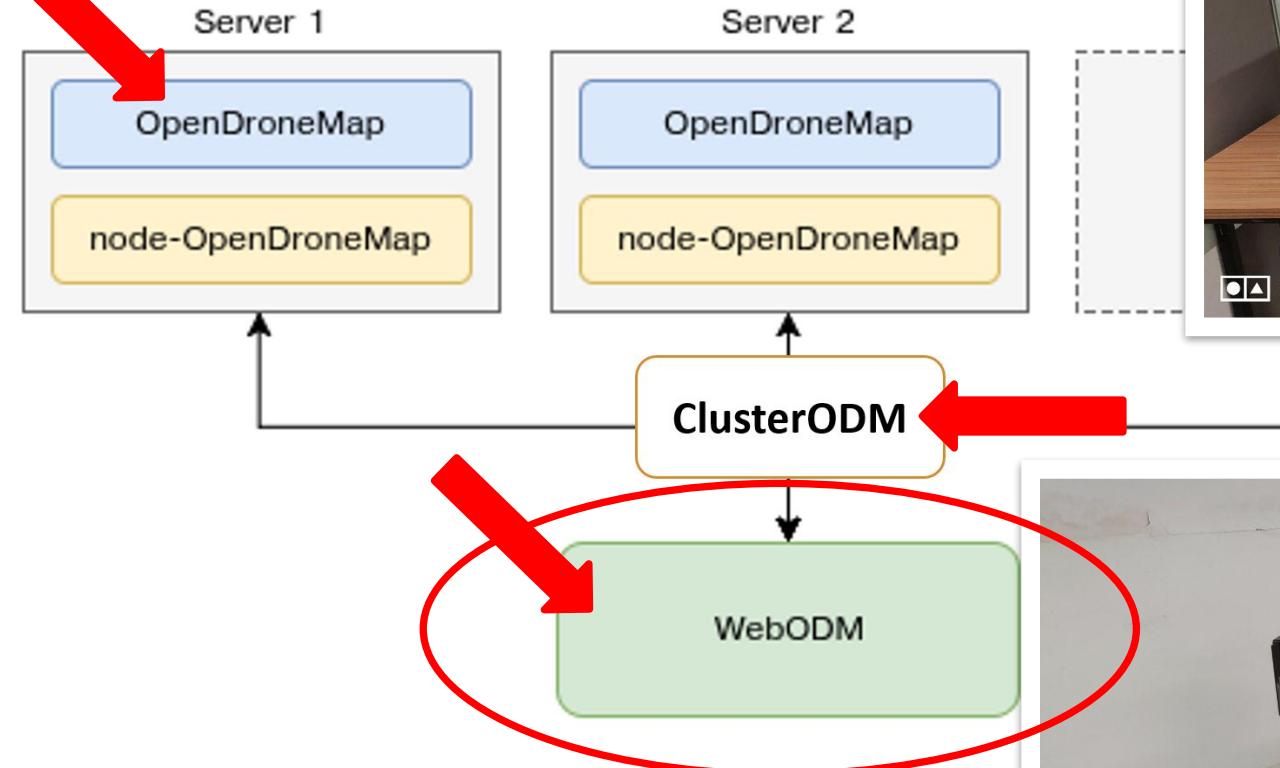
TANZANIA
URBAN RESILIENCE PROGRAMME



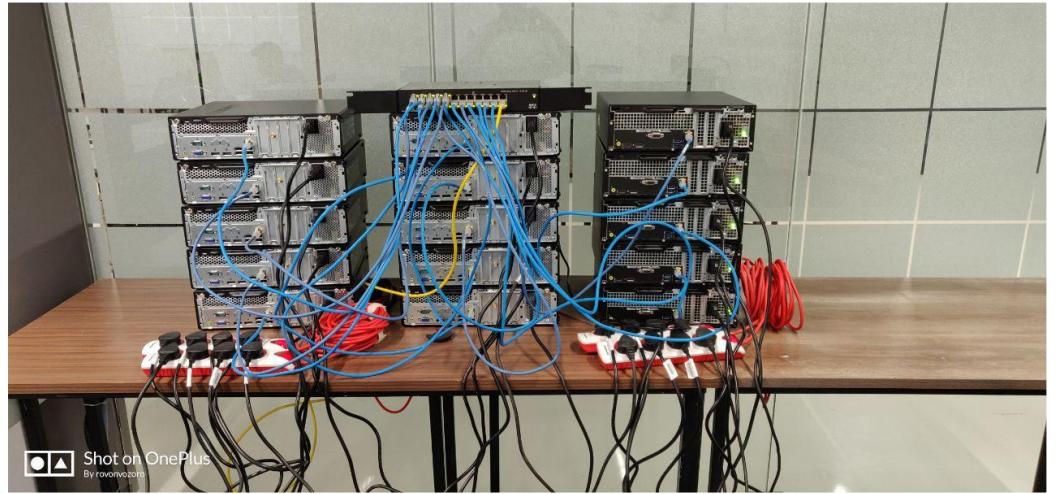


GETTING STARTED

Architecture

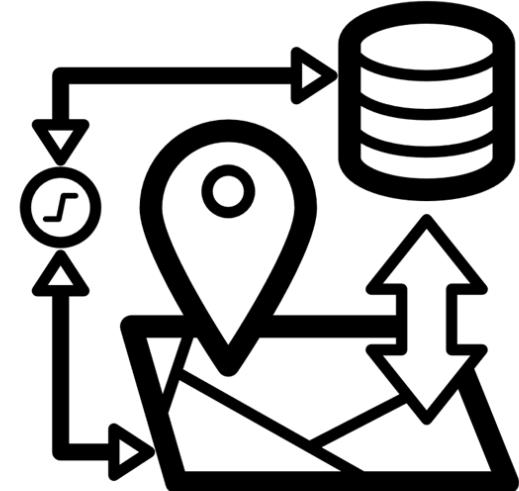


70,000 – 90,000 images



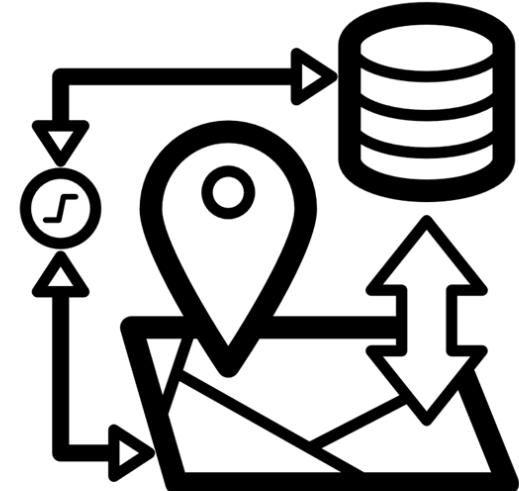
Supported Systems

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



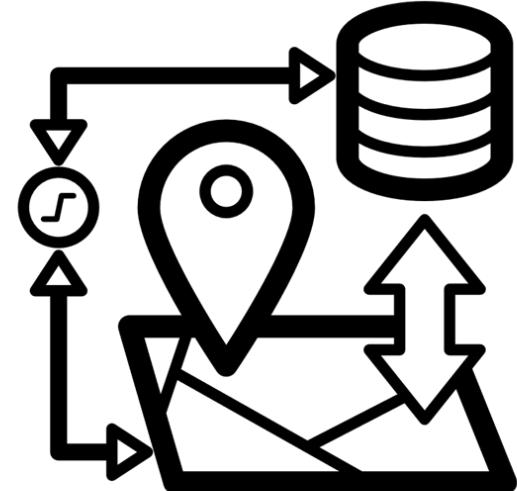
System Requirements

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

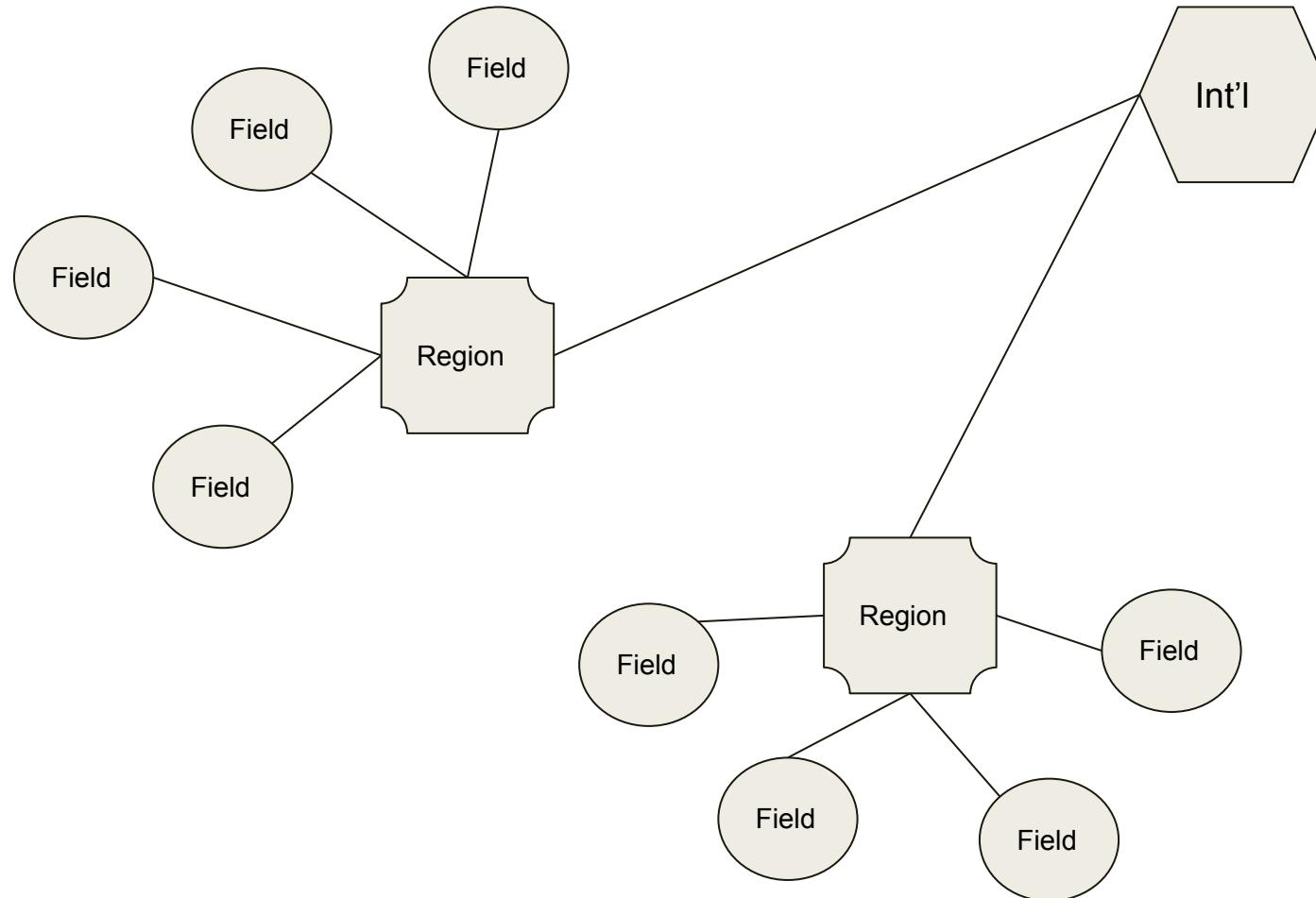


Your First Dataset

- 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>

OpenDroneMap

This is the community forum of [OpenDroneMap](#). Ask questions, discuss new features and meet fellow mappers. If you want to re instead.

