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Using Drones and 3D Models to Assess Risks Related to Mines

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Outline

- After Mining is Gone
- Identifying Risks
- 3D Modelling With Drones
- Current Study Site
- Other Projects in Armenia
- Future Work

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After Mining Is Gone

What happens when a mine closes?

What happened when a Soviet mine closed?

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Post Closure Mining Risks

- Unmaintained Tailing Management Facilities (TMF)
- Unknown or Unmonitored Sites
- Acid Rock/Mine Drainage
- Unstable landscapes

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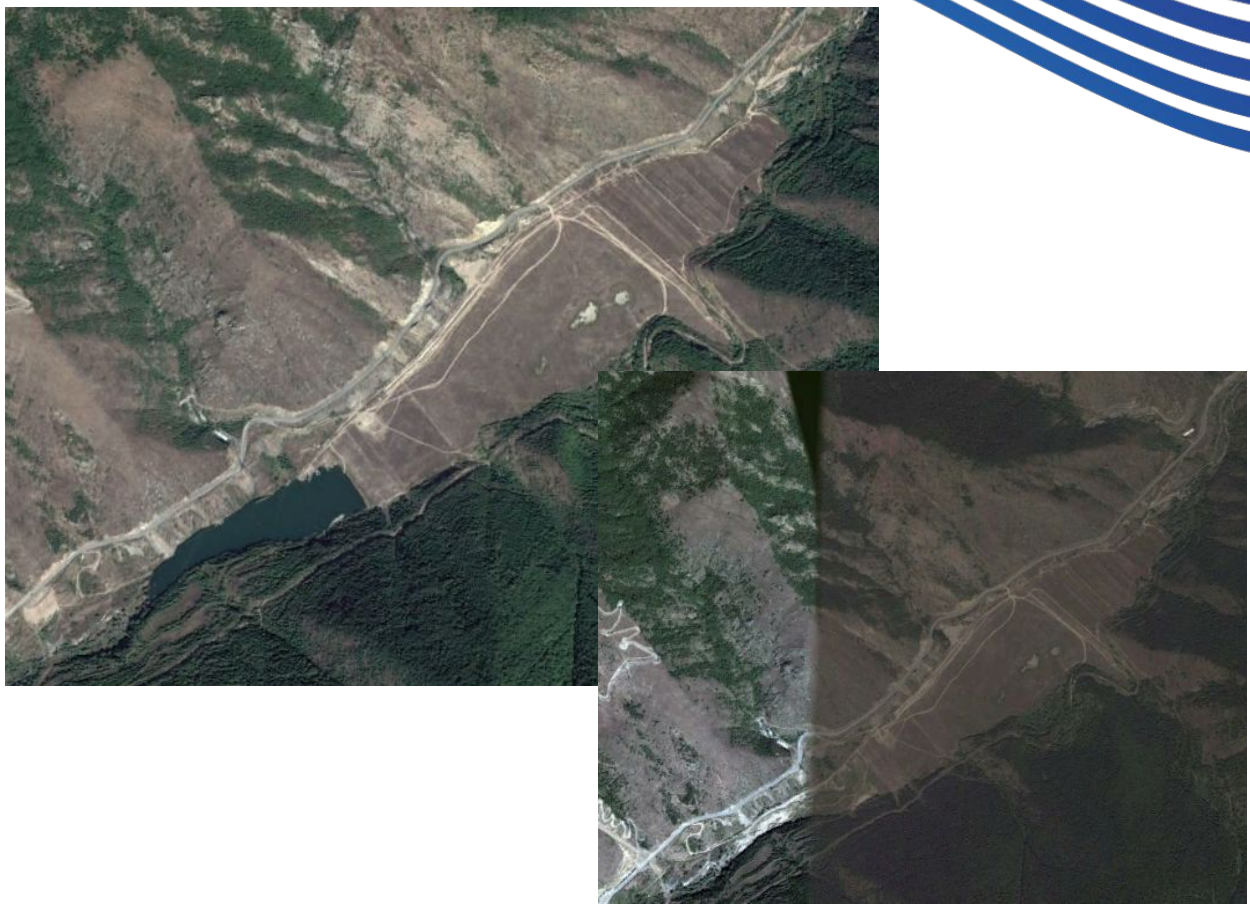
Unmaintained TMFs

After recultivation, monitoring happens, but how much?



