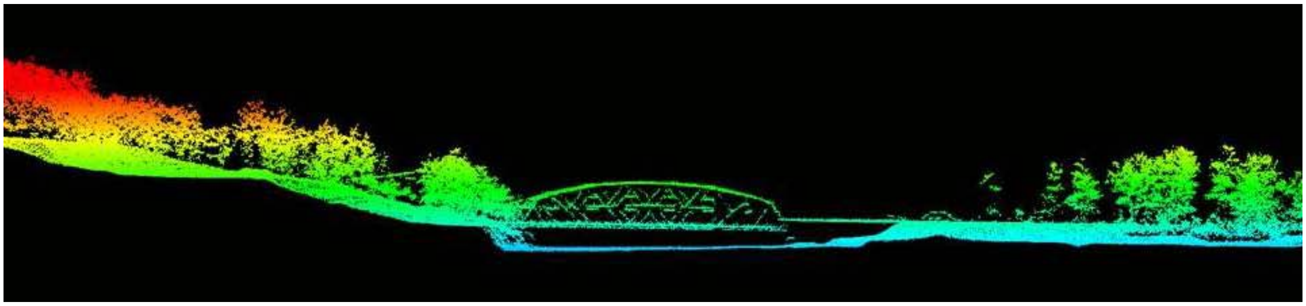


Matanuska-Susitna Borough LiDAR & Imagery Project Quality Assurance Report Talkeetna Block

Written by Rick Guritz

Alaska Satellite Facility

Nov 1, 2012

Contents

Study Area – Talkeetna Block

The study area for this report is the Talkeetna block, which includes 597 square miles covering the next block just North of Caswell Lake block. In the delivery blocks and tile map, it is shown in light orange (see Figure 1).

Basis for Evaluation

The Software used for the evaluation includes:

- ESRI ArcMap and ArcCatalog 10.0
- Applied Imagery Quick Terrain Modeler v7.1.5 64-bit
- Blue Marble Geographics, Global Mapper v13.1.2

Each block of LiDAR will be evaluated in the following ways:

- Check formatting and completeness of data delivery,
- Check completeness, clarity, and compliance of metadata,
- Assess the planimetric accuracy of the LiDAR data,
- Assess the vertical accuracy of the LiDAR data,
- Assess the LiDAR point cloud data of return density and classification accuracy,
- Assess the LiDAR bare-Earth and first-return surface data by mosaic and shaded relief analysis, identifying gaps, seams, anomalies, and hydro-flattening of data,
- Verify consistency of various derived products being provided by LiDAR contractor.

Itemized products to be evaluated include:

- Metadata
- Classified point cloud data in LAS format
- Bare-Earth surface (below canopy raster DEM)
- First-Return surface (top of canopy raster DSM)
- Intensity image composite
- Hydro-flattening breaklines (single and double line) and lake polygons
- Contours (elevation)
- Shaded relief mosaics
- Tile Index (full and quarter tile) and building feature classes (structures >400 square feet)

Format and Completeness of Data Delivery

Five separate data deliveries were required to correct all identified data anomalies. Each delivery provided data on an external computer disk organized by block and data type or smaller tile fixes were staged to FTP. The Caswell Lake block deliveries included:

- Metadata – A single metadata file for each major product type including point clouds, raster bare-Earth DEM, raster first-return DSM, elevation contours, elevation contours in DXF.
- LiDAR DATA - LAS point cloud data for 238 quarter tiles covering 63 full tiles of data.
- Contours – DXF format contours for 238 quarter tiles covering 63 full tiles of data.
- Block Geodatabase which contained the following elements:
    - Bare-Earth DEM raster catalog,
    - Buildings feature dataset,
    - Contours feature dataset,
    - First-return DSM raster catalog,
    - Hydro features dataset including single and double breaklines and lake polygons,
    - Intensity Imagery raster catalog,
    - Tile index feature datasets including full and quarter tile,
    - Block boundary polygon.

The contents of the LiDAR point cloud files were verified to include the expected LiDAR classification layers. Then each layer was loaded into Quick Terrain Modeler (QTM) to verify coverage and extent of each classification layer. Each layer was captured to a computer graphic image in jpeg format for review. In some cases, the number of points within a classification layer needed to be separated into quarter block areas to keep within available memory (16 GB) to optimize RAM use. In these cases up to four jpeg images were saved for the layer. Although this process was time consuming, it proved very useful in identifying omissions in coverage for particular classifications. By saving each layer in QTM, the number of points included in each classification layer was compiled to verify that the data was distributed appropriately between classification layers.

The contractor supplied GIS layers including block boundary, full and quarter tile indexes were displayed and evaluated to insure consistency with the original project coverage feature class (see Figure 2). The raster catalogs stored in the block geodatabase were combined into large scale raster mosaics and stored as geotiff products for evaluation purposes. Shaded relief images were produced from each of the surface elevation products to evaluate completeness of coverage, gaps, seams, or other data anomalies. The intensity image mosaic was also evaluated for completeness of coverage and quality of data. We observed variability in the LiDAR intensity data that is typical for this type of data. This is due to variations in sunlight conditions at time of acquisition and other factors that are beyond the contractor's control.

Completeness, Clarity, and Compliance of Metadata

Each metadata file was examined for both content and clarity of the included metadata descriptions. Minor changes were requested when UAF spotted inaccuracies or omissions. In general, UAF found the metadata to be very good. To test for FGDC metadata format compliance, we used the USGS Metadata Parser (MP) program. No metadata errors were reported with the revised metadata after the initial errors reported in Point Mackenzie block.

Planimetric Accuracy of the LiDAR Data

There were seven checkpoints for the developed classification in the Talkeetna block. The survey contractor, Lounsbury & Associates, identified and surveyed paint markings or storm covers on the asphalt surface of roads. Although these points provide a reliable elevation, they were not identifiable within the LiDAR data or complement ortho imagery. I understand from MSB staff that the contract language did not convey correctly map identifiable features such as road intersections, corners of buildings, or unique lake shoreline features that would not be influenced by water level change. A PowerPoint presentation file was assembled with ground survey pictures with image chips from both the LiDAR intensity and complement ortho imagery. In review of this data, in proximity to the survey checkpoint locations the LiDAR intensity data agreed well with the complement ortho imagery.

Vertical Accuracy of the LiDAR Data

There were twelve checkpoints within the Talkeetna block. These included seven developed and five forested points in separate land cover classifications. Using ArcMap, a Bare-Earth DEM mosaic was produced and elevation values for all checkpoints were extracted from the DEM. This was compiled into a spreadsheet and organized by land cover classifications on separate worksheets (see Figure 3). A vertical accuracy assessment was done for each land cover classification and compared to target accuracy specifications included in the LiDAR contract. For thoroughness, two methods were included for consideration including the RMSE at 95% and the 95 percentile. Usually one or the other is used based on the expected error distribution for a given land cover classification. However, a minimum of twenty points is required for the 95 percentile to be statistically valid. UAF also looked at the combined class statistics which are included below. The target accuracy specifications are listed to the right of each accuracy measurement. The target accuracy is colored green if it passed or red if it failed to meet the requirement. For Talkeetna block, the developed and forested class checkpoints were accurate enough to meet the target accuracy specification. The combined accuracies of all points were also accurate enough to meet the target accuracy specification. **The Talkeetna block easily met the target accuracy specification for all land cover classes.**

Developed		Developed	
Statistical Summary:	**Feet**	**Meter**	**Accuracy**
Count = 7 pts			
Min =	-0.323	-0.098	
Max =	0.238	0.073	
Mean =	-0.071	-0.022	
RMSE =	0.174	0.053	
RMSE*1.96 (95%) =	0.342	0.104	< 0.363 m
95 Percentile =	0.164	0.050	< 0.363 m
Stddev =	0.159	0.049	

Table 1, Developed Class (SVA) Accuracy Assessment Summary

Forested			Target
Statistical Summary:	**Feet**	**Meter**	**Accuracy**
Count = 5 pts			
Min =	0.005	0.001	
Max =	0.713	0.217	
Mean =	0.377	0.115	
RMSE =	0.480	0.146	
RMSE*1.96 (95%) =	0.941	0.287	< 0.363 m
95 Percentile =	0.710	0.217	< 0.363 m
Stddev =	0.297	0.091	

Table 2, Forested Class (SVA) Accuracy Assessment Summary

Combined			Target
Statistical Summary:	**Feet**	**Meter**	**Accuracy**
Count = 12 pts			
Min =	-0.323	-0.098	
Max =	0.713	0.217	
Mean =	0.116	0.035	
RMSE =	0.337	0.103	
RMSE*1.96 (95%) =	0.661	0.202	< 0.363 m
95 Percentile =	0.705	0.215	< 0.363 m
Stddev =	0.317	0.097	

Table 3, Combined (CVA) Accuracy Assessment Summary

LiDAR Point Cloud Data Density and Classification Accuracy

Point Density was determined using LAS tools provided by Aerometric. The application provides an ability to count point density creating ESRI ASCII GRID files for each tile. Global Mapper was used to read and display all of these grid files for the block (see Figure 4). We had to limit the point density per cell to a maximum of 12 points clamping values greater to that value so that the color map would show sufficient color variation at the low end. Point density is displayed using a color map from blue (low) to red (high). The grid spacing used for the evaluation was 4 feet per pixel, 2*NPS of 0.6 meter as specified in the contract. The First-Return of all valid classes (2-6, 8-11, and 13-14), excluding withheld bit data classes (1 and 7). At least 90% of the cells should contain at least one LiDAR point. For the Talkeetna block, first-return density was confirmed to exceed 90% for all interior cells of the combined point cloud data.

Each classification layer in the LAS point cloud was loaded into Quick Terrain Modeler to verify extent and completeness of coverage, number of points per class, and accuracy of classification. Given the number of points included in some of the larger classifications, it is necessary to split the block into quarters (i.e. SW, SE, NW, and NE). Some classes such as the low, medium, and high vegetation are texture mapped using a solid color such as light, medium, and dark green respectively. Otherwise, the data is displayed with a color ramp for the elevation range of the block. In this way, the four blocks can be assembled into complete block coverage with a consistent color map for the height variation. During the assessments, UAF found and reported inconsistencies where data were omitted. Aerometric used the improved class definitions of previously processed blocks such as separation of unclassified data swaths ends (CLASS 1) from surface clutter data (class 13), and redefining low vegetation from 1 to 6 feet. For the Talkeetna block, cross calibration swaths were observed in the unclassified data (class 1), and the low vegetation class included returns over water were identified and fixed by Aerometric.

