Blue Marble GEOGRAPHICS

Mind the gap between world and map

bluemarblegeo.com

Generating a 3D Point Cloud from UAV Images

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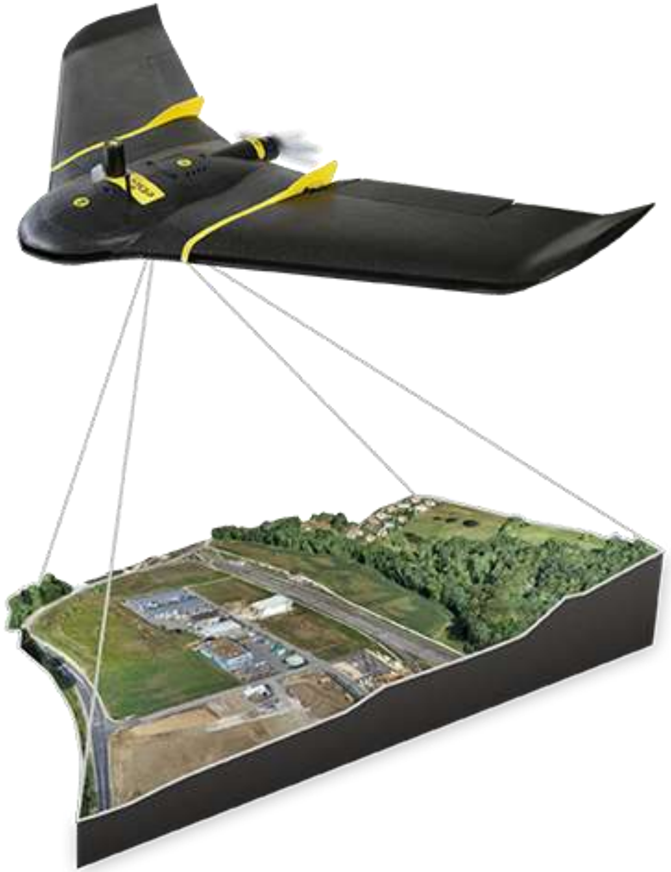
Reseller Account Manager

LiDAR vs. PhoDAR

- Active vs. Passive data collection techniques
- Both have value, depending on project requirements

Light Detection & Ranging	PhoDAR (photogrammetric PC)
Requires flight planning	UAS/UAV & ground pilot
Laser scanner required	RGB Camera (20Mpx)
More expensive	Less expensive
Typically clean, sharp PC	Usually processing required
PC classifications exist	No PC classifications exist

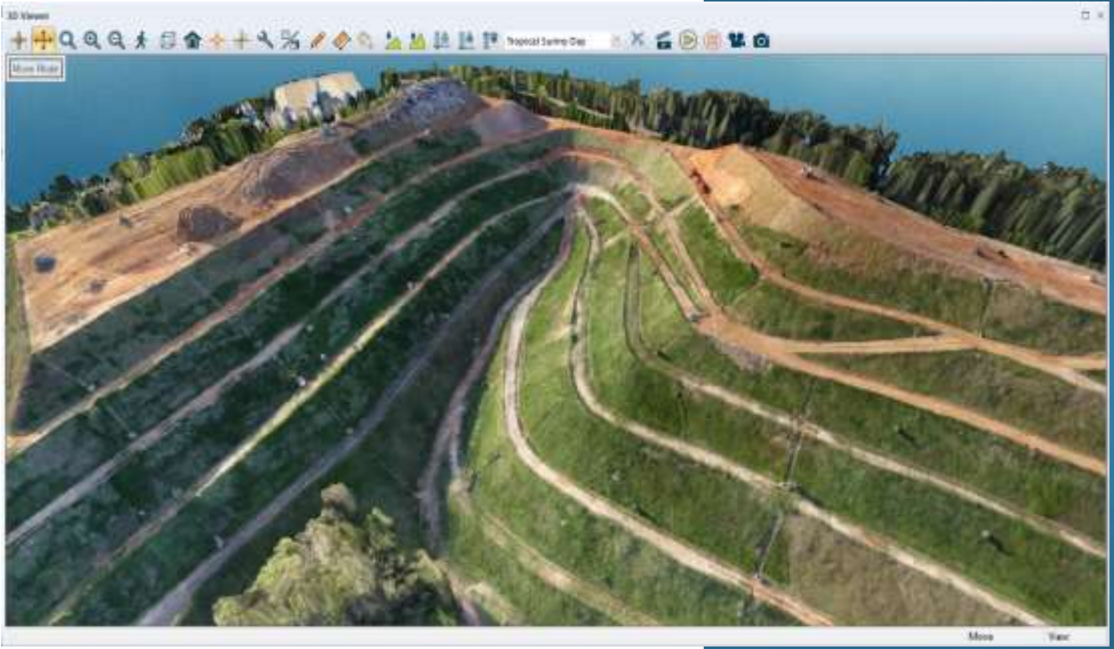
- Budget/cost, intended use, and delivery time are main decision making factors



UAS/UAVs and Drones

- Over recent years, the availability and use of UAVs (Unmanned Aerial Vehicles) has rapidly expanded
- Drones are now equipped with on-board GPS receivers, miniaturized cameras
- 1-2 cm image resolution is relatively common
- “Flying for Work” rules are still evolving
  - Visual line of sight
  - 400’ ceiling over target
  - Daytime only
  - 100 mph limit
  - Airport airspace restrictions

Project Challenge



- Landfill area volume reporting requirement (national & regional agencies)
- Regulators require periodic volumetric calculation of landfill area, project when capacity is reached
- Landfill topography changes regularly
- Drone flights using pre-set flight paths monitored by certified pilot
- 200+ images acquired, georeferenced