Want to create a new channel? Just [request a new community space](#).

[all categories](#) [Categories](#) [Latest](#) [New \(93\)](#) [Unread \(24\)](#) [Top](#)

Online (2): A

Category	Topics	Latest
The Hangar New to the forum? Come say hi! Introductions Events Off Topic	58 2 unread 3 new	 What may cause this scr WebODM
ODM Use this category to post questions about usage, features, or anything else ODM related.	288 1 unread 22 new	 ★ Let's Get Stuff Funded [Quadratic Funding] The Hangar
WebODM Questions and discussions related to WebODM. Use this category to ask questions or propose new features.	797 10 unread 45 new	 ClusterODM with HAHO The Hangar
ClusterODM An area to discuss use of ClusterODM	6 1 new	 Image is deformed? WebODM
NodeMICMAC	3	 WebODM lightning to local WebODM to view 3D model doesn't work WebODM

I can't generate orthophoto and dtm with GCPs

Hubertus_Paetow 5d

It seems that you try to process a small object where GCPs are not very useful. I processed your dataset using the 3d-object-preset without a problem. Here is the result shown as a textured 3d-model.

Task of 2020-06-06T05:06:53.101Z



2   ... 

Vande93 5d

Hi Hubertus and thank you. I've tried also with a larger dataset, but the result was the same. With all datasets that I've used, I've obtained textured and scaled 3d models, the only problem is in the raster files, the dtm and orthophoto, and I don't know why because the GCP file is correctly read. So do you think that