The classifications included in the LAS point cloud data are listed below in order of class with point count totals per class:

Class # - Class Description	Point Count	Reference
Class 1 - Unclassified Data (marked as withheld)	690,043,798	Figure 5
Class 2 - Ground	1,567,024,362	Figure 6
Class 3 - Low Vegetation	319,050,527	Figure 7
Class 4 - Medium Vegetation	447,039,002	Figure 8
Class 5 - High Vegetation	2,103,350,111	Figure 9
Class 6 - Buildings	698,771	Figure 10
Class 7 - Error Points (Noise)	14,647,914	Figure 11
Class 8 - Ground Model Keypoints	116,136,822	Figure 12
Class 9 - Water	40,004,514	Figure 13
Class 10 - Breakline Proximity	1,427,511	Figure 14
Class 11 - Power Transmission Lines	223,208	Figure 15
Class 13 - Surface Clutter (within foot of surface)	690,043,798	Figure 16
Class 14 - Bridge Decks	32,145	Figure 17

Table 6, LiDAR Point Cloud Classes Summary Table

Cross validation analysis was performed between each of the class layers and other source data. Quick Terrain Modeler was used initially to produce height profiles of multiple layers from a point cloud. This capability was used to verify issues with the low vegetation layer extending across rivers and streams (see Figure 18). This shows the presence of LiDAR returns from each vegetation layer, low, medium, high, ground, and water surfaces. Another example, a canopy height can be estimated by subtracting the bare-Earth surface DEM from the first-return DSM (see Figure 19). This product could then be colorized based on a number of classifications to match each of the three vegetation layers (see Figure 20), i.e. 1-6 feet for low vegetation (light green), 6-15 feet for medium vegetation (medium green), and greater than 15 feet for high vegetation (dark green). Barren ground could have height differences from -1 to 1 foot. Other classes could draw attention to outlier heights such as values less than one (red) and values greater than 120 feet (violet). The individual layer product could be compared to this classified product, keeping in mind that in high vegetation, there may also be returns for medium vegetation, low vegetation, or even ground. Other layers such as water can be compared to bare Earth elevations of the lakes and rivers by using the contractor supplied polygons of lakes and single and double breakline polyline feature files to clip and compare elevations of hydro flattened water to the LiDAR point cloud elevations. Similarly, the buildings layer can be compared to both the buildings feature class and to the ortho imagery for the block to verify the accuracy of the buildings layer.

LiDAR Gridded Products

There are three gridded products being delivered for each block. These include the bare-Earth DEM, the first-return DSM, and the LiDAR intensity image. Each of these raster data sets are being delivered as raster catalogs within the block geodatabase. For each type of data, a mosaic product was produced from each raster catalog (see Figure 21, 22, and 23). Then for the two surface products, a shaded relief image is produced with consistent elevation and angle of the sun to provide consistency (see Figure 24 and 25). These derived images are then evaluated visually by zooming up to a quarter-tile per screen and panning through the mosaic, left to right, and top to bottom. Any height discontinuity between swaths or tiles would show up as a darker linear feature with a common orientation (to detect seams). Any regions of missing data will show up as dark edge to white interior of the missing data (to detect voids). Surface texture gives clues to intermittent vegetation (to detect corn rows) which may or may not be valid depending on the surface type. If anomalies are detected, then comparison to tile edges or swath edges can be made by bringing in other GIS layers for comparison. For the Talkeetna block, between block seams were detected between Talkeetna and North Susitna blocks in both bare-Earth DEM and shaded relief images. Holes over water feature were also reported in the bare-Earth DEM. Negative height differences were observed in the canopy height product of eight small regions due to alignment issues in the first return DSM. The LiDAR intensity data had a missing tile and visible tile seams. These problems were reported and later fixed in subsequent deliveries. Other issues such as power transmission lines and related height anomalies over water were reported as a result of redelivery of data, requiring multiple deliveries of the same product.

The bare-Earth gridded DEM is hydro flattened according to contract specifications. To verify this and to insure consistent heights were retained over water features, GIS analysis was performed on the contractor supplied data. The hydro breaklines include lake polygons, and either single for small streams and double breaklines for larger streams are included (see Figure 26). First the lake polygons were used to clip the bare-Earth DEM elevations for lake heights. This was compared to the water heights layer from the point cloud data. By loading consistent color map, contract stretch method to linear and minimum/maximum height range into both ArcMap and Quick Terrain Modeler the resulting images can be compared for consistency. Streams greater than 100 feet nominal width and a list of nineteen streams supplied by the Matanuska-Susitna Borough should be delineated with double breaklines. These polyline structures are combined to create polygons for each stream or river contained in the block. The hydro breaklines were delivered as polylines, so additional editing was needed to separate major rivers and streams from each other as individual polygons. Then the bare-Earth DEM was clipped for each river, stream, or slough, colorized and compared to the point cloud layer for that specific water body. A similar approach is taken within Quick Terrain Modeler for the specific water body so that the heights of the flattened water can be compared to the original LiDAR returns over that water surface. In this way, all streams could be checked for flow direction, magnitude, and consistency to the original LiDAR returns over that water body. In some cases, stream width and long length of smaller streams required dividing a stream into multiple equal length sections to retain visibility of the resulting image. For the Talkeetna block, we analyzed lakes (see Figure 27) and streams including Nine Mile Creek (see Figure 28 - 29), Moose Creek (see Figure 30- 32), Papa Bear Creek (see Figure 33), Rabideux Creek (see Figure 34), Susitna River (See Figure 35), Talkeetna River (see Figure 36), Tokositna River (see Figure 37) and Trapper Creek (see Figure 38 - 41). A height anomaly was reported for Papa Bear Creek, due to an island not being included in the double breakline drainage. Lack of LiDAR returns over the south end of Rabideux Creek was investigated and reported due to deep clear water. Corrected double breakline drainage and bare-Earth DEM tiles were redelivered to fix Papa Bear Creek. All other water bodies looked good.

LiDAR Derived Products

Derived products include a variety of GIS layers including tile index, hydro breaklines of lakes and streams, building feature class and topographic contours. These are delivered as elements in a block geodatabase. The tile index feature class provides both full tile and quarter tile. Aerometric was asked to include a block boundary feature class for each block that defines the geographic extent of each block. This should align where blocks join each other and provide a 100 meter buffer where no adjacent blocks are present. The boundary file is first checked against the original block definition provided with the LiDAR contract by Matanuska-Susitna Borough. The desired coverage and added buffer distance has been verified.

The building feature class is verified by performing a detailed examination of the quarter tile with the most buildings. Visual verification is performed on each building to the ortho imagery or canopy height difference classification (see Figure 42 and 43) looking for buildings that were missed or classified building that were incorrectly identified (false positives). Buildings of greater than 400 square feet should be included at 97% success rate. Separate feature classes are created for new buildings and buildings that were misclassified (false positives). Areas are calculated for new buildings and the accuracy for this quarter tile is checked and reported. Given the limited time, the quarter tile with the highest building density was checked for accuracy and reported as representative of the block. For the Talkeetna block, tile TAL_031_SW was identified as the quarter tile with the most buildings in it, including 316 buildings. First I determined which quarter tile contained the most buildings and found

TAL_031_SW to have the most buildings at 316. I then performed my analysis and found 6 false positives of which 2 were greater than 400 square feet. I also found 28 missed buildings some of which may be trailers of which 4 were
greater than 400 square feet. This left 317 correctly detected buildings of which 244 were greater than 400 square feet. So if we just count building greater than 400 square feet, we have 2 false positives and 4 missed buildings for a total of six errors in 248 total buildings or an error rate of 2.4 percent. This can also be stated as a 97.6 percent success rate which exceeds the accuracy requirement of 97%.A final building analysis graphic (see Figure 44) was produced with accurate buildings (light blue), incorrect buildings (red), and new buildings (dark blue) to document results from the analysis. Separate feature classes for each of the three categories are also produced for further analysis and provided to the Matanuska-Susitna Borough GIS staff.

The elevation contours are supplied in two different formats, one as a polyline feature for each tile in the block geodatabase, and the other is in AutoCAD format DXF format. A set of four contour tiles are displayed as an overlay to the bare-Earth DEM and visually examined for consistency. Due to limited time, only a statistical sample of the data is evaluated. The Matanuska-Susitna Borough GIS staff suggested that UAF pick contour tiles with the steepest slope as candidates for testing. A slope map in degrees was first generated from the bare-Earth DEM mosaic and colorized with a blue to red color map with steepest terrain in red (see Figure 45). From this map, tiles with the steepest terrain were selected. Each of four tiles were displayed and compared with the bare-Earth DEM elevations for that tile. The tighter the space between contours, the steeper the slope should be in the corresponding DEM. This can be visually compared to how rapid the change in color is of the underlying DEM. Next, UAF created topologies for each of the selected tiles, testing for contour topology errors based on four selected rules. These rules include: there are no intersects, there are no overlaps, there are no dangles (except at tile edges), and must be single part. Each contour tile was then evaluated to these topology rules and errors were documented and reported to Aerometric. For Talkeetna block, four tiles tested showed topology errors that needed to be fixed. Using the topology edit tool, zooms of each error was captured in a graphic file and sent to Aerometric to be fixed. We requested that Aerometric test all tiles using the same methodology, not just the ones we reported. Upon redelivery of the data, we doubled the number of tiles tested to verify that everything was good (see Figure 46 and 47).

Quick Terrain Modeler has an ability to drape the AutoCAD contour files in DXF format over a corresponding DEM and visualize it in either 2D or 3D. This capability was used to spot check the DXF files for problems (see Figure 48 and Figure 49). The selected Talkeetna contour products were spot checked for completeness and accuracy.

Talkeetna Block Results and Recommendations

After significant effort testing, documenting data quality issues, consulting with Aerometric and the Matanuska-Susitna Borough GIS staff, and testing six redeliveries. UAF is confident that the Talkeetna block is of acceptable quality. The spatial extent, coverage provided, vertical accuracy, completeness and consistency of products makes this block the fourth of which we recommend acceptance. Aerometric has worked hard to address all of the identified quality issues to date. UAF has thoroughly documented the results of its assessments, including a complete record of all quality issues to date and what the solution was for each case.

Upon completion of writing this report and reviewing the results of our assessments, UAF recommends that the Talkeetna block be accepted. We are very pleased with the quality of data for this block. Aerometric is applying lessons learned from each reported data quality issue to subsequent block deliveries.