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Unknown & Unmonitored Mining Sites

Extensive records are available for Soviet era and earlier mines

Monitoring missions typically take place every 10 years

47 documented (active/inactive) metal mines in Armenia (Geofund.am)

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Acid Mine/Rock Drainage

~10 known ARD sites in Armenia.

Fewer officially documented.

Erosion/Instability complicates the issue.

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Unstable Landscapes

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3D Modelling With Drones

LiDAR is amazing.

But...

Photogrammetry on a simple DJI drone gets similar results at a fraction of the cost.

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Required for Photogrammetry

UAV Systems

Automated Flight Software

Photogrammetric Processing

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UAS Systems

Any drone with a camera that faces down can be used for photogrammetry.

Having a drone with GPS integrated geotagging helps considerably.

Platforms In Use In Armenia

DJI Phantom Series

DJI Matrice Series

SenseFly eBee

IDS IA3 Colibri

Custom Built Platforms

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Is manual or automated flight best suited to Photogrammetry?

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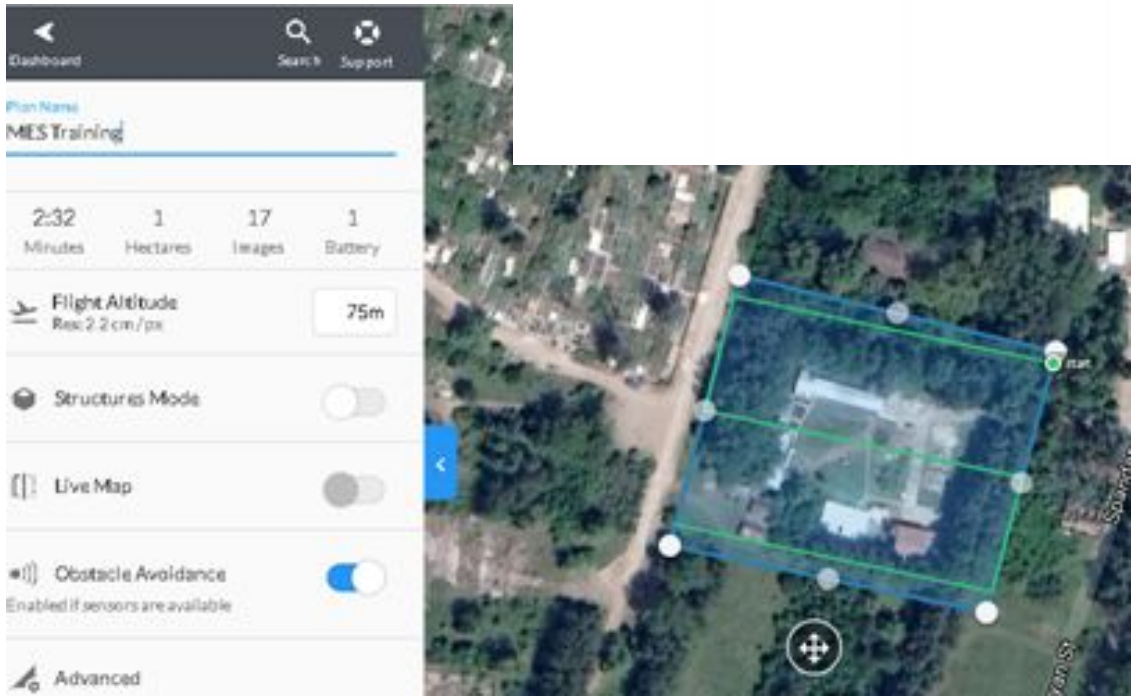
Automated Flight

Automated flight is much more efficient, stable, and effective in getting the imagery needed for photogrammetry.