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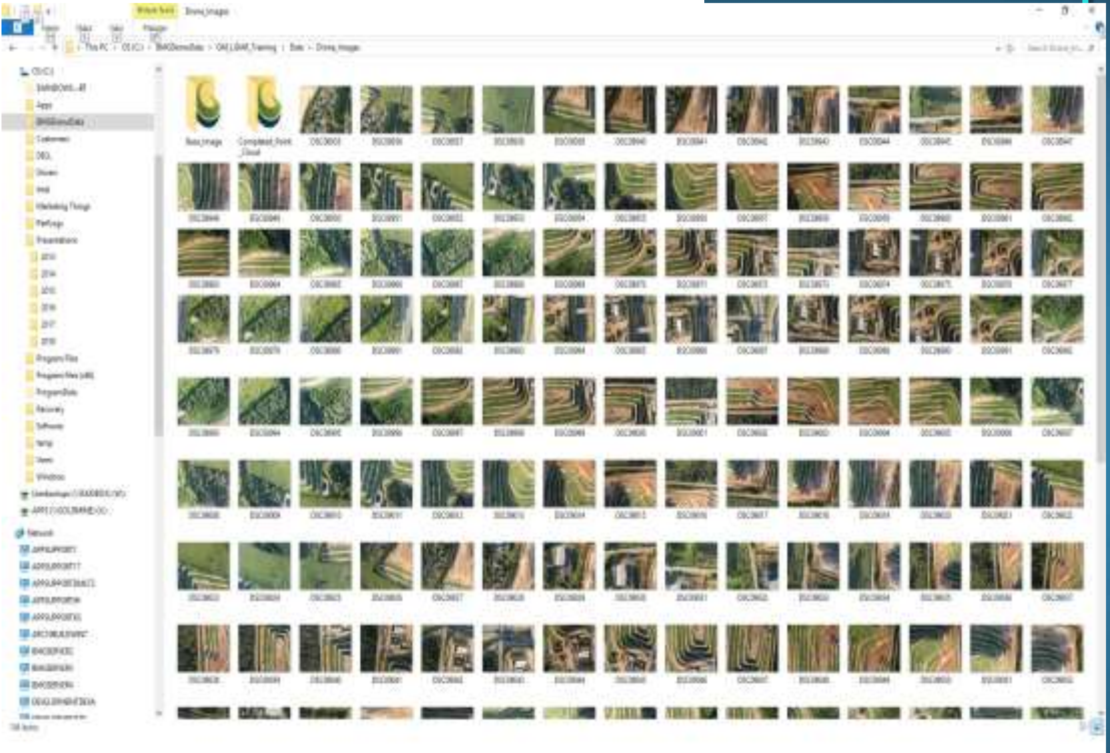
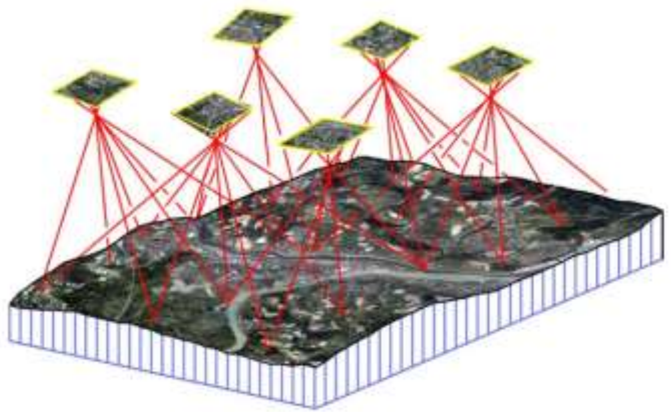
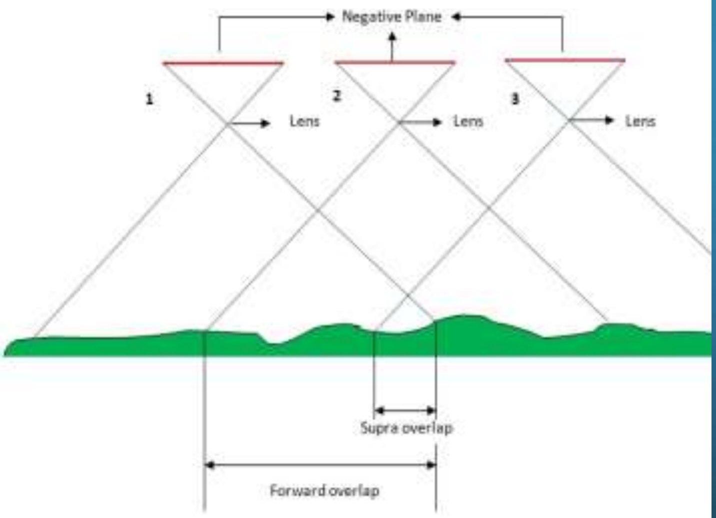
Structure from Motion Photogrammetry