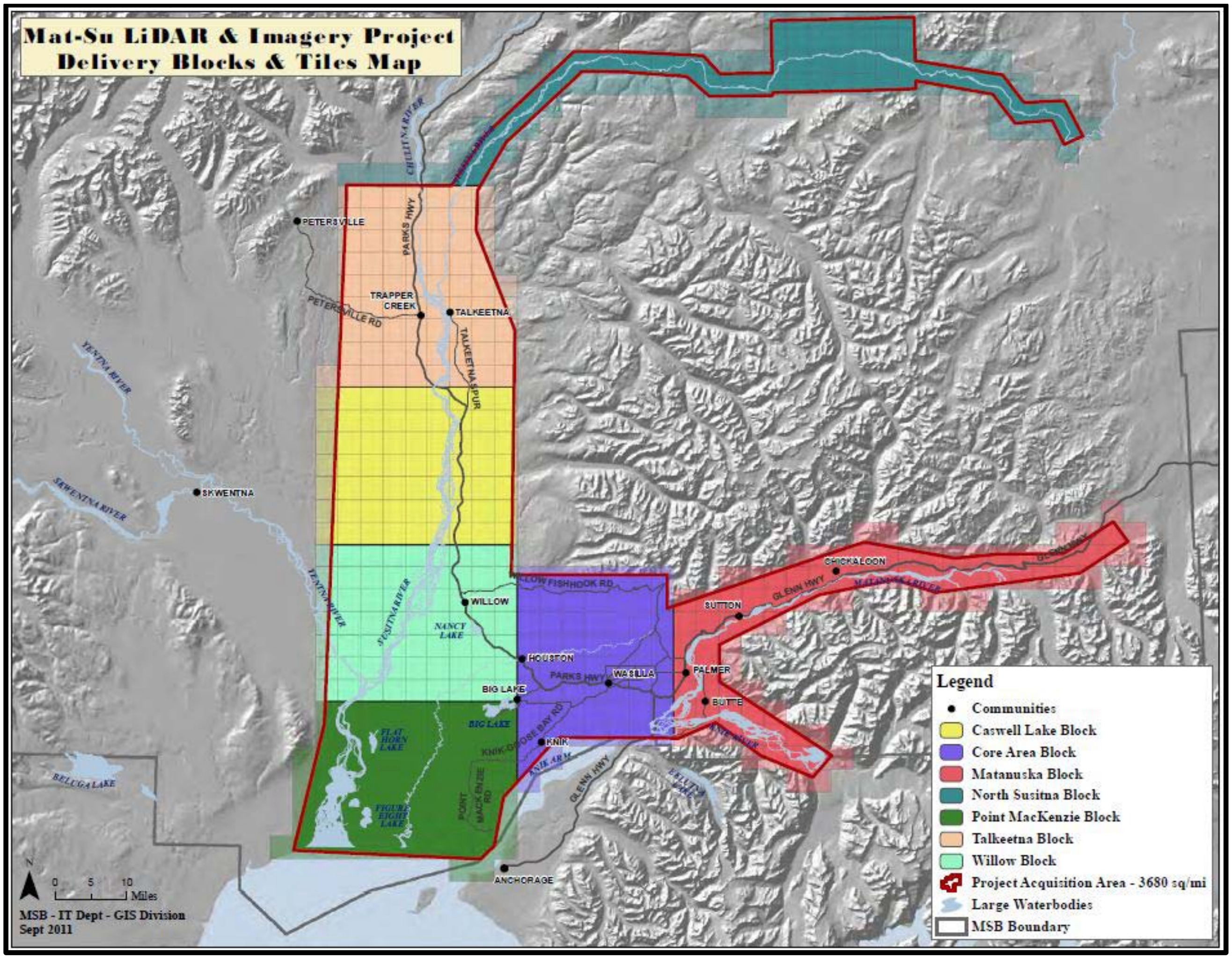


Figure 1, Mat-Su LiDAR & Imagery Project Delivery Blocks & Tiles Map

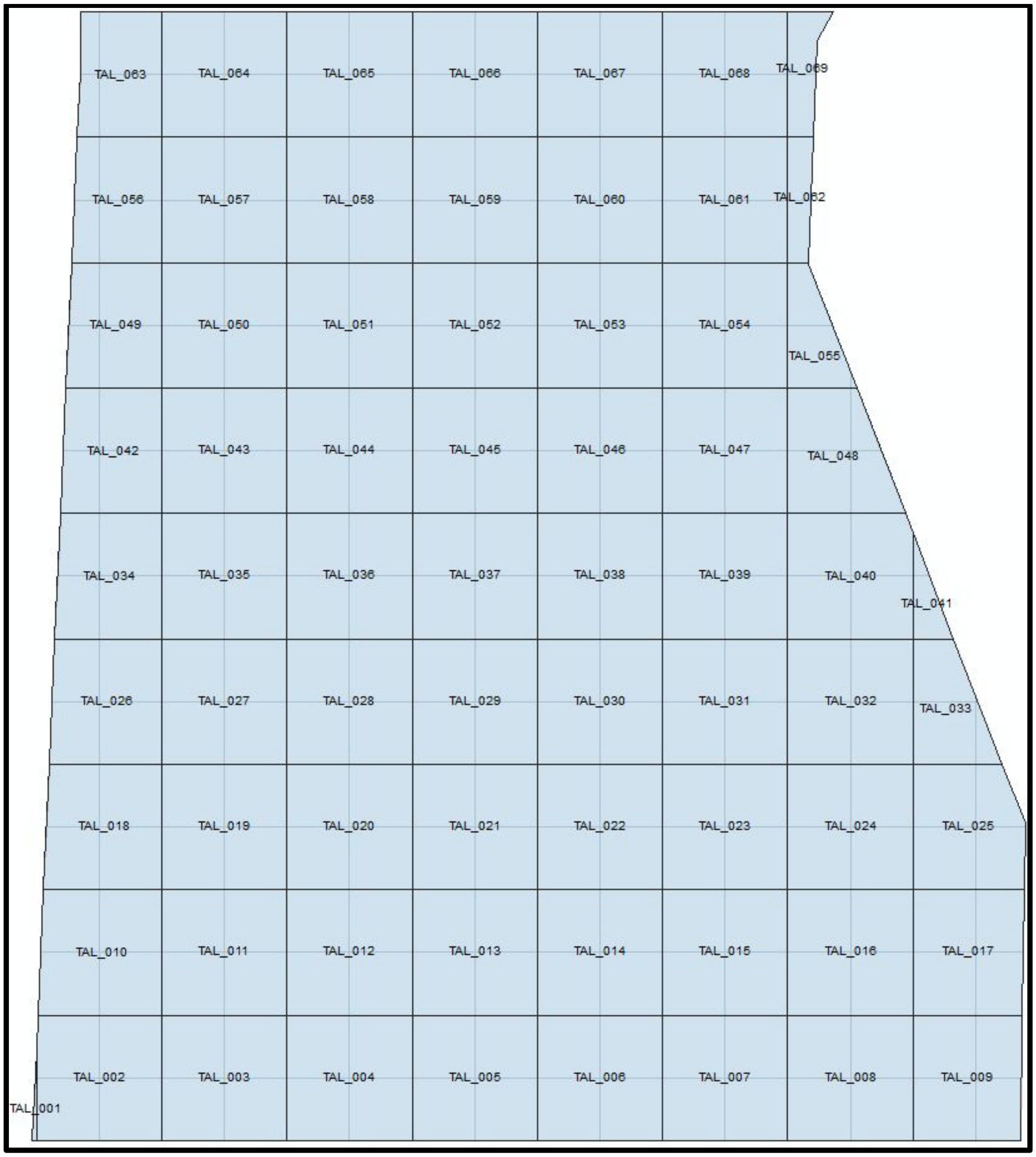
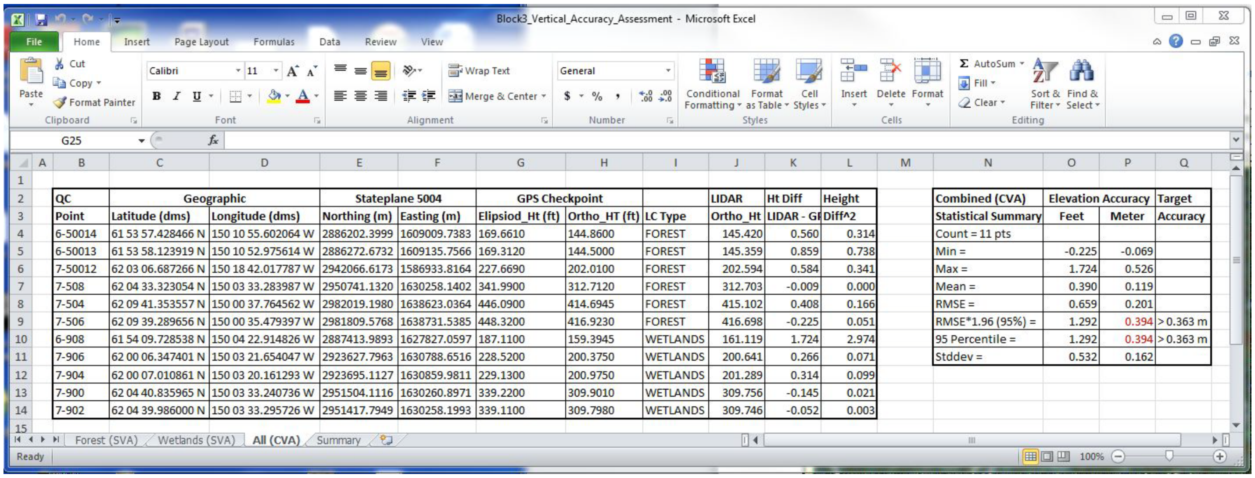


Figure 2, Contractor Supplied GIS Layers. Full tile (green), quarter tile (light green), and block boundary (green).



QC	Geographic		Stateplane 5004		GPS Checkpoint			LIDAR	Ht Diff	Height
Point	Latitude (dms)	Longitude (dms)	Northing (m)	Easting (m)	Elipsiod_Ht (ft)	Ortho_HT (ft)	LC Type	Ortho_Ht	LIDAR - GI	Diff^2
6-50014	61 53 57.428466 N	150 10 55.602064 W	2886202.3999	1609009.7383	169.6610	144.8600	FOREST	145.420	0.560	0.314
6-50013	61 53 58.123919 N	150 10 52.975614 W	2886272.6732	1609135.7566	169.3120	144.5000	FOREST	145.359	0.859	0.738
7-50012	62 03 06.687266 N	150 18 42.017787 W	2942066.6173	1586933.8164	227.6690	202.0100	FOREST	202.594	0.584	0.341
7-508	62 04 33.323054 N	150 03 33.283987 W	2950741.1320	1630258.1402	341.9900	312.7120	FOREST	312.703	-0.009	0.000
7-504	62 09 41.353557 N	150 00 37.764562 W	2982019.1980	1638623.0364	446.0900	414.6945	FOREST	415.102	0.408	0.166
7-506	62 09 39.289656 N	150 00 35.479397 W	2981809.5768	1638731.5385	448.3200	416.9230	FOREST	416.698	-0.225	0.051
6-908	61 54 09.728538 N	150 04 22.914826 W	2887413.9893	1627827.0597	187.1100	159.3945	WETLANDS	161.119	1.724	2.974
7-906	62 00 06.347401 N	150 03 21.654047 W	2923627.7963	1630788.6516	228.5200	200.3750	WETLANDS	200.641	0.266	0.071
7-904	62 00 07.010861 N	150 03 20.161293 W	2923695.1127	1630859.9811	229.1300	200.9750	WETLANDS	201.289	0.314	0.099
7-900	62 04 40.835965 N	150 03 33.240736 W	2951504.1116	1630260.8971	339.2200	309.9010	WETLANDS	309.756	-0.145	0.021
7-902	62 04 39.986000 N	150 03 33.295726 W	2951417.7949	1630258.1993	339.1100	309.7980	WETLANDS	309.746	-0.052	0.003

Combined (CVA)	Elevation Accuracy		Target
Statistical Summary	Feet	Meter	Accuracy
Count = 11 pts			
Min =	-0.225	-0.069	
Max =	1.724	0.526	
Mean =	0.390	0.119	
RMSE =	0.659	0.201	
RMSE*1.96 (95%) =	1.292	0.394	> 0.363 m
95 Percentile =	1.292	0.394	> 0.363 m
Stddev =	0.532	0.162	

Figure 3, Vertical Accuracy Assessment using Lounsbury Checkpoint Survey.