Several apps are available on Android for DJI and other consumer drones. Mission Planner is a laptop based program for larger drones.

Two of the best ‘free’ apps are:

- DroneDeploy
- Pix4D Capture



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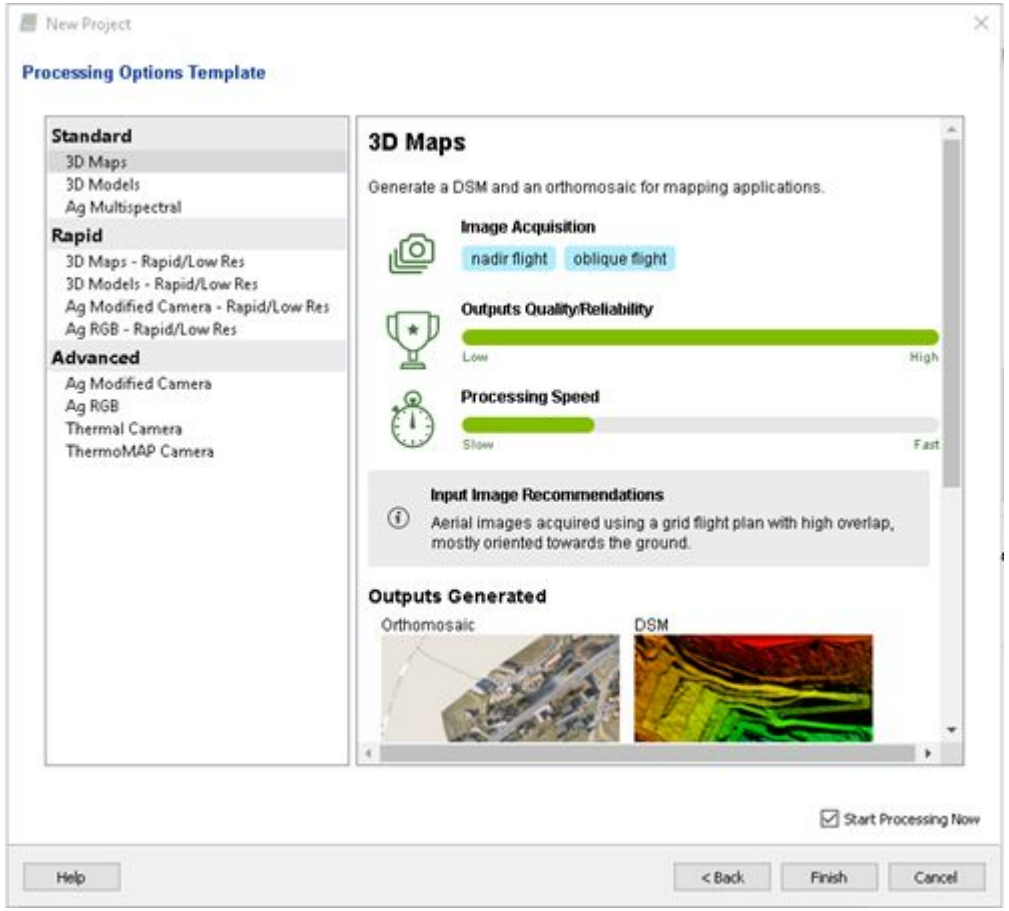
Photogrammetry Software

Paid:

- Pix4D ($3000 USD non-commercial)
- Agisoft Photoscann ($400 student)
- Several cloud based softwares including Hexagon Geospatial & DroneDeploy

Open Source:

- Micmac - requires very powerful PC and takes a bit of getting used to, but works just fine.