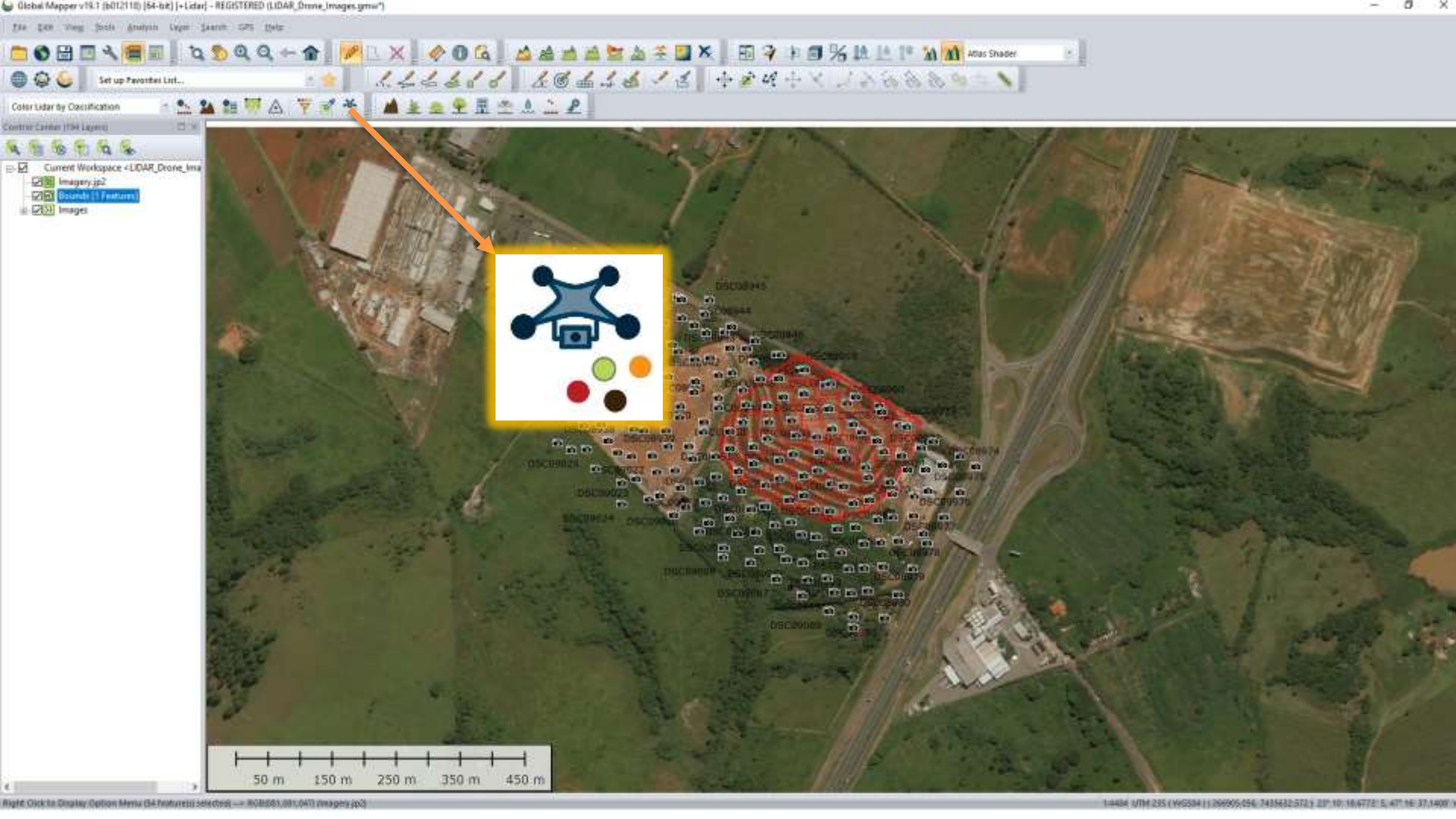
- Take a sequence of 2D photos and use pre-defined flight plan
- Import adjacent images from a range of different perspectives
- Focus on the stereoscopic overlap
- Recommended overlap:
  45% - 55%
- Triangulate using geotagged reference points
- Use network of ground control points to tighten accuracy