Image is deformed? 5 7h

WebODM lightning to local WebODM to view 3D model doesn't work 3 13h

ODM Docs

<https://docs.opendronemap.org>

▪ Installation and Getting Started

▪ Tutorials

 Options and Flags

▪ OpenDroneMap Outputs

▪ Ground Control Points

▪ Splitting Large Datasets

▪ Additional References

 Flying Tips

▪ Multispectral Support

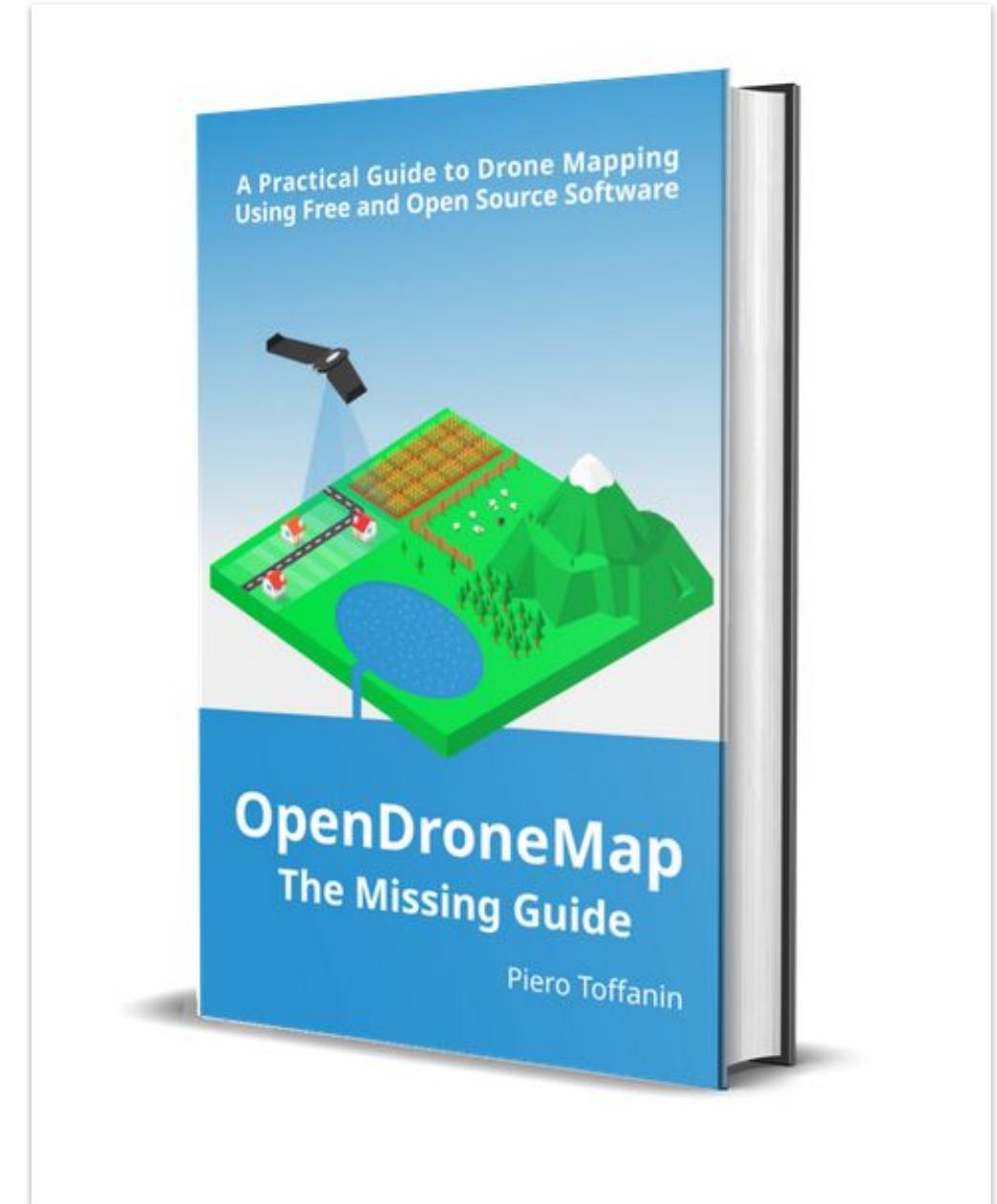
 How To Request Features

▪ How To Contribute

ODM Book

<https://odmbook.com>

\$30



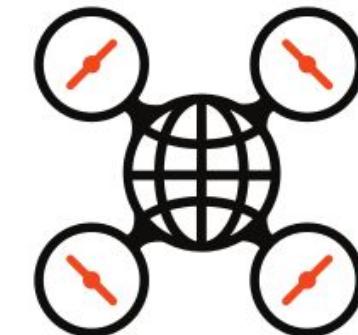
UAV Arena

- 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



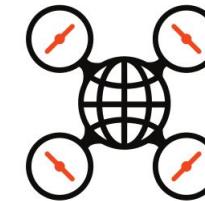
OpenDroneMap

GETTING INVOLVED

Ways to Get Involved

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

Questions?



OpenDroneMap
<https://opendronemap.org>

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@smathermather
- Corey Snipes
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@coreysnipes

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>