Pix4D Interface

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Applications for Data

Monitoring & Mitigation

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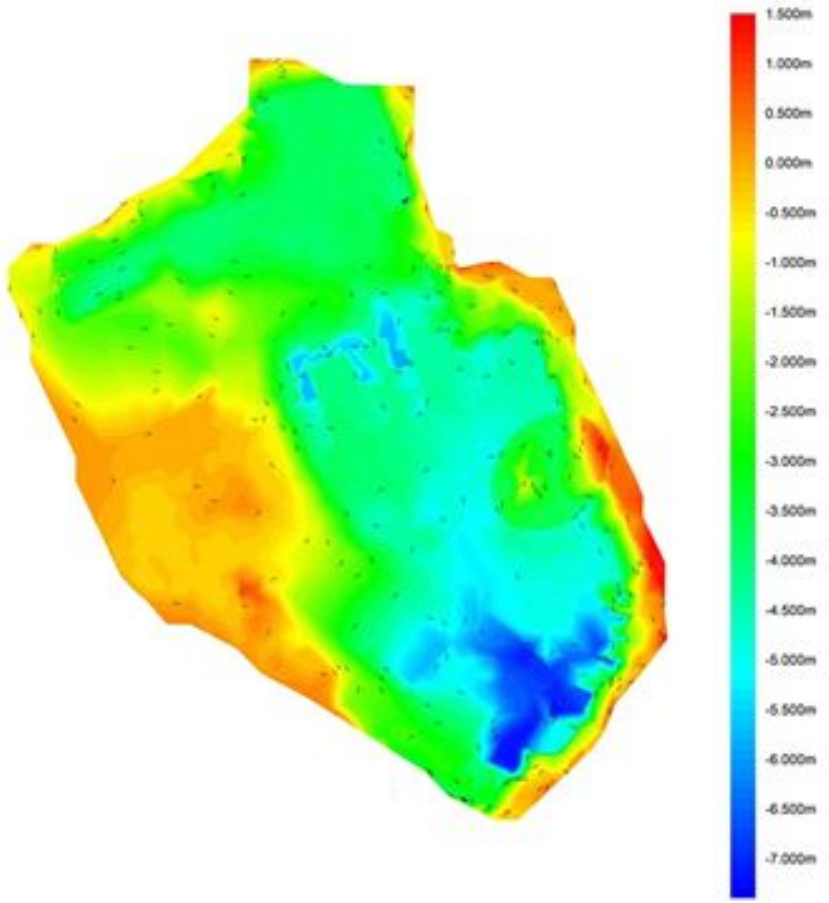
Monitoring

High temporal and spatial resolution allows monitoring of:

- Landslides
- Earth Dams
- Land Creep
- Tailing levels
- Extraction levels



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Mitigation

High detail 3D models can be exported to CAD/other platforms for manipulation.

- Remediation of Acid Rock Drainage
- Mitigating risks in the built environment

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What to watch out for?

What might we need to think about with time series analysis, etc.

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Caution - Spatio-temporal Continuity

A GPS receiver is only accurate to 5m.

- Multiple models of the same site need to be planned with ground control points in mind.
- Failure to ensure ground control can mean datasets that are 5 or even 10 meters off of one another.
- This can be remediated with RTK.

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Caution - Batteries, Checklists, & Drone Maintenance

- Technicians get to field only to notice the battery on the tablet is dead.
- Technicians charge the battery of the tablet and forget to put the drone in the car.
- Technicians successfully bring the drone and the charged tablet to the field only to realize that the firmware on the drone needs an update.