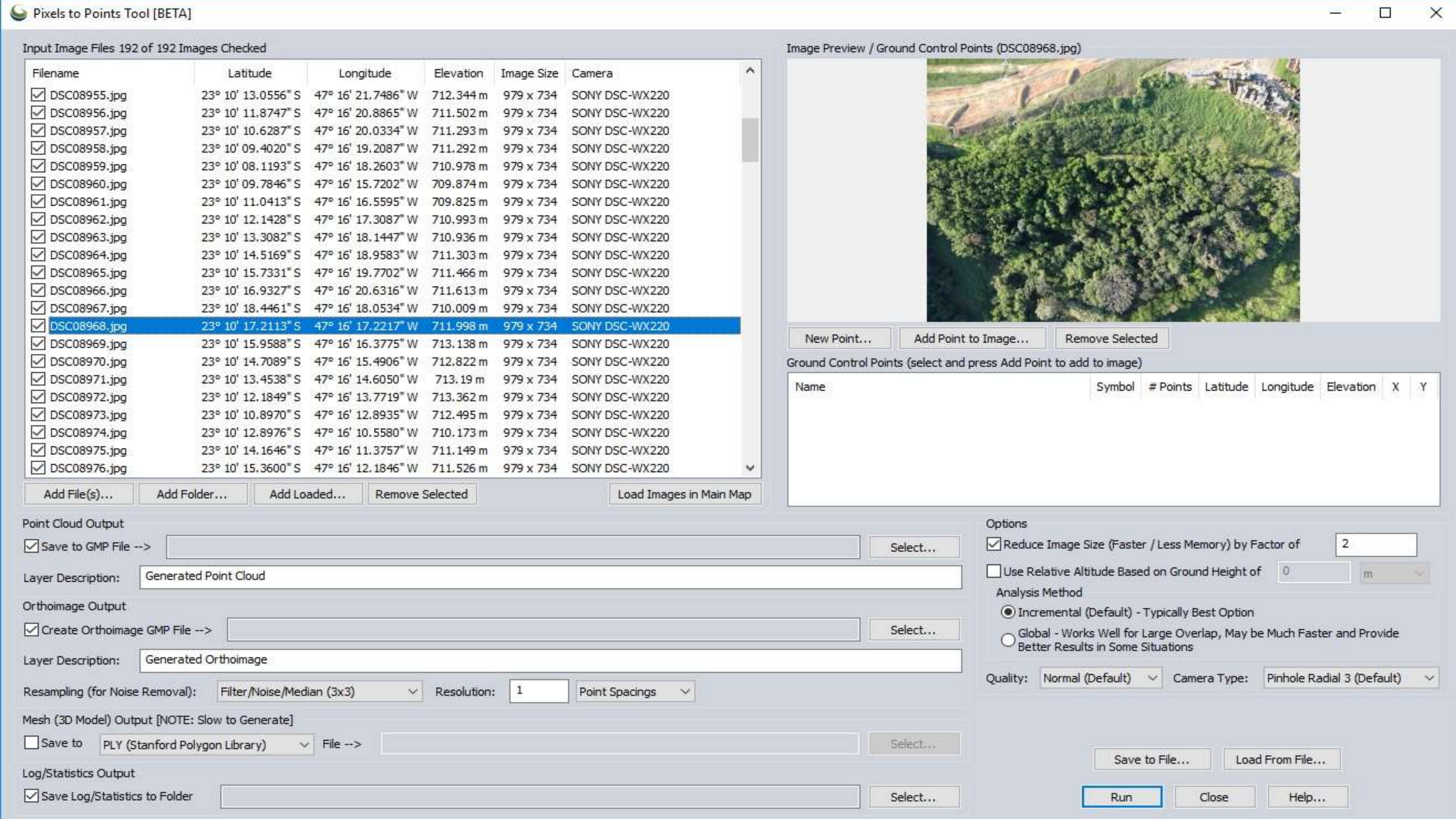


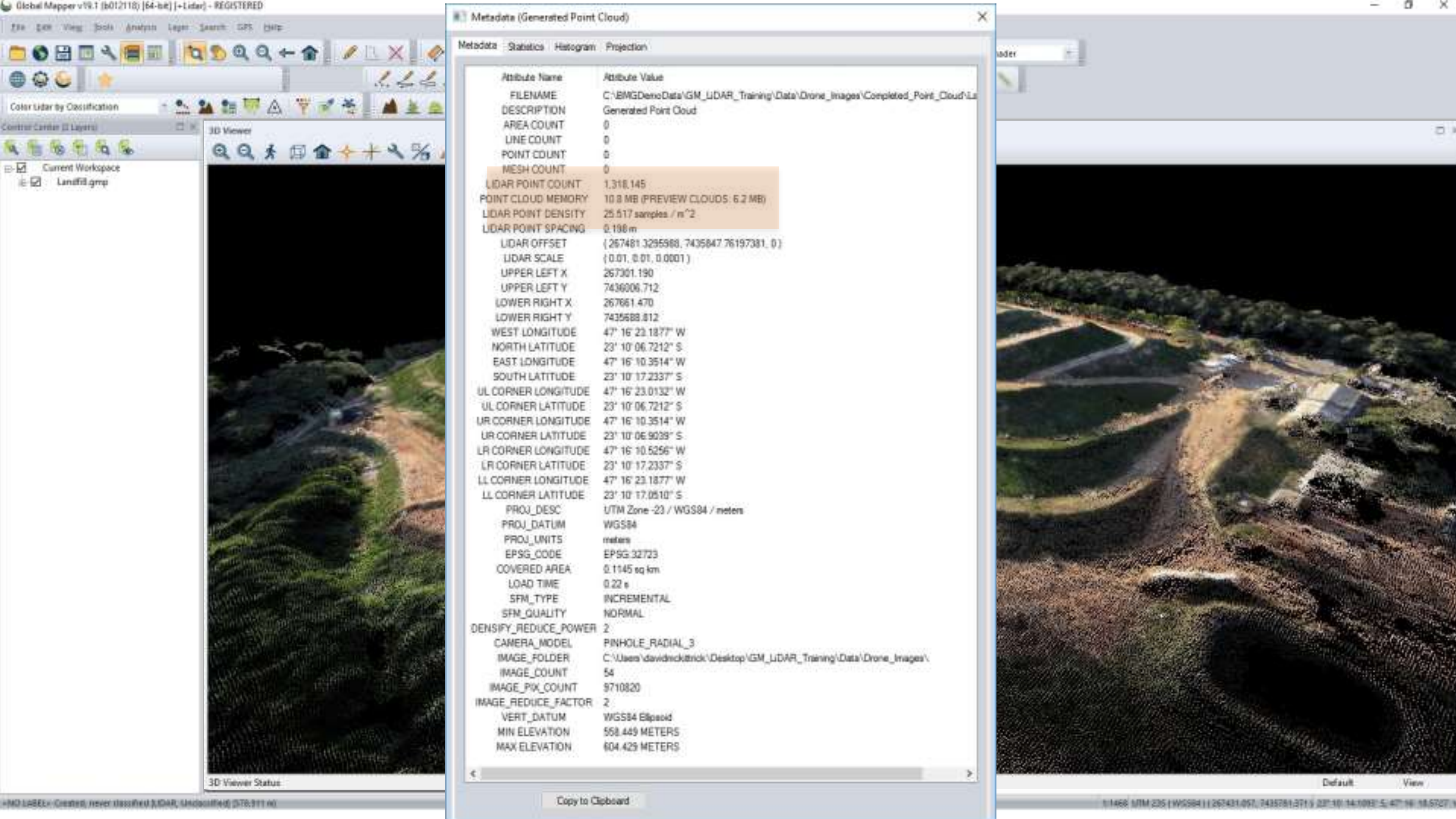
Process

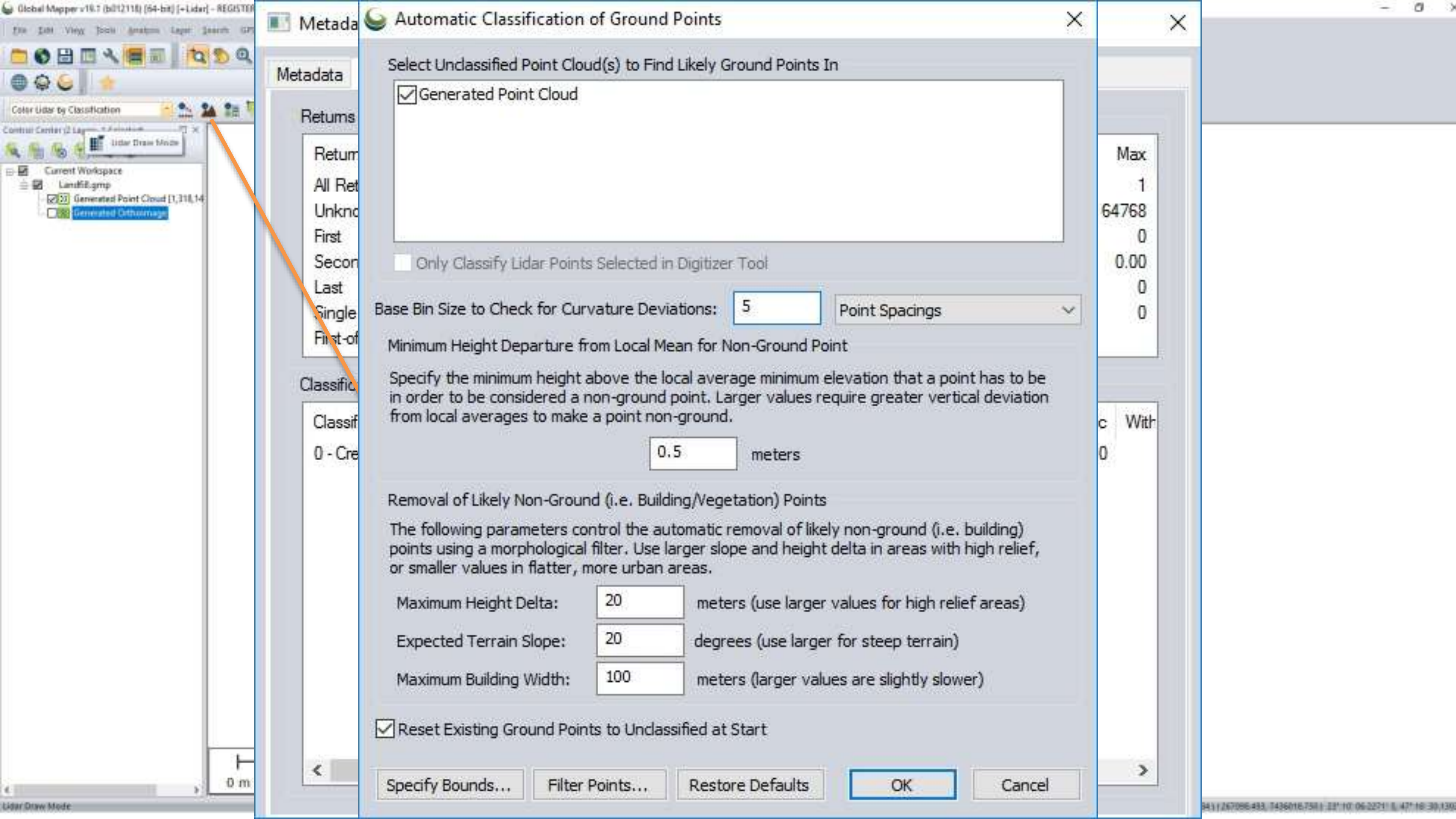
- Acquire images > The Software Tool
- Selection of correct images (removal of extra or erroneous images)
- Create high-density 3D point cloud using SfM
- Identify points for ground classification
- Create Elevation Grid
  - Apply smoothing based on sample area
  - Use one point at minimum elevation
- Calculate volume based on area selection