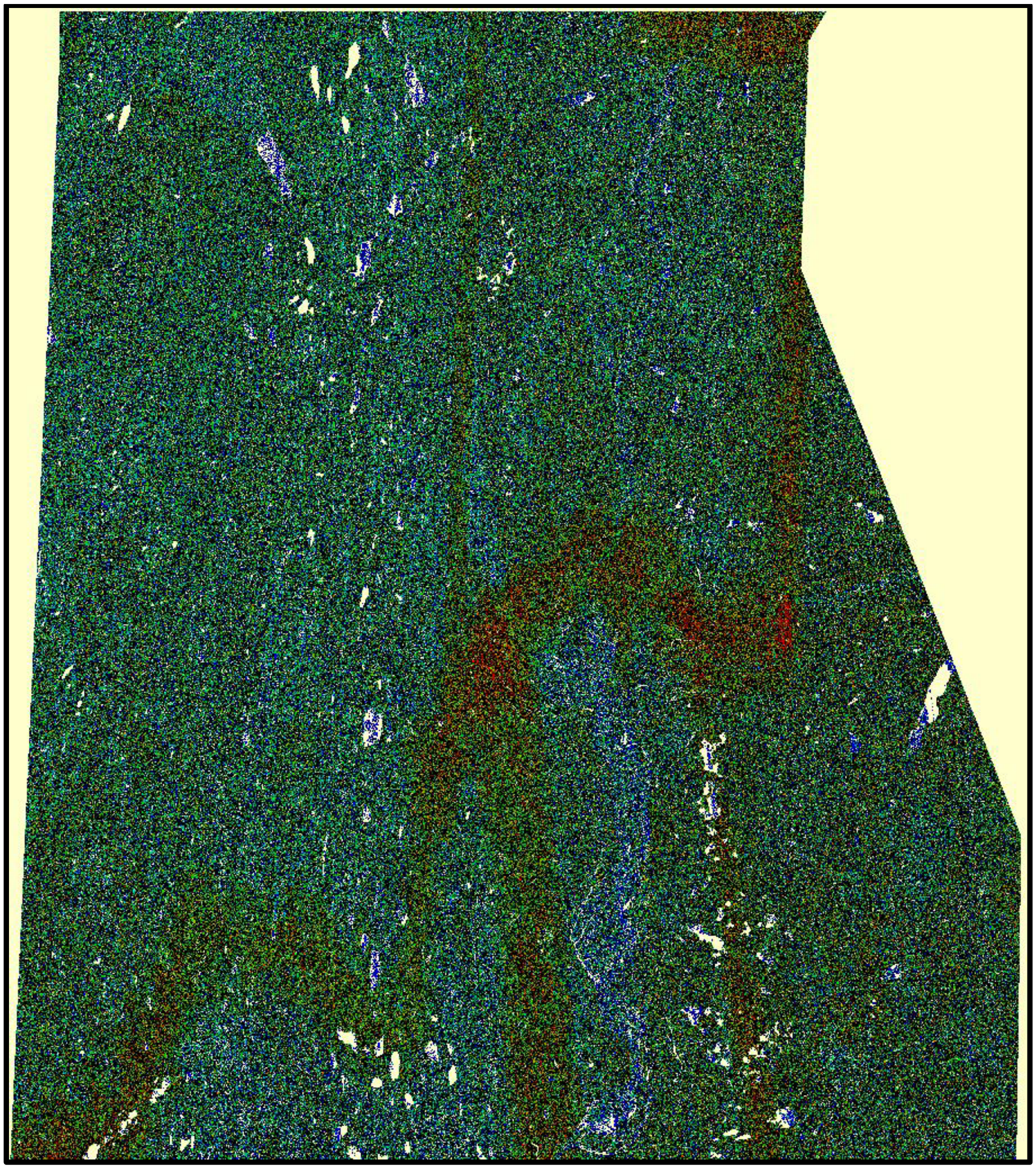


Figure 4, LiDAR Point Count

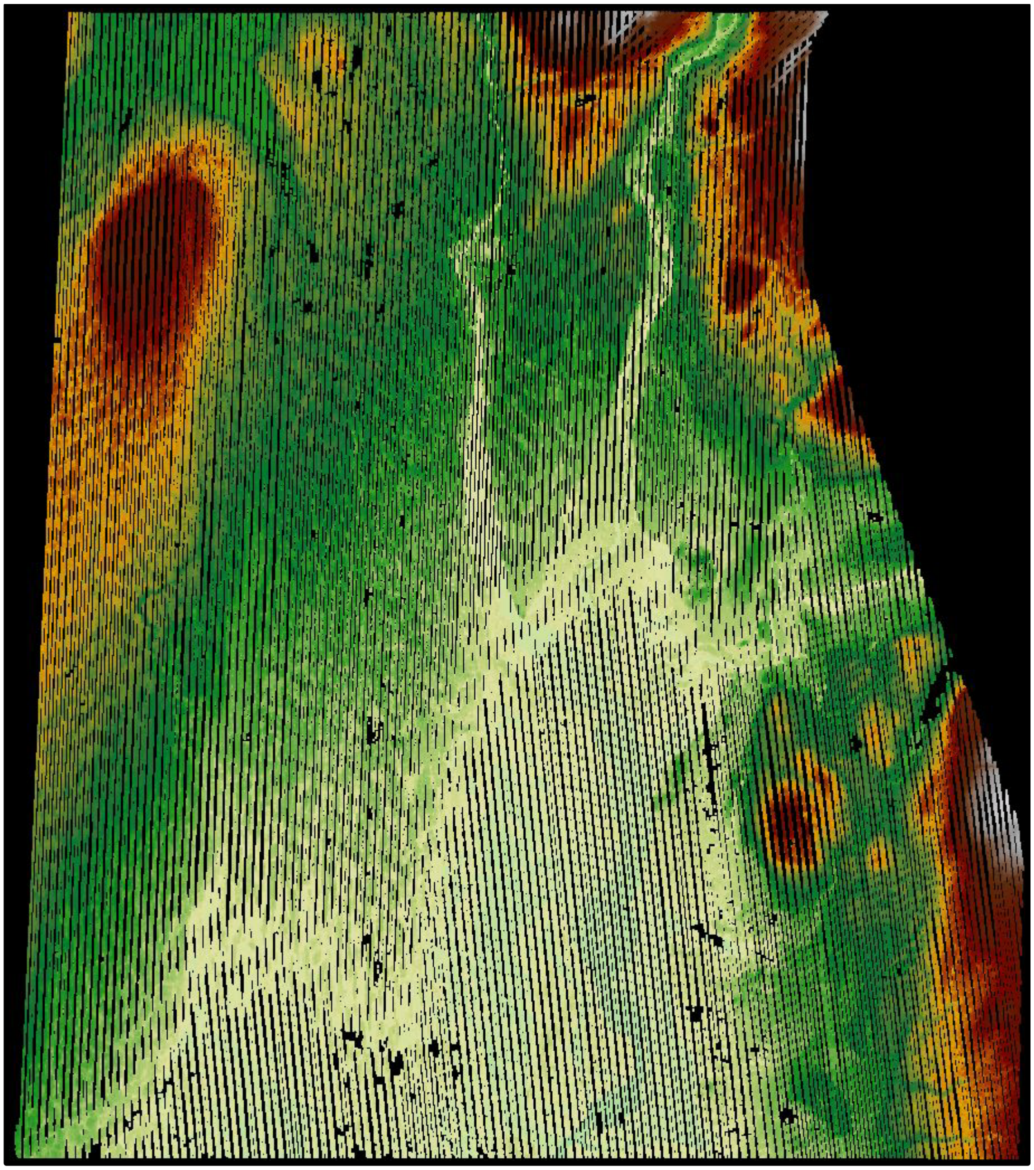


Figure 5, Class 1 – Unclassified.

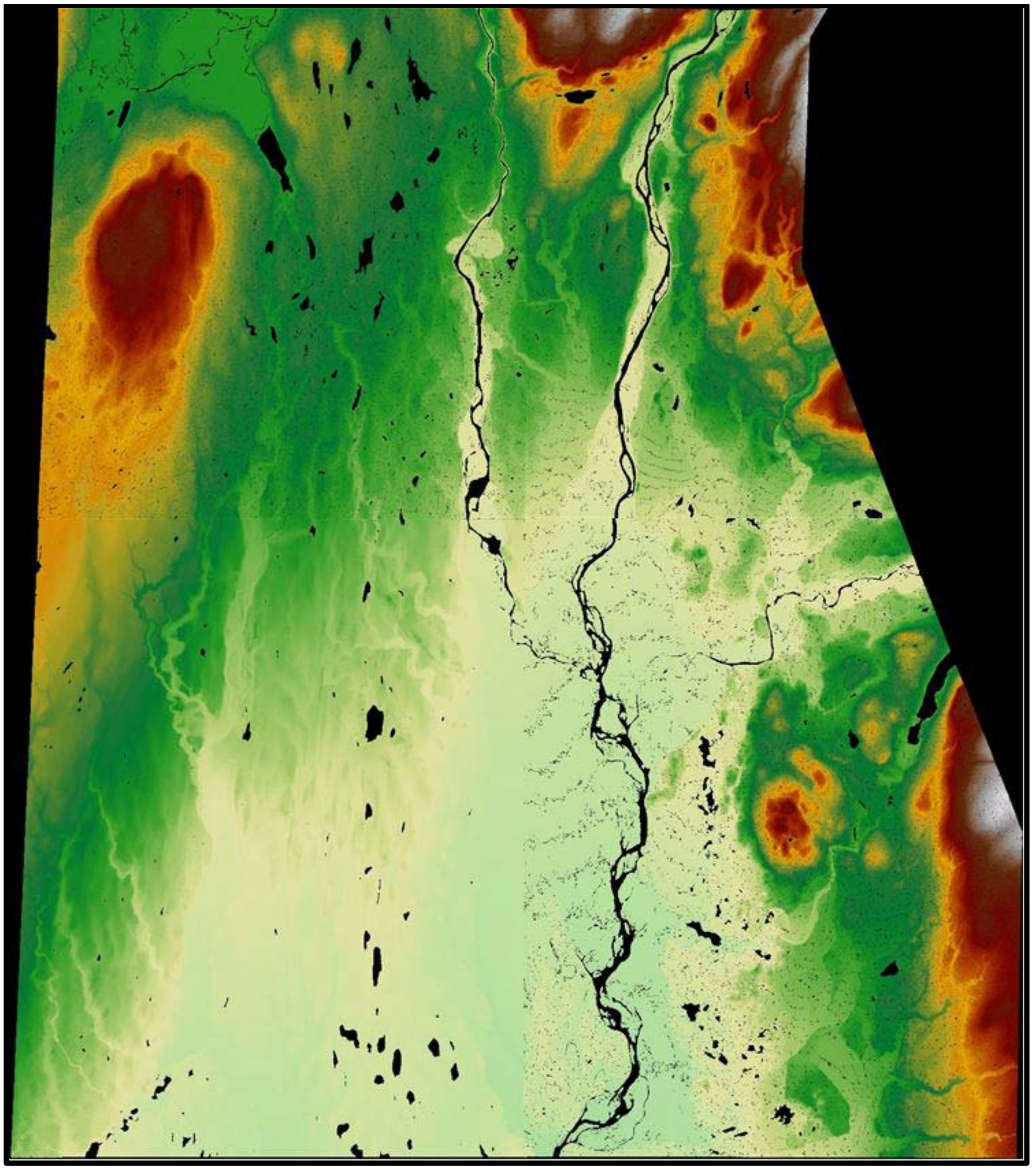


Figure 6, Class 2 – Ground.