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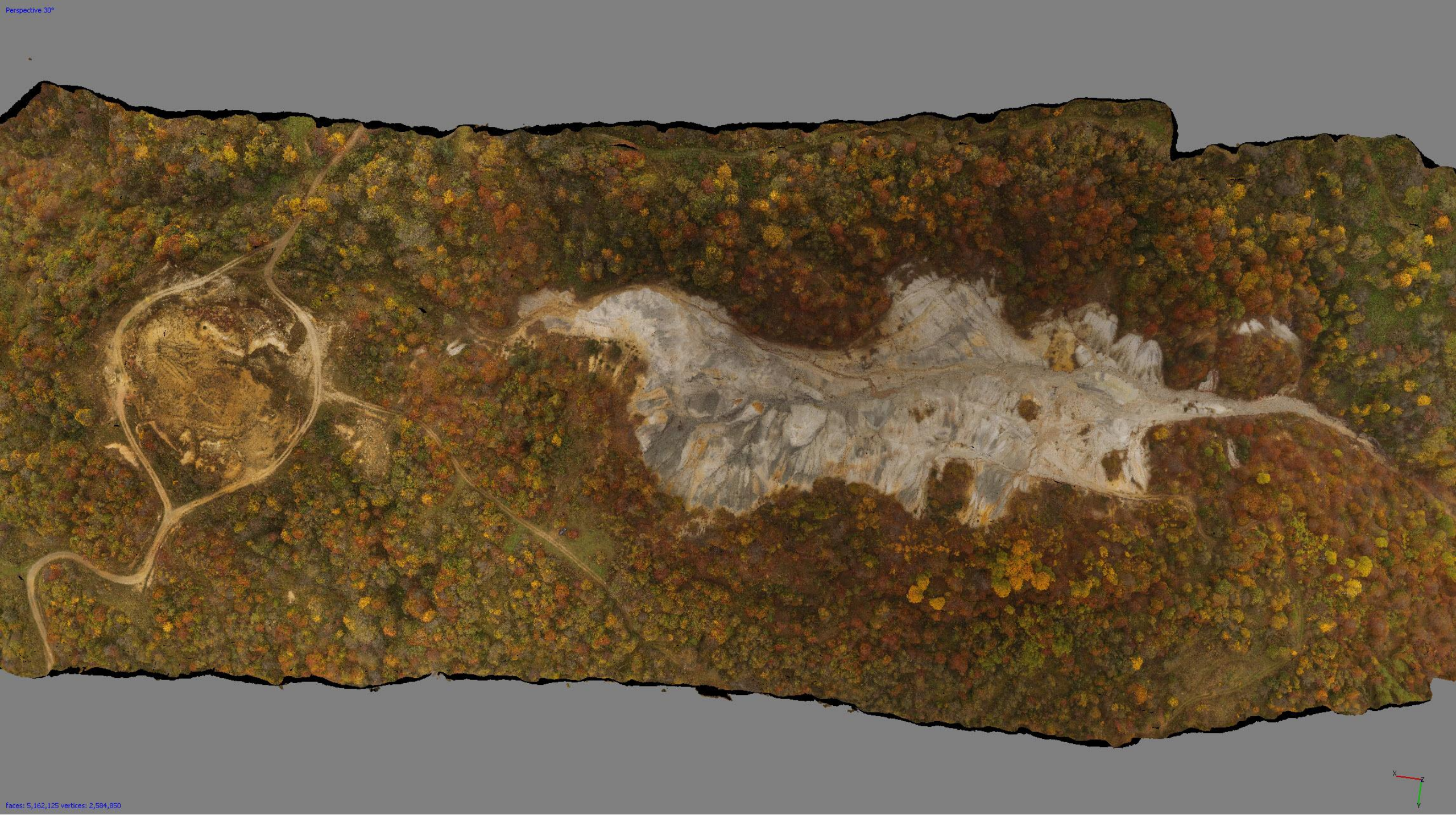
Caution - Flight Planning Considerations

- Fly from above - calculating how high the drone needs to fly to cover an area ‘up the mountain’ is time consuming and dangerous.
- Follow the law!
- Consider your neighbors.