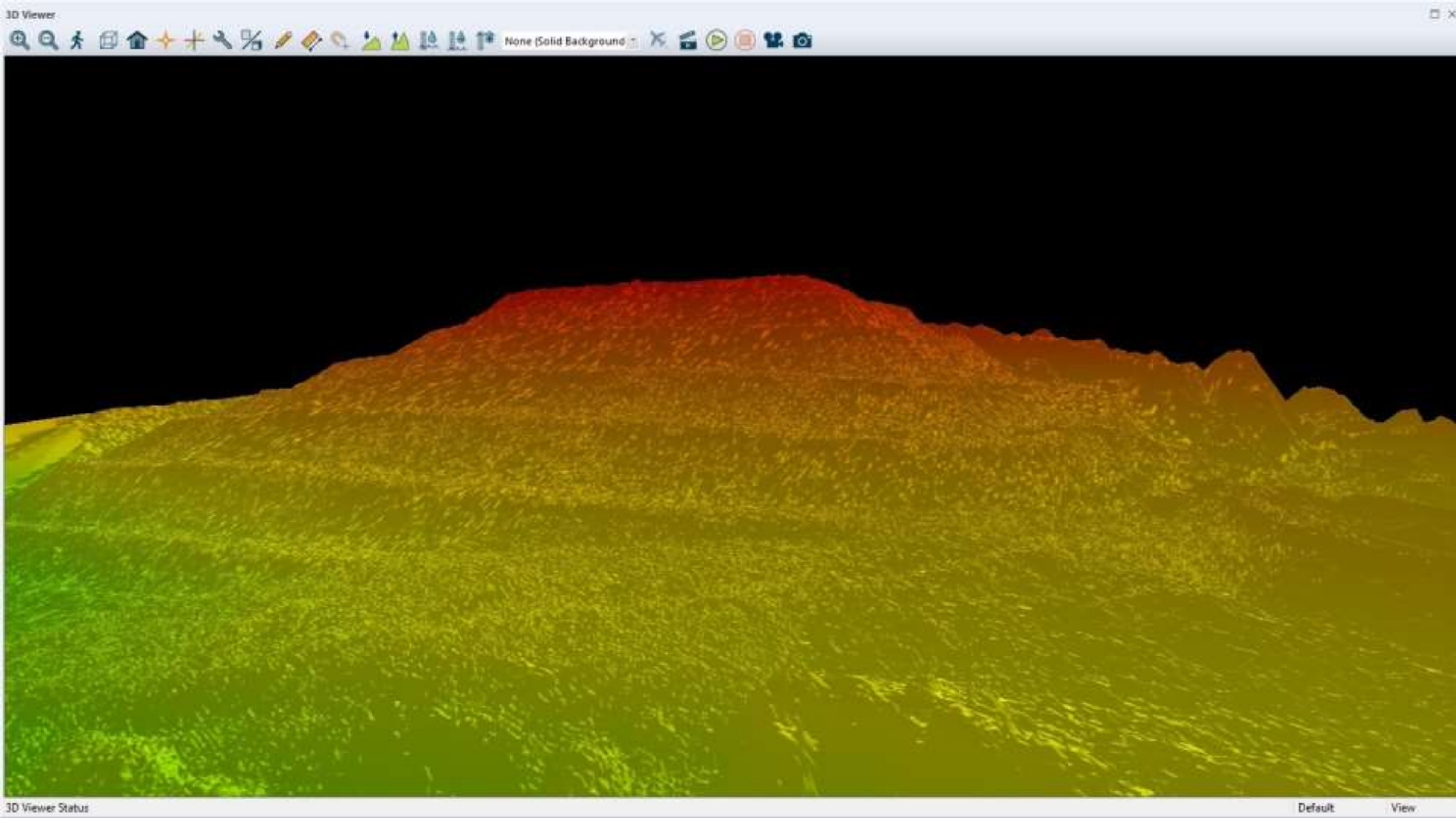


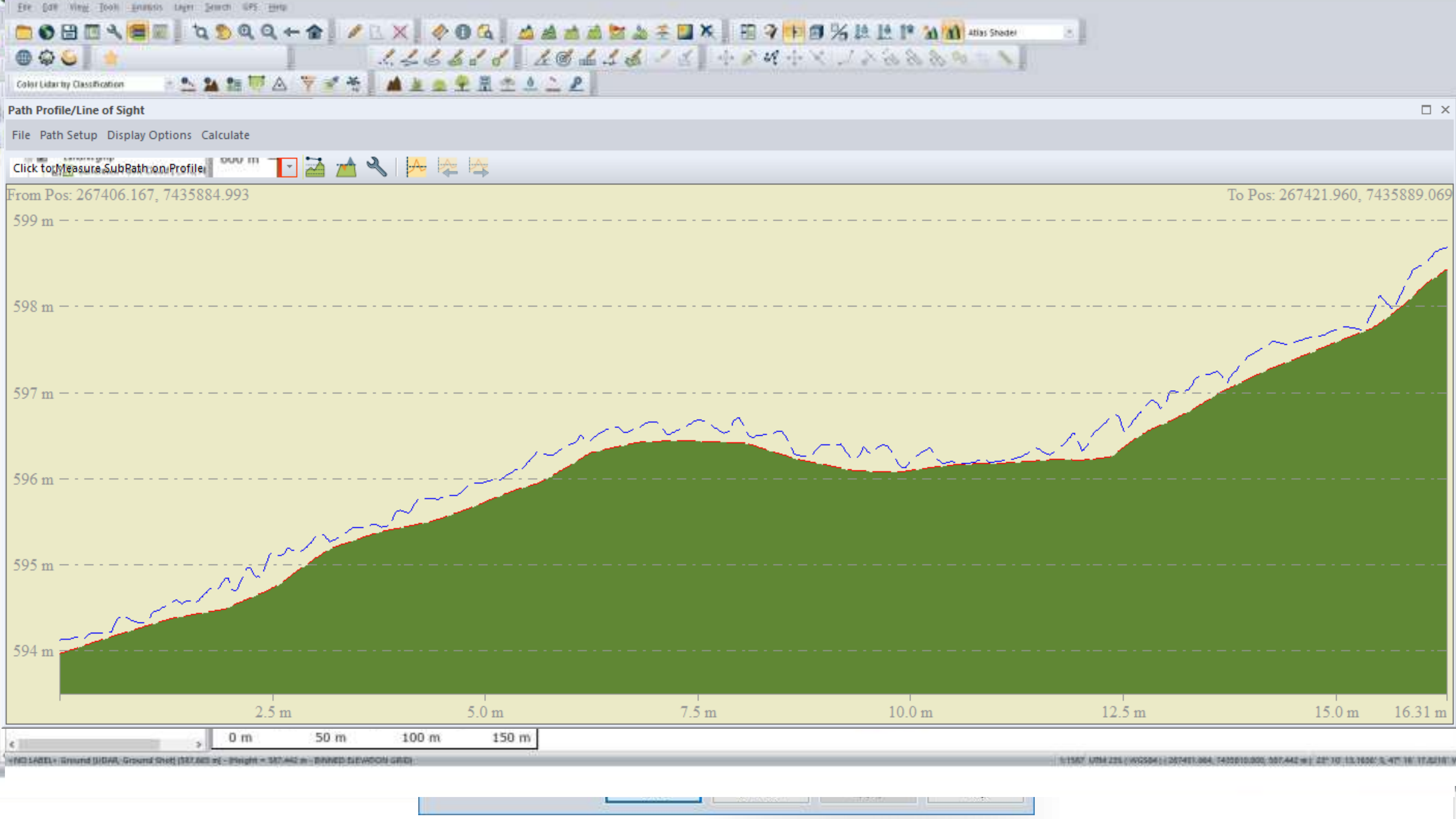
Global Mapper v19.1 (b012118) [64-bit] [+Lidar] - REGISTERED (LIDAR_Drone_Images.gmw*)
File Edit View Tools Analysis Layer Search GPS Help
Atlas Shader
Set up Favorites List...
Color Lidar by Classification
Current Workspace <LIDAR_Drone_Ima
Imagery.jp2
Bounds (1 Features)
Images
50 m
150 m
250 m
350 m
450 m