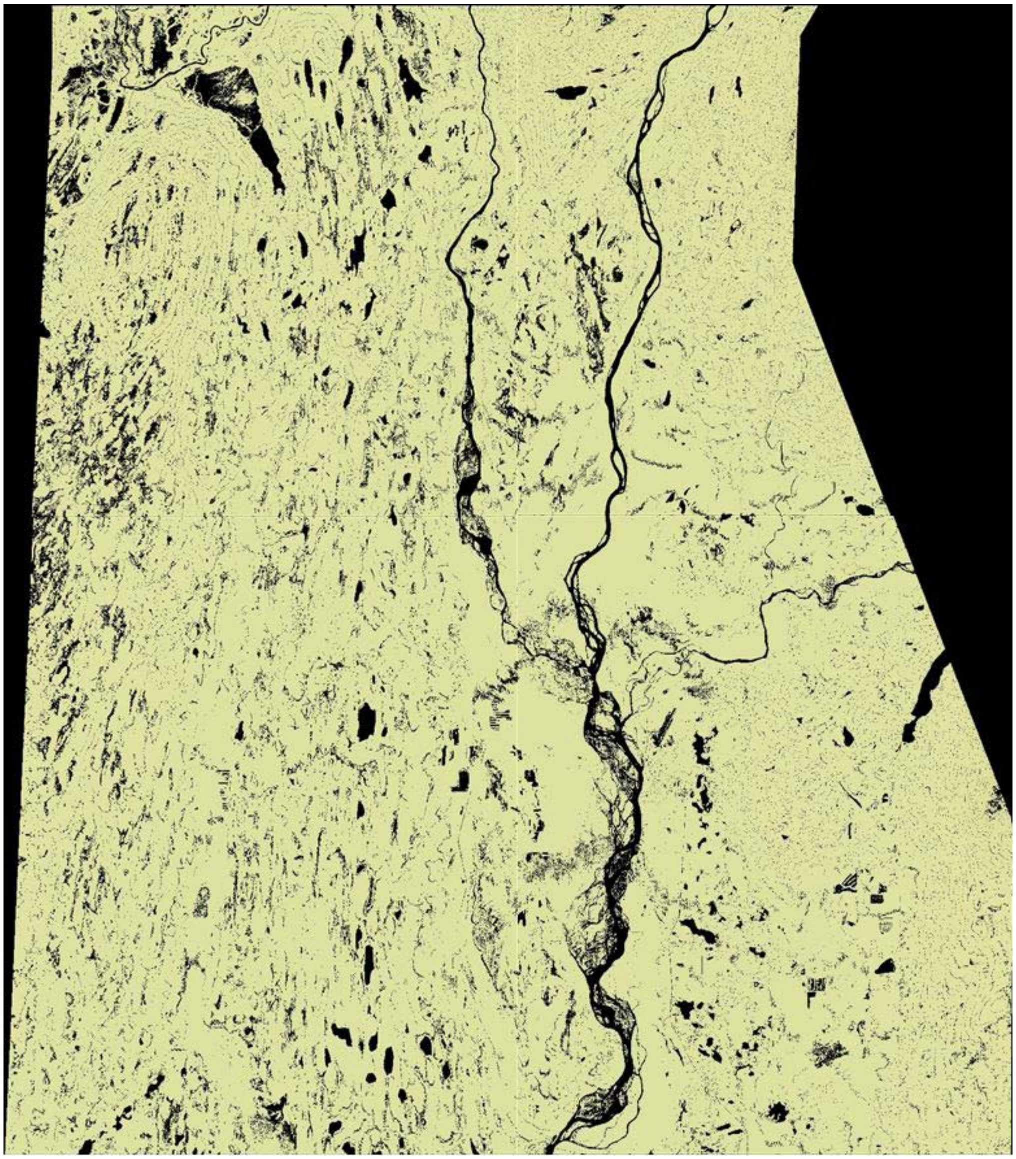


Figure 7, Class 3 – Low Vegetation.

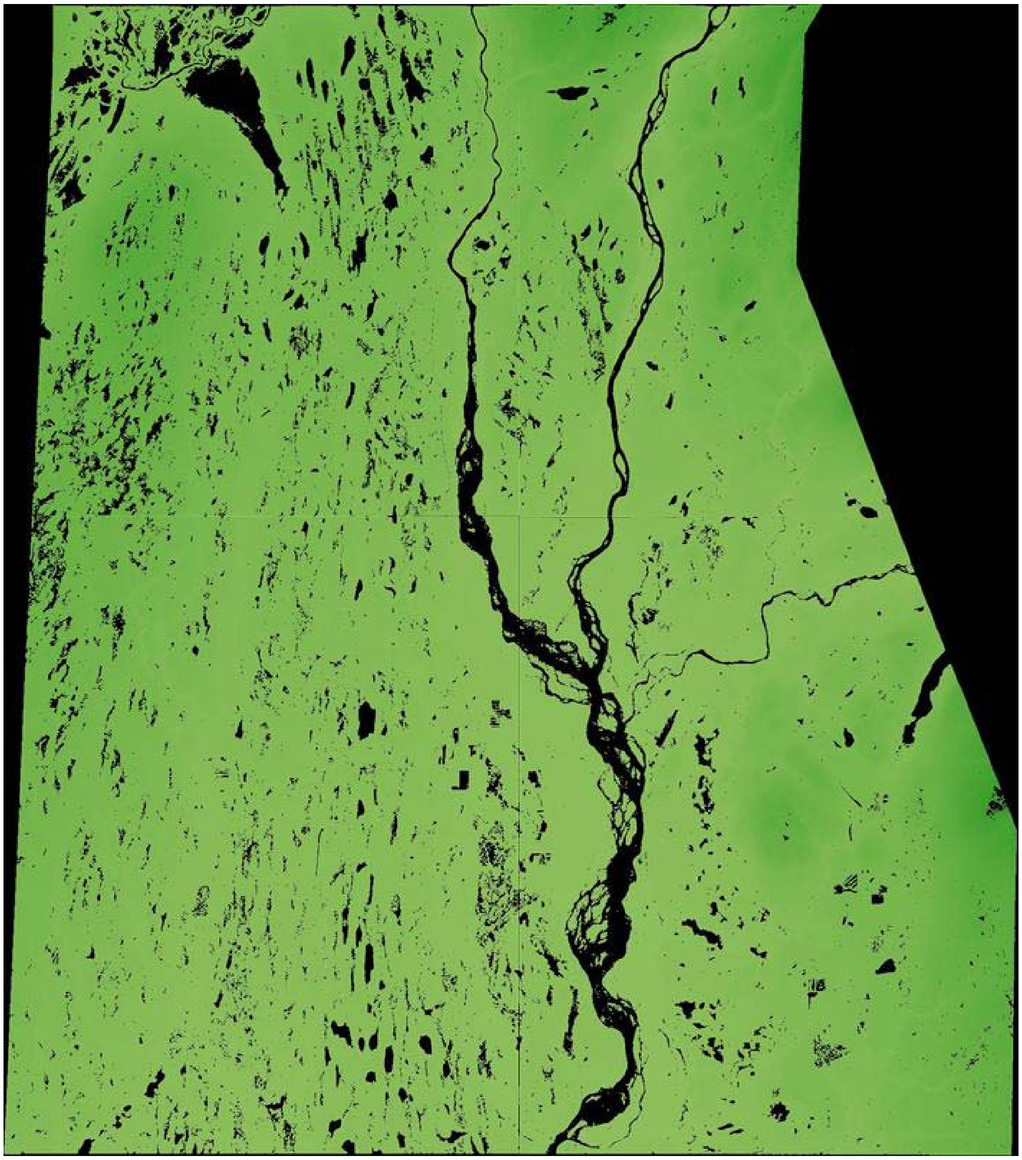


Figure 8, Class 4 – Medium Vegetation

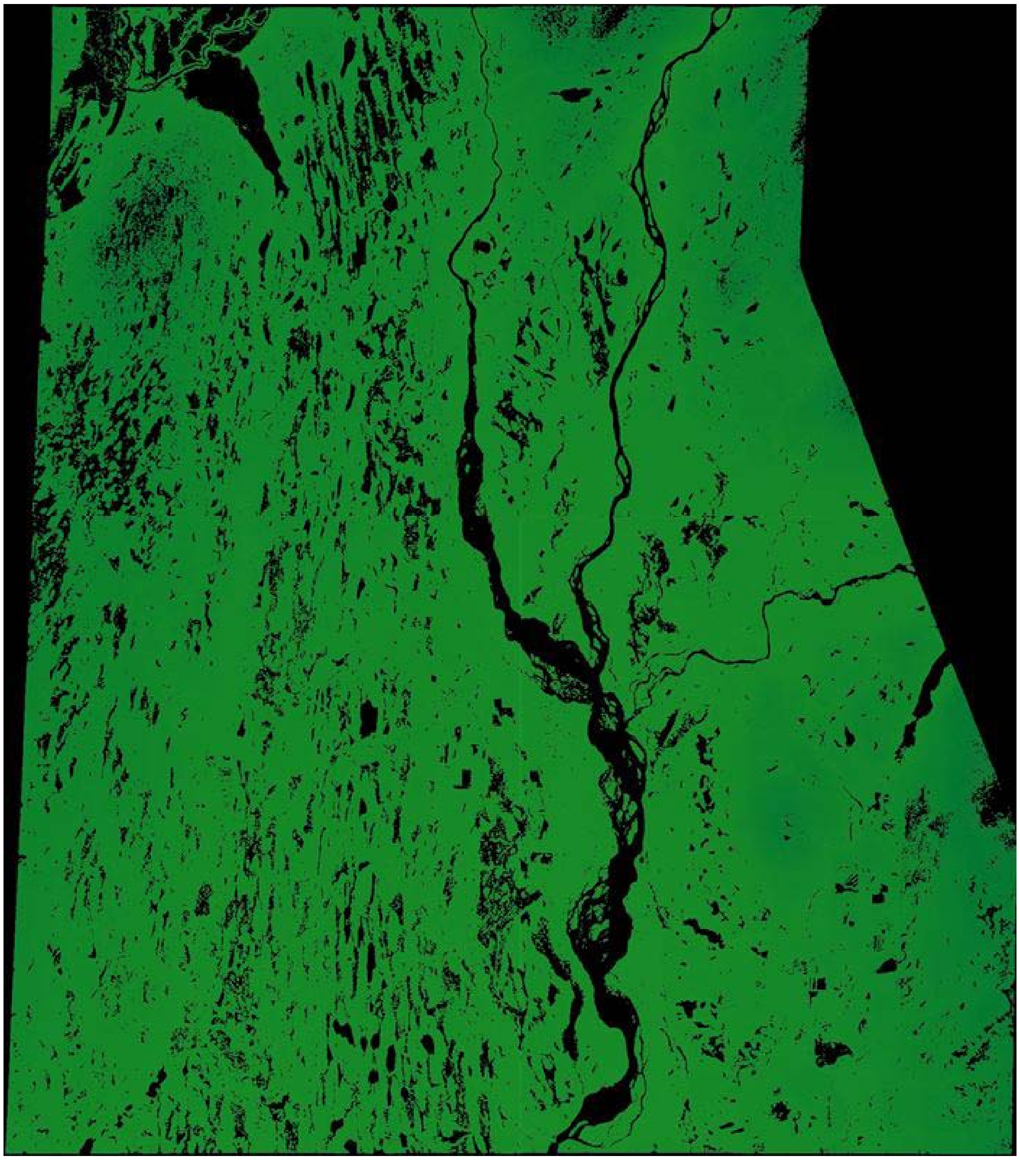


Figure 9, Class 5 – High Vegetation.

Figure 10, Class 6 – Buildings.

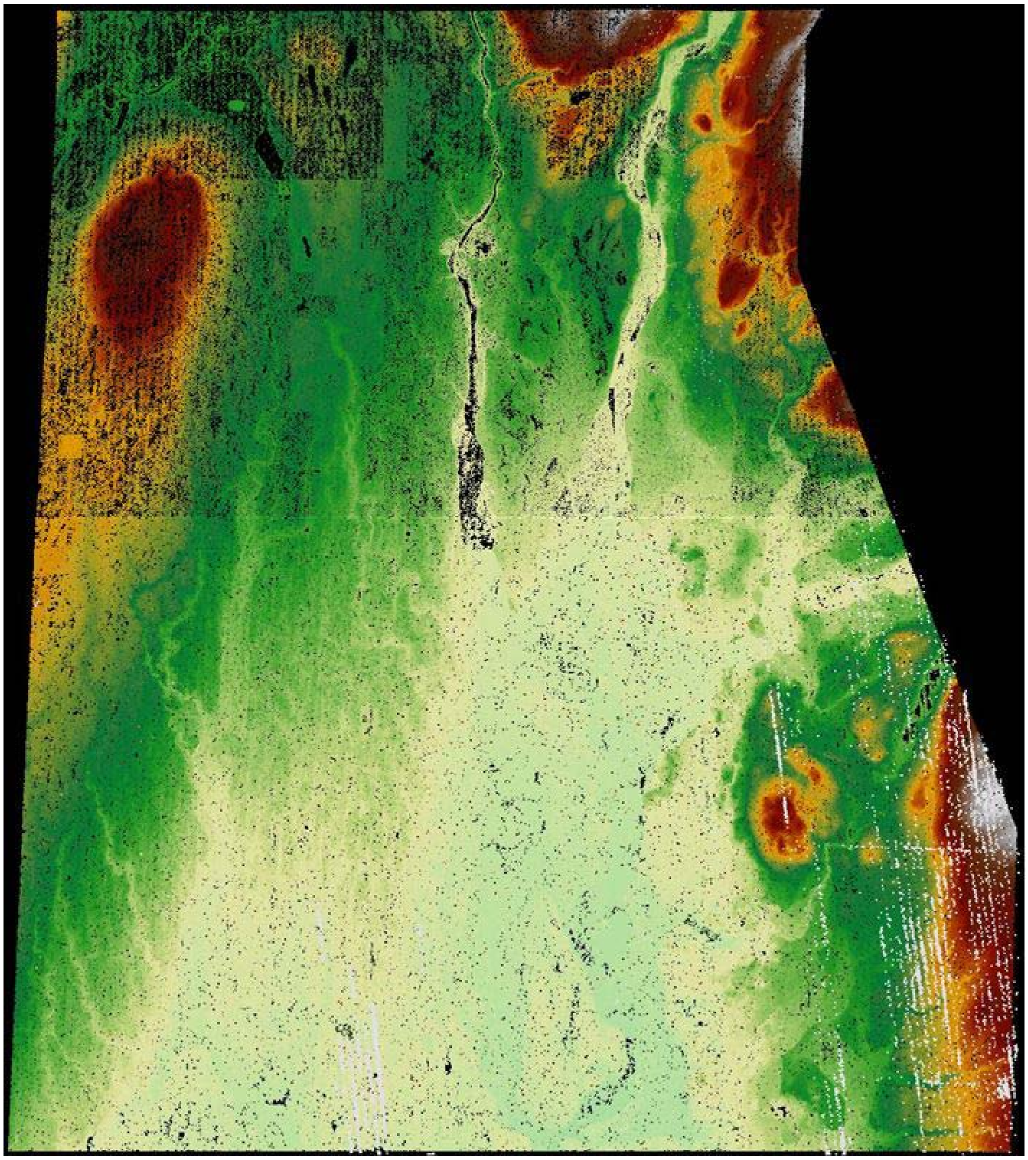


Figure 11, Class 7 – Error Points.

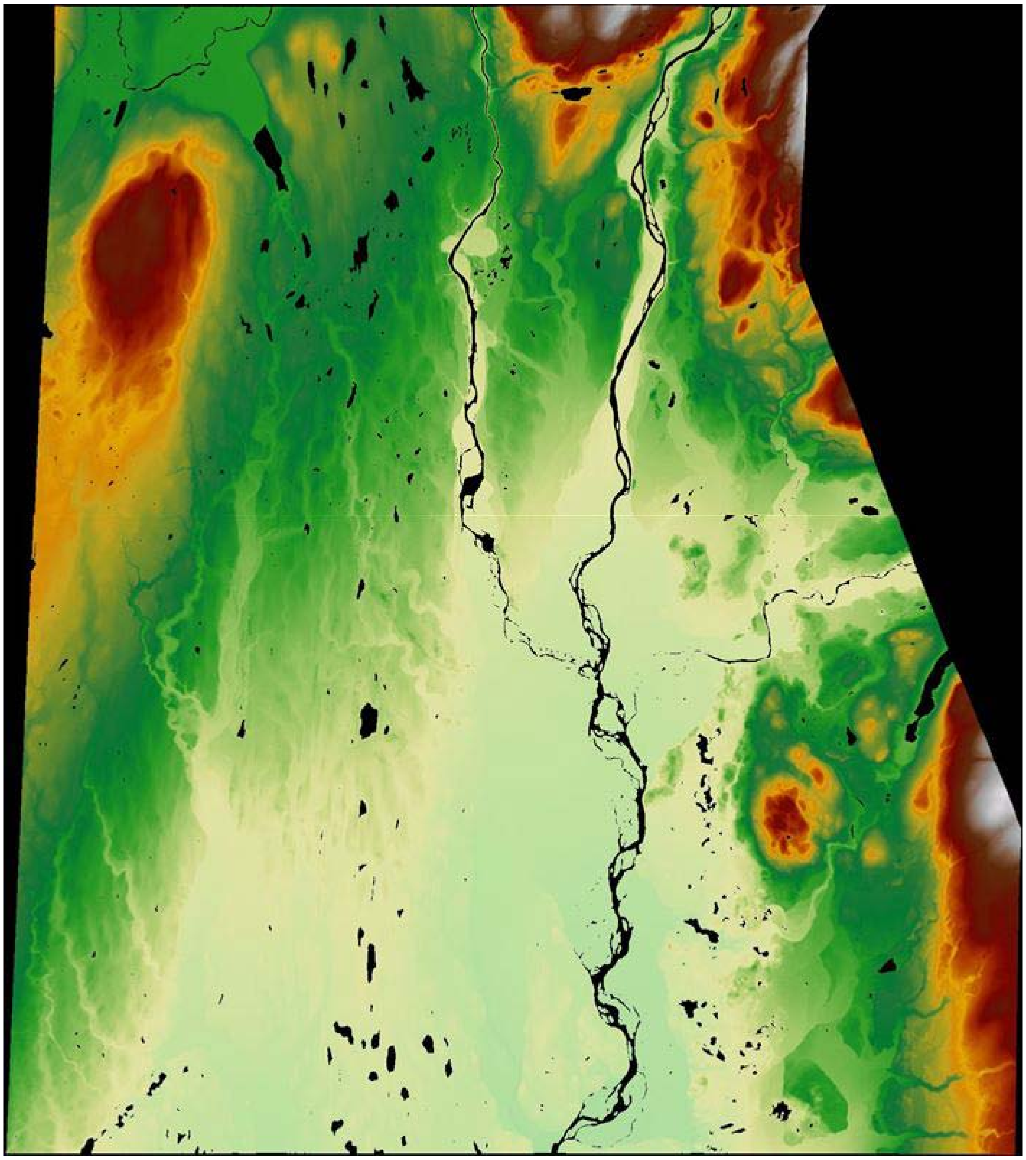


Figure 12, Class 8 – Ground Model Keypoints.