Current Project

Tandzut West

- Exploration site from Soviet era
- No actual mining
- Significant erosion
- ARD with a pH of 1.4 - Downstream is ~2.0
- Significant heavy metal pollution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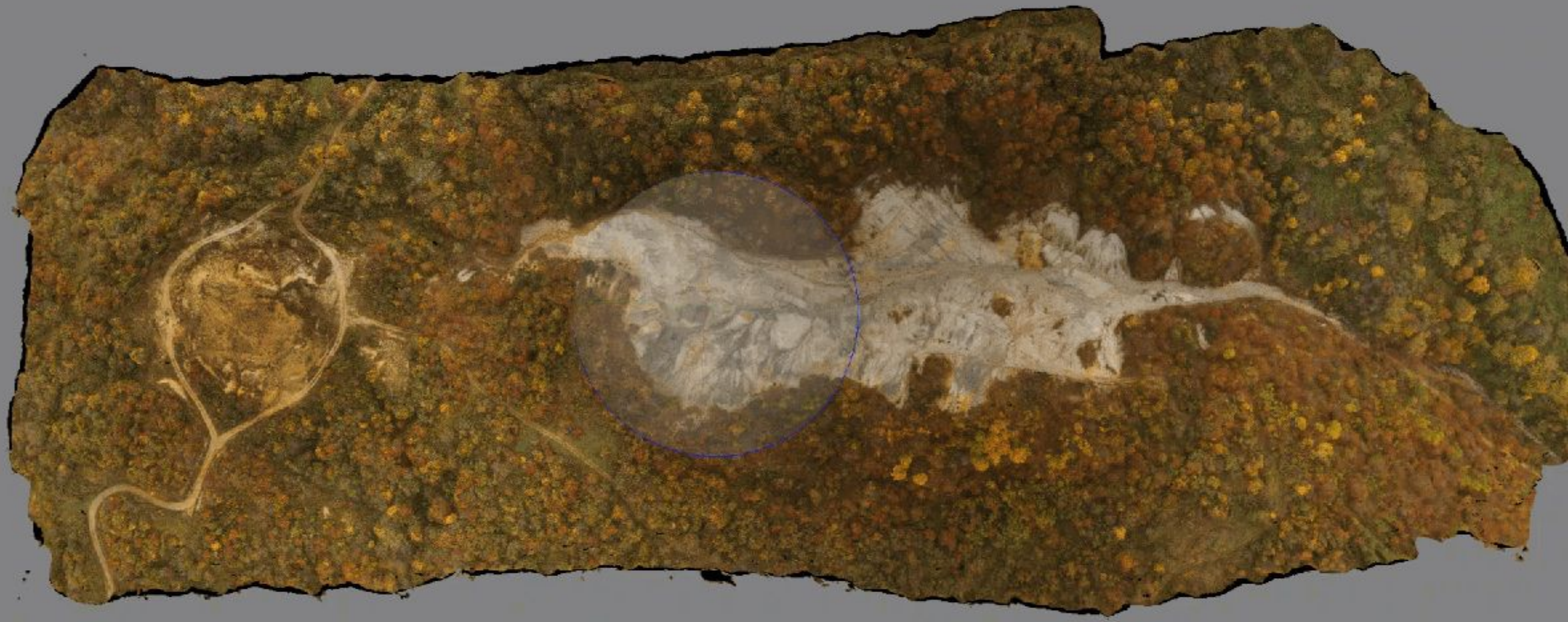

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Current UNDP Project

- Trained 40 Ministry of Emergency Situations staff on the use of drones for 3D Modelling and Search & Rescue.
- Trained 4 trainers on advanced topics concerning drones.
- Using drones to 3D model all kindergartens for use in risk awareness trainings with kindergarten staff.

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Work with Armenia's State Forest Monitoring Center

Using the drone to model:

- Illegal cutting.
- Burn severity and time series analysis of fire recovery.
- Wind damage to forests in northern Armenia.

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Future Work

- Identify and model all ARD sites in Armenia.
- Use Tandzut West as a possible model for remediation using filtering ponds.
- Understand the amount of heavy metal pollution affecting downstram villages.

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