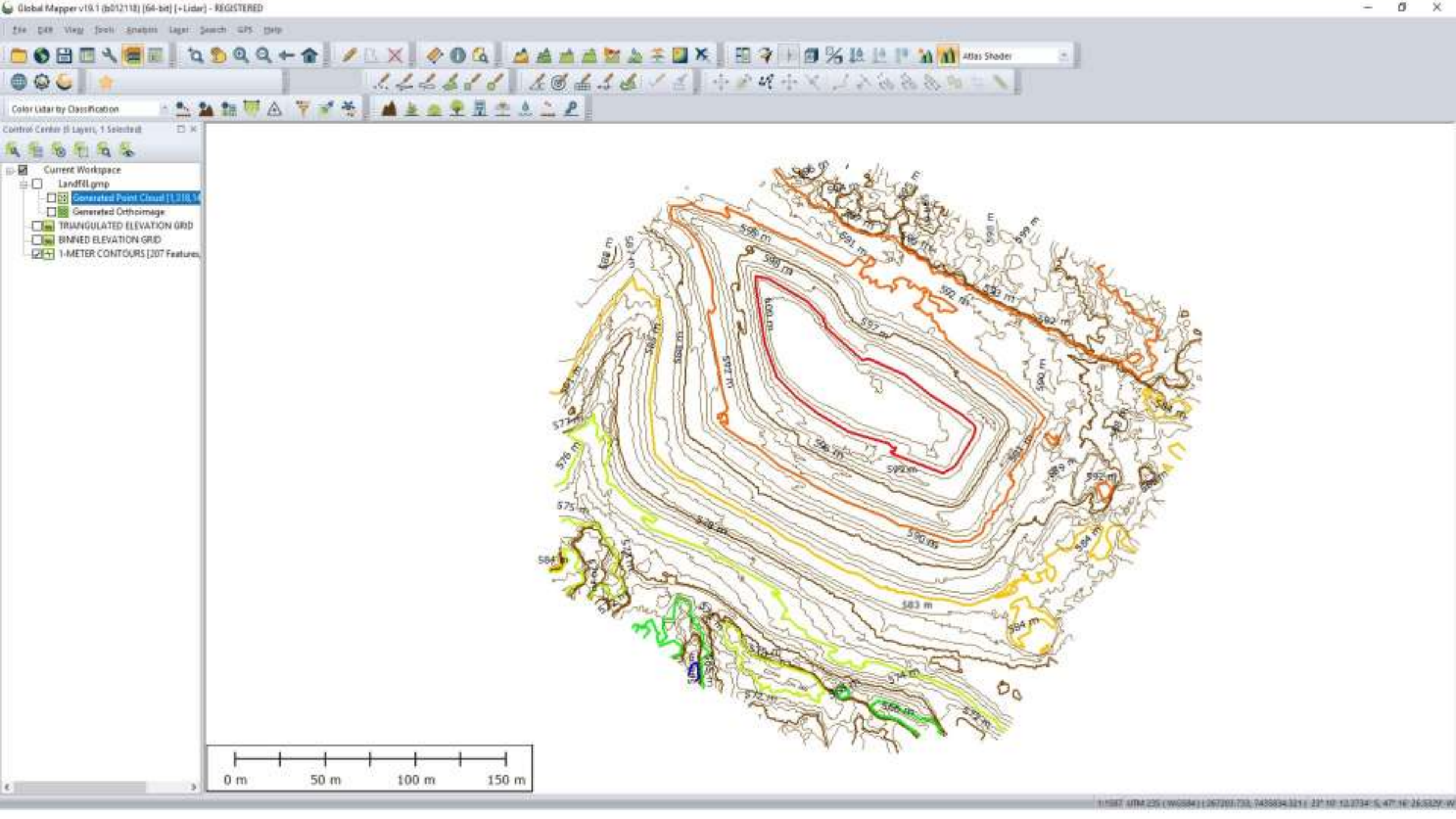

Pixels to Points Tool [BETA]
Input Image Files 192 of 192 Images Checked
Filename Latitude Longitude Elevation Image Size Camera
DSC08955.jpg 23° 10' 13.0556" S 47° 16' 21.7486" W 712.344 m 979 x 734 SONY DSC-WX220
DSC08956.jpg 23° 10' 11.8747" S 47° 16' 20.8865" W 711.502 m 979 x 734 SONY DSC-WX220
DSC08957.jpg 23° 10' 10.6287" S 47° 16' 20.0334" W 711.293 m 979 x 734 SONY DSC-WX220
DSC08958.jpg 23° 10' 09.4020" S 47° 16' 19.2087" W 711.292 m 979 x 734 SONY DSC-WX220
DSC08959.jpg 23° 10' 08.1193" S 47° 16' 18.2603" W 710.978 m 979 x 734 SONY DSC-WX220
DSC08960.jpg 23° 10' 09.7846" S 47° 16' 15.7202" W 709.874 m 979 x 734 SONY DSC-WX220
DSC08961.jpg 23° 10' 11.0413" S 47° 16' 16.5595" W 709.825 m 979 x 734 SONY DSC-WX220
DSC08962.jpg 23° 10' 12.1428" S 47° 16' 17.3087" W 710.993 m 979 x 734 SONY DSC-WX220
DSC08963.jpg 23° 10' 13.3082" S 47° 16' 18.1447" W 710.936 m 979 x 734 SONY DSC-WX220
DSC08964.jpg 23° 10' 14.5169" S 47° 16' 18.9583" W 711.303 m 979 x 734 SONY DSC-WX220
DSC08965.jpg 23° 10' 15.7331" S 47° 16' 19.7702" W 711.466 m 979 x 734 SONY DSC-WX220
DSC08966.jpg 23° 10' 16.9327" S 47° 16' 20.6316" W 711.613 m 979 x 734 SONY DSC-WX220
DSC08967.jpg 23° 10' 18.4461" S 47° 16' 18.0534" W 710.009 m 979 x 734 SONY DSC-WX220
DSC08968.jpg 23° 10' 17.2113" S 47° 16' 17.2217" W 711.998 m 979 x 734 SONY DSC-WX220
DSC08969.jpg 23° 10' 15.9588" S 47° 16' 16.3775" W 713.138 m 979 x 734 SONY DSC-WX220
DSC08970.jpg 23° 10' 14.7089" S 47° 16' 15.4906" W 712.822 m 979 x 734 SONY DSC-WX220
DSC08971.jpg 23° 10' 13.4538" S 47° 16' 14.6050" W 713.19 m 979 x 734 SONY DSC-WX220
DSC08972.jpg 23° 10' 12.1849" S 47° 16' 13.7719" W 713.362 m 979 x 734 SONY DSC-WX220
DSC08973.jpg 23° 10' 10.8970" S 47° 16' 12.8935" W 712.495 m 979 x 734 SONY DSC-WX220
DSC08974.jpg 23° 10' 12.8976" S 47° 16' 10.5580" W 710.173 m 979 x 734 SONY DSC-WX220
DSC08975.jpg 23° 10' 14.1646" S 47° 16' 11.3757" W 711.149 m 979 x 734 SONY DSC-WX220
DSC08976.jpg 23° 10' 15.3600" S 47° 16' 12.1846" W 711.526 m 979 x 734 SONY DSC-WX220
Add File(s)...
Add Folder...
Add Loaded...
Remove Selected
Load Images in Main Map
Image Preview / Ground Control Points (DSC08968.jpg)
New Point...
Add Point to Image...
Remove Selected
Ground Control Points (select and press Add Point to add to image)
Name Symbol # Points Latitude Longitude Elevation X Y
Point Cloud Output
Save to GMP File -->
Select...
Layer Description: Generated Point Cloud
Orthoimage Output
Create Orthoimage GMP File -->
Select...
Layer Description: Generated Orthoimage
Resampling (for Noise Removal): Filter/Noise/Median (3x3)
Resolution: 1
Point Spacings
Mesh (3D Model) Output [NOTE: Slow to Generate]
Save to PLY (Stanford Polygon Library) File -->
Select...
Log/Statistics Output
Save Log/Statistics to Folder
Select...
Options
Reduce Image Size (Faster / Less Memory) by Factor of 2
Use Relative Altitude Based on Ground Height of 0 m
Analysis Method
Incremental (Default) - Typically Best Option
Global - Works Well for Large Overlap, May be Much Faster and Provide Better Results in Some Situations
Quality: Normal (Default)
Camera Type: Pinhole Radial 3 (Default)
Save to File...
Load From File...
Run
Close
Help...