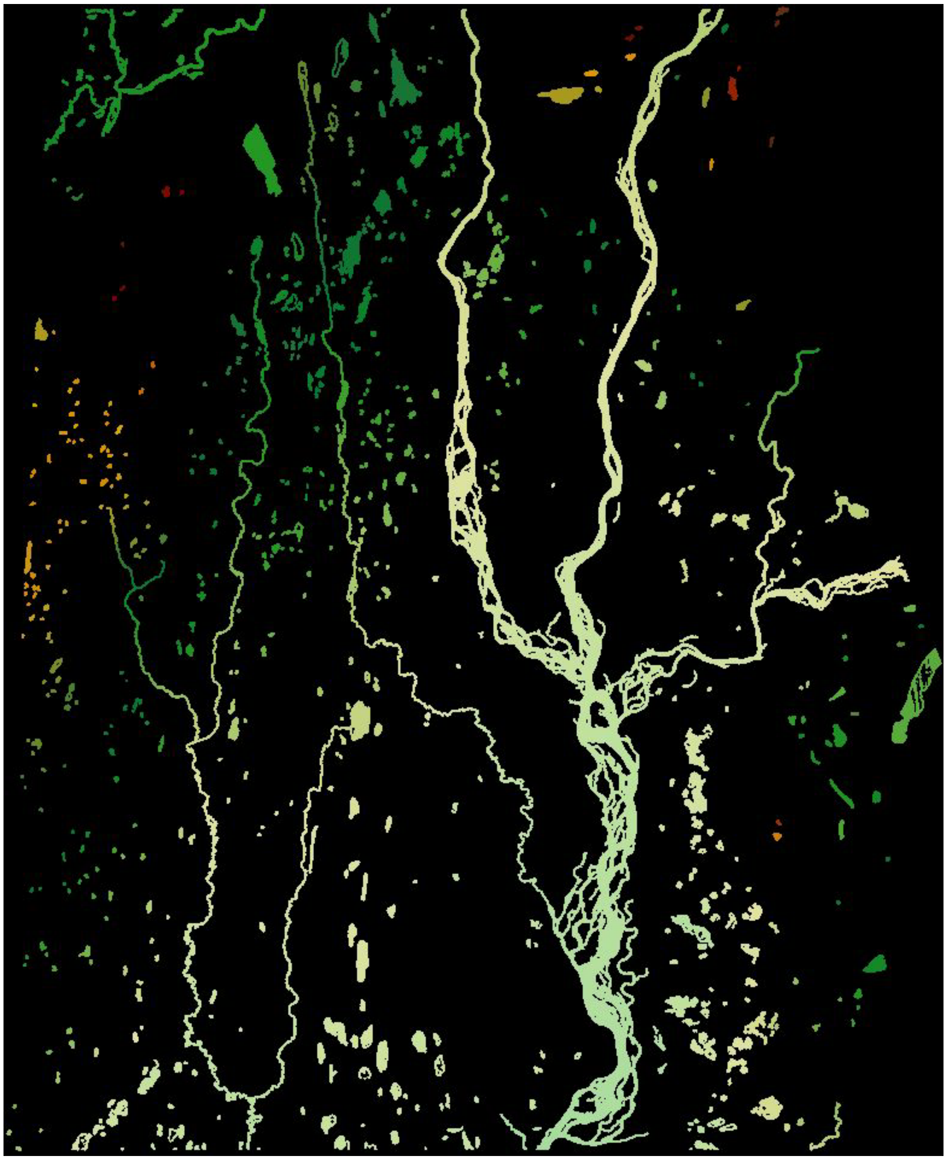


Figure 13, Class 9 – Water.

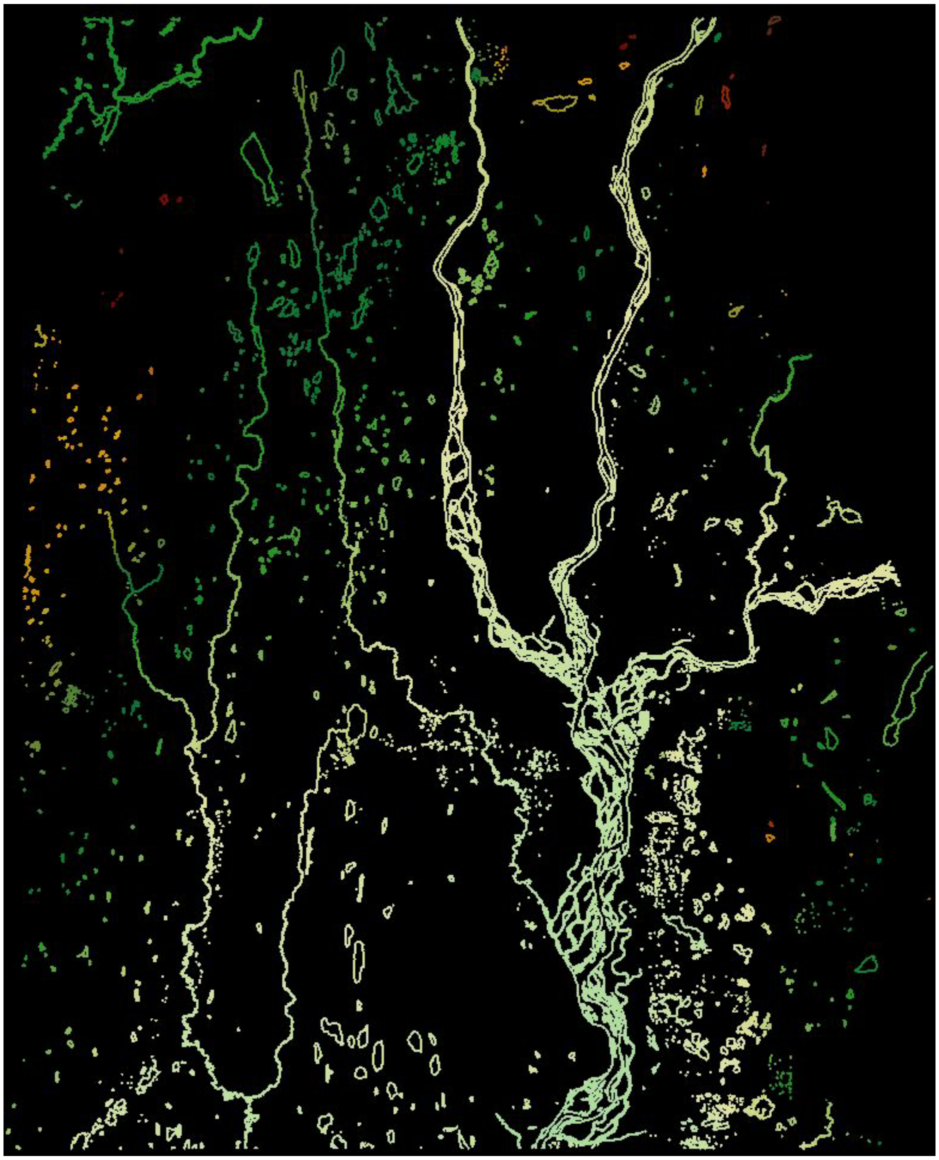


Figure 14, Class 10 – Breakline Proximity.

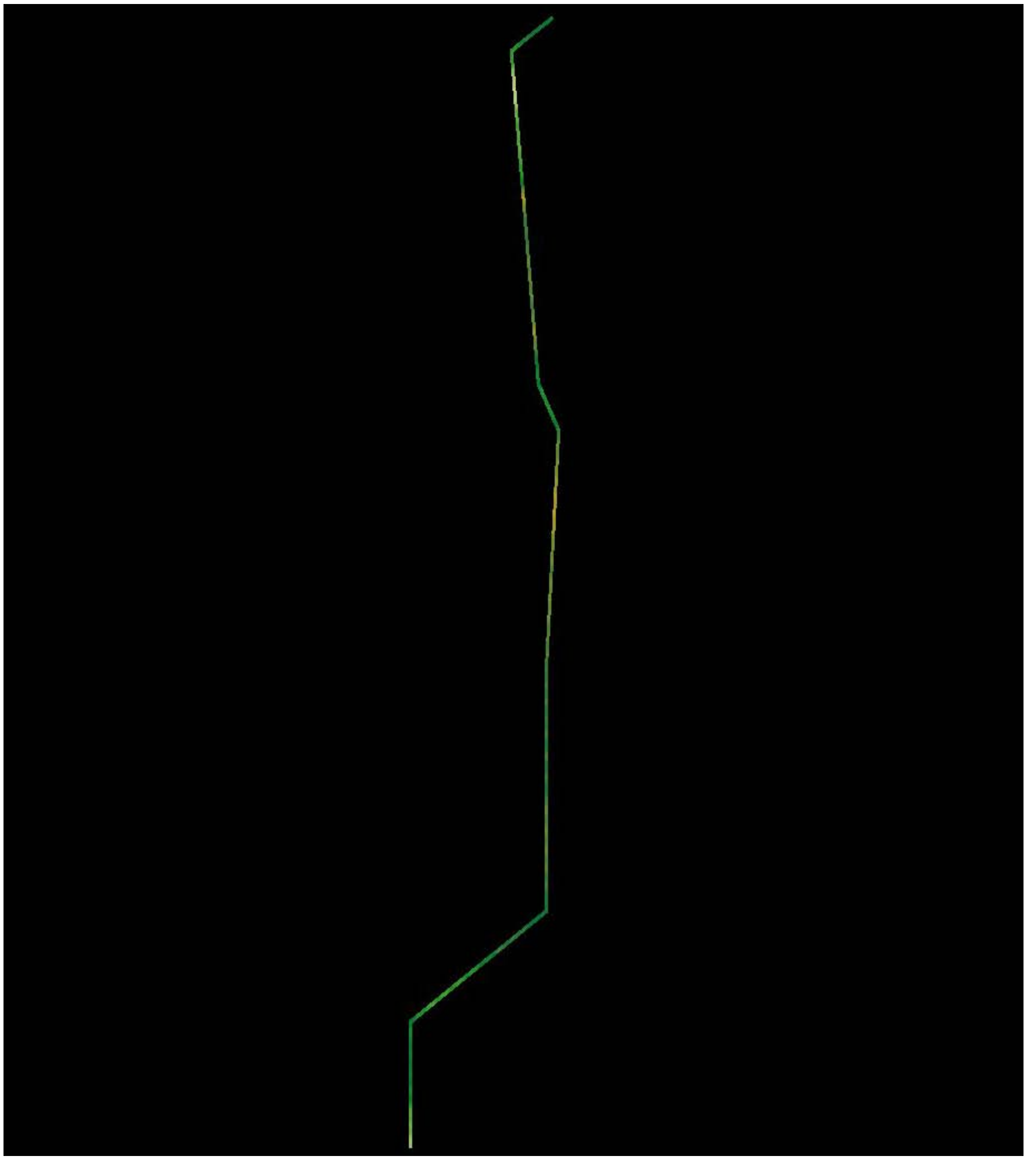


Figure 15, Class 11 – Power Transmission Lines.

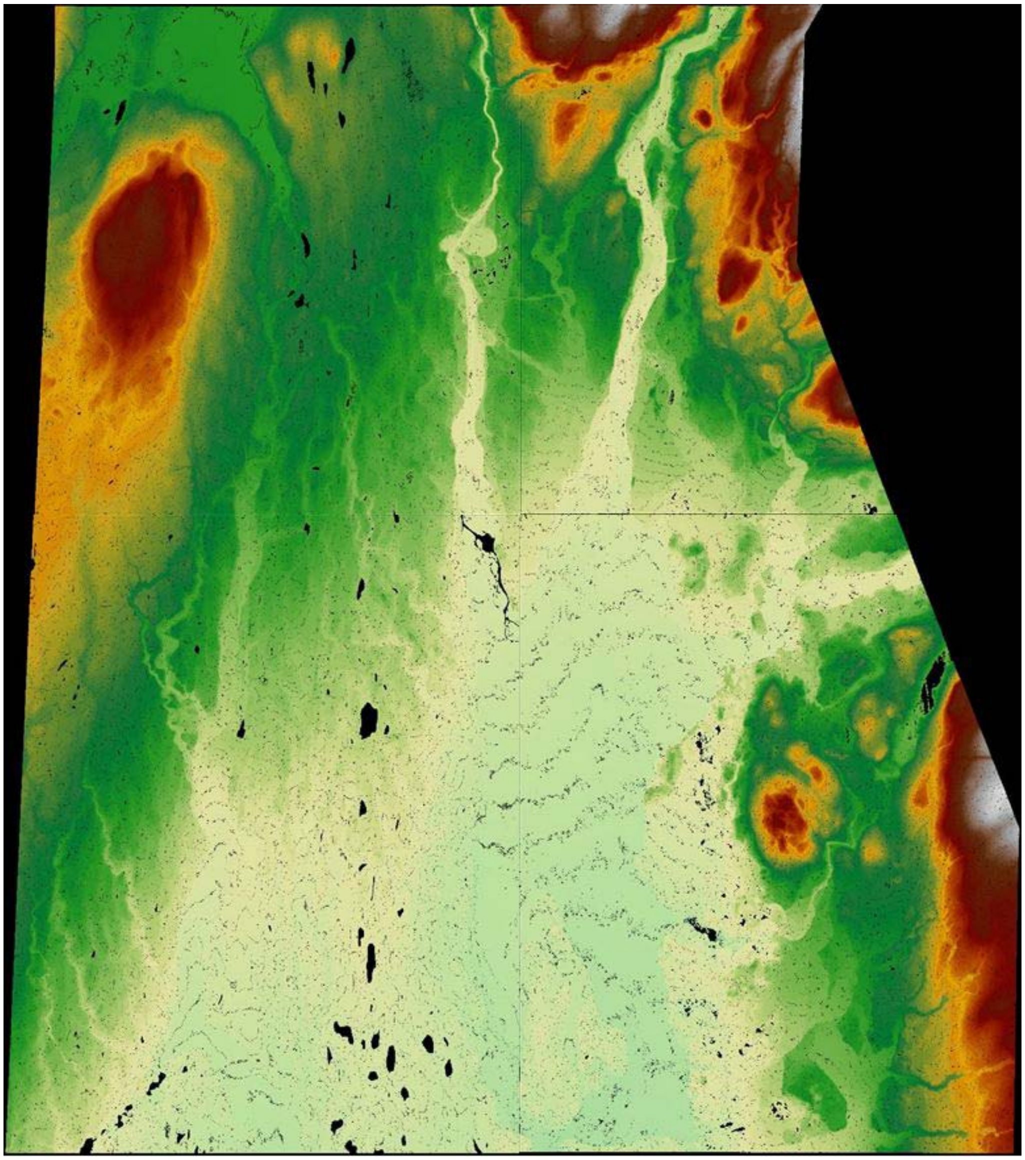


Figure 16, Class 13 – Surface Clutter.

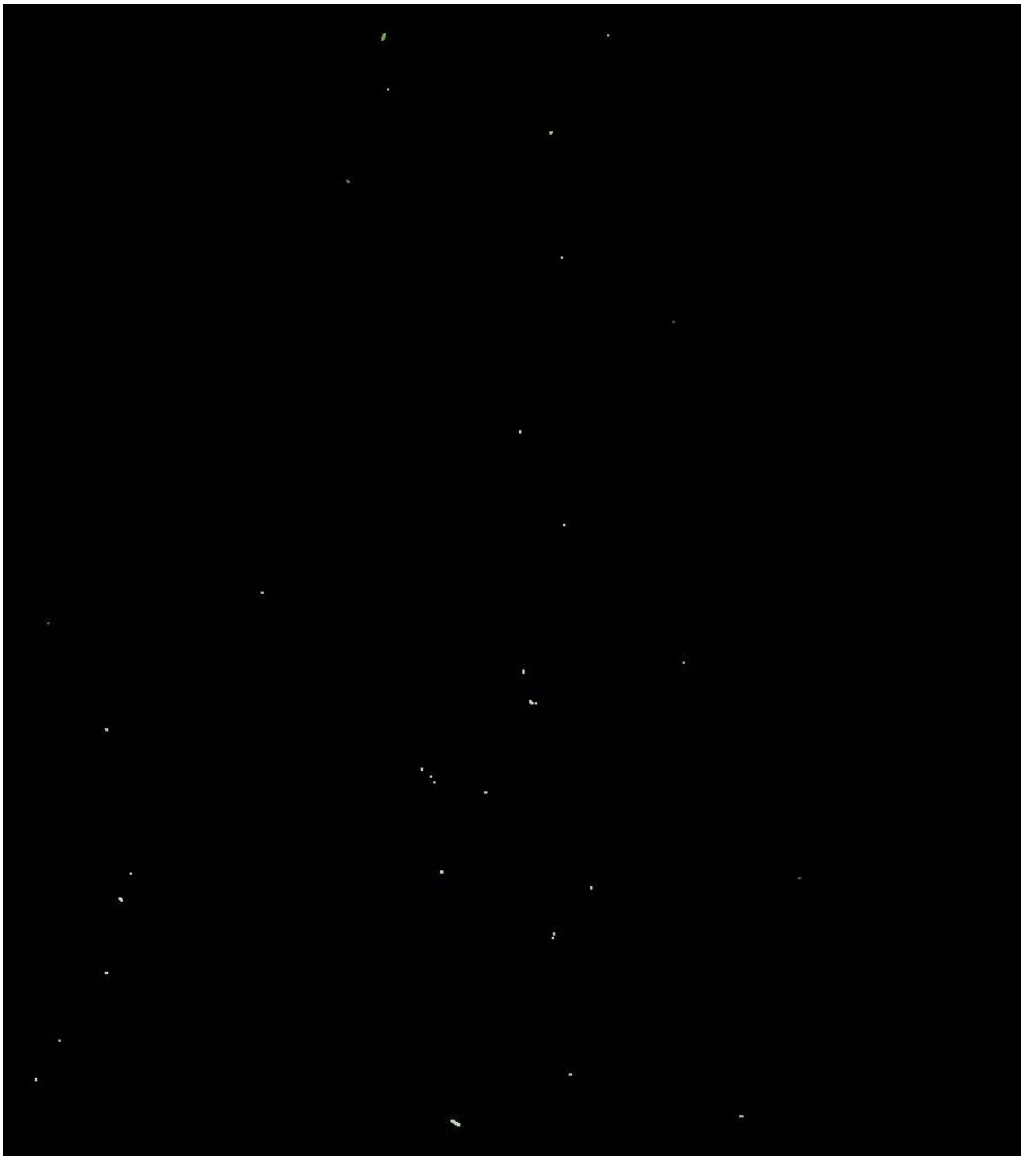


Figure 17, Class 14 – Bridge Decks with Zoom showing one Bridge Deck.

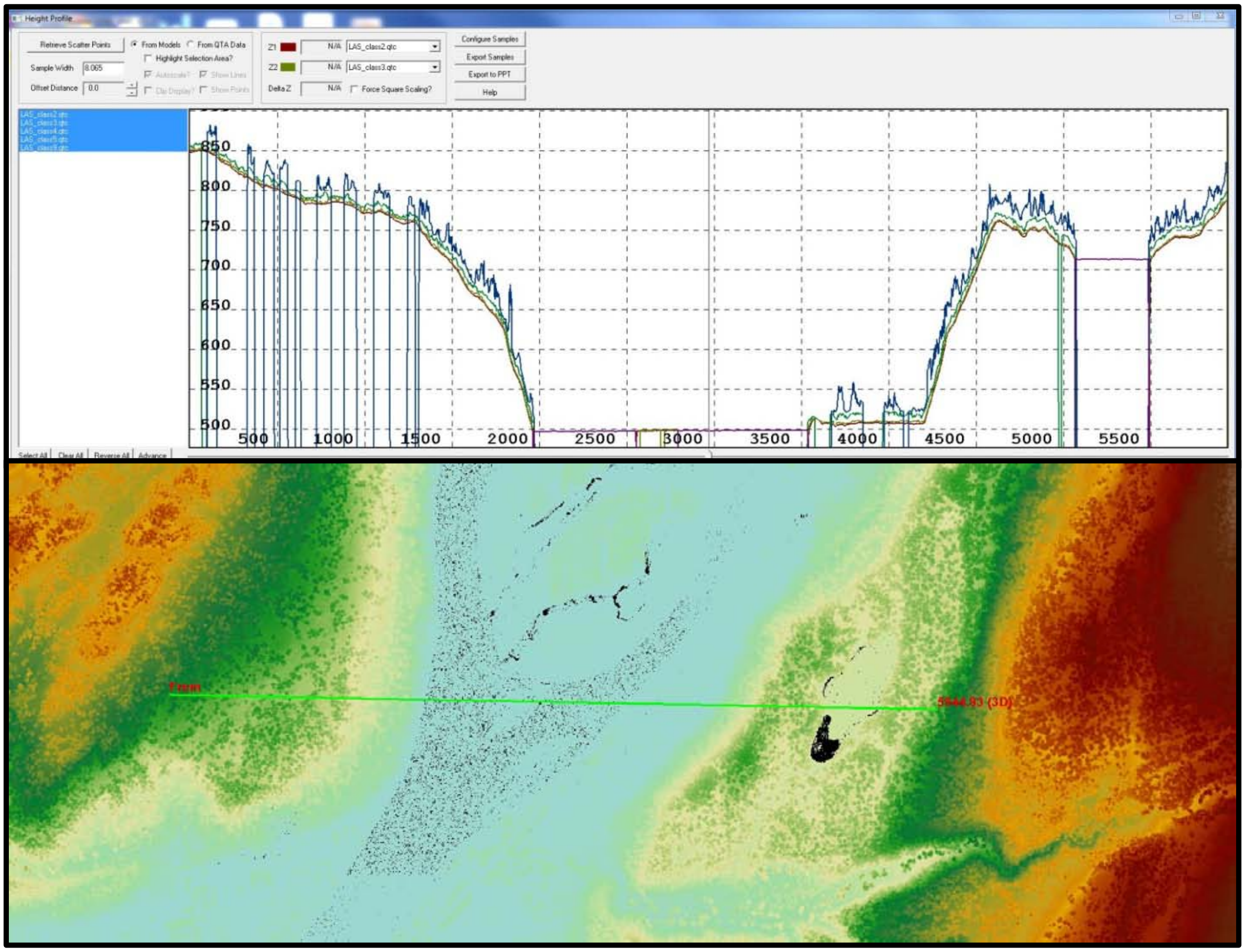


Figure 18, Vegetation Class Height Profile.