Global Mapper v19.1 (b012118) [64-bit] [+Lidar] - REGISTERED
Metadata (Generated Point Cloud)
Metadata
Statistics
Histogram
Projection
Attribute Name Attribute Value
FILENAME C:\BMGDemoData\GM_LIDAR_Training\Data\Drone_Images\Completed_Point_Cloud\La
DESCRIPTION Generated Point Cloud
AREA COUNT 0
LINE COUNT 0
POINT COUNT 0
MESH COUNT 0
LIDAR POINT COUNT 1,318,145
POINT CLOUD MEMORY 10.8 MB (PREVIEW CLOUDS: 6.2 MB)
LIDAR POINT DENSITY 25.517 samples / m^2
LIDAR POINT SPACING 0.198 m
LIDAR OFFSET (267481.3295988, 7435847.76197381, 0)
LIDAR SCALE (0.01, 0.01, 0.0001)
UPPER LEFT X 267301.190
UPPER LEFT Y 7436006.712
LOWER RIGHT X 267661.470
LOWER RIGHT Y 7435688.812
WEST LONGITUDE 47° 16' 23.1877" W
NORTH LATITUDE 23° 10' 06.7212" S
EAST LONGITUDE 47° 16' 10.3514" W
SOUTH LATITUDE 23° 10' 17.2337" S
UL CORNER LONGITUDE 47° 16' 23.0132" W
UL CORNER LATITUDE 23° 10' 06.7212" S
UR CORNER LONGITUDE 47° 16' 10.3514" W
UR CORNER LATITUDE 23° 10' 06.9039" S
LR CORNER LONGITUDE 47° 16' 10.5256" W
LR CORNER LATITUDE 23° 10' 17.2337" S
LL CORNER LONGITUDE 47° 16' 23.1877" W
LL CORNER LATITUDE 23° 10' 17.0510" S
PROJ_DESC UTM Zone -23 / WGS84 / meters
PROJ_DATUM WGS84
PROJ_UNITS meters
EPSG_CODE EPSG:32723
COVERED AREA 0.1145 sq km
LOAD TIME 0.22 s
SFM_TYPE INCREMENTAL
SFM_QUALITY NORMAL
DENSIFY_REDUCE_POWER 2
CAMERA_MODEL PINHOLE_RADIAL_3
IMAGE_FOLDER C:\Users\davidmckittrick\Desktop\GM_LIDAR_Training\Data\Drone_Images\
IMAGE_COUNT 54
IMAGE_PIX_COUNT 9710820
IMAGE_REDUCE_FACTOR 2
VERT_DATUM WGS84 Ellipsoid
MIN ELEVATION 558.449 METERS
MAX ELEVATION 604.429 METERS
Copy to Clipboard
Color Lidar by Classification
Current Workspace
Landfill.gmp
3D Viewer
3D Viewer Status
Default
View


Automatic Classification of Ground Points
Select Unclassified Point Cloud(s) to Find Likely Ground Points In
Generated Point Cloud
Only Classify Lidar Points Selected in Digitizer Tool
Base Bin Size to Check for Curvature Deviations:
5
Point Spacings
Minimum Height Departure from Local Mean for Non-Ground Point
Specify the minimum height above the local average minimum elevation that a point has to be in order to be considered a non-ground point. Larger values require greater vertical deviation from local averages to make a point non-ground.
0.5
meters
Removal of Likely Non-Ground (i.e. Building/Vegetation) Points
The following parameters control the automatic removal of likely non-ground (i.e. building) points using a morphological filter. Use larger slope and height delta in areas with high relief, or smaller values in flatter, more urban areas.
Maximum Height Delta:
20
meters (use larger values for high relief areas)
Expected Terrain Slope:
20
degrees (use larger for steep terrain)
Maximum Building Width:
100
meters (larger values are slightly slower)
Reset Existing Ground Points to Unclassified at Start
Specify Bounds...
Filter Points...
Restore Defaults
OK
Cancel
Metadata
Returns
Max
1
64768
0
0.00
0
0
With
0
Current Workspace
Generated Point Cloud
Generated Orthoimage
Color Lidar by Classification
Lidar Draw Mode


3D Viewer
None (Solid Background
3D Viewer Status
Default
View


Path Profile/Line of Sight
File
Path Setup
Display Options
Calculate
Click to Measure SubPath on Profile
From Pos: 267406.167, 7435884.993
To Pos: 267421.960, 7435889.069
599 m
598 m
597 m
596 m
595 m
594 m
2.5 m
5.0 m
7.5 m
10.0 m
12.5 m
15.0 m
16.31 m
0 m
50 m
100 m
150 m
Atlas Shader
Color Lidar by Classification


Global Mapper v19.1 (b012118) [64-bit] [+Lidar] - REGISTERED
File Edit View Tools Analysis Layer Search GPS Help
Atlas Shader
Color Lidar by Classification
Current Workspace
Landfill.gmp
Generated Orthoimage
TRIANGULATED ELEVATION GRID
BINNED ELEVATION GRID
1-METER CONTOURS [207 Features
600 m
598 m
597 m
596 m
592 m
591 m
590 m
589 m
584 m
583 m
577 m
576 m
575 m
574 m
0 m
50 m
100 m
150 m

Summary – Pixels to Points workflow

- How Pixels to Points uses Photogrammetry & Triangulation
- Generate point clouds w/EXIF geotags/georeferenced pixels OR…
- Use network of ground control points for tighter accuracy
- Selection of correct images (removal of extra or erroneous images)
- Identify classified ground points
- Grid DEMs from point cloud– Triangulate or Bin to create a“bare-earth” model
- 3D volumetric measurements
- Contour, area feature generation

GlobalMapper

LiDAR Module

NOW WITH PIXELS-TO-POINTS™

Questions?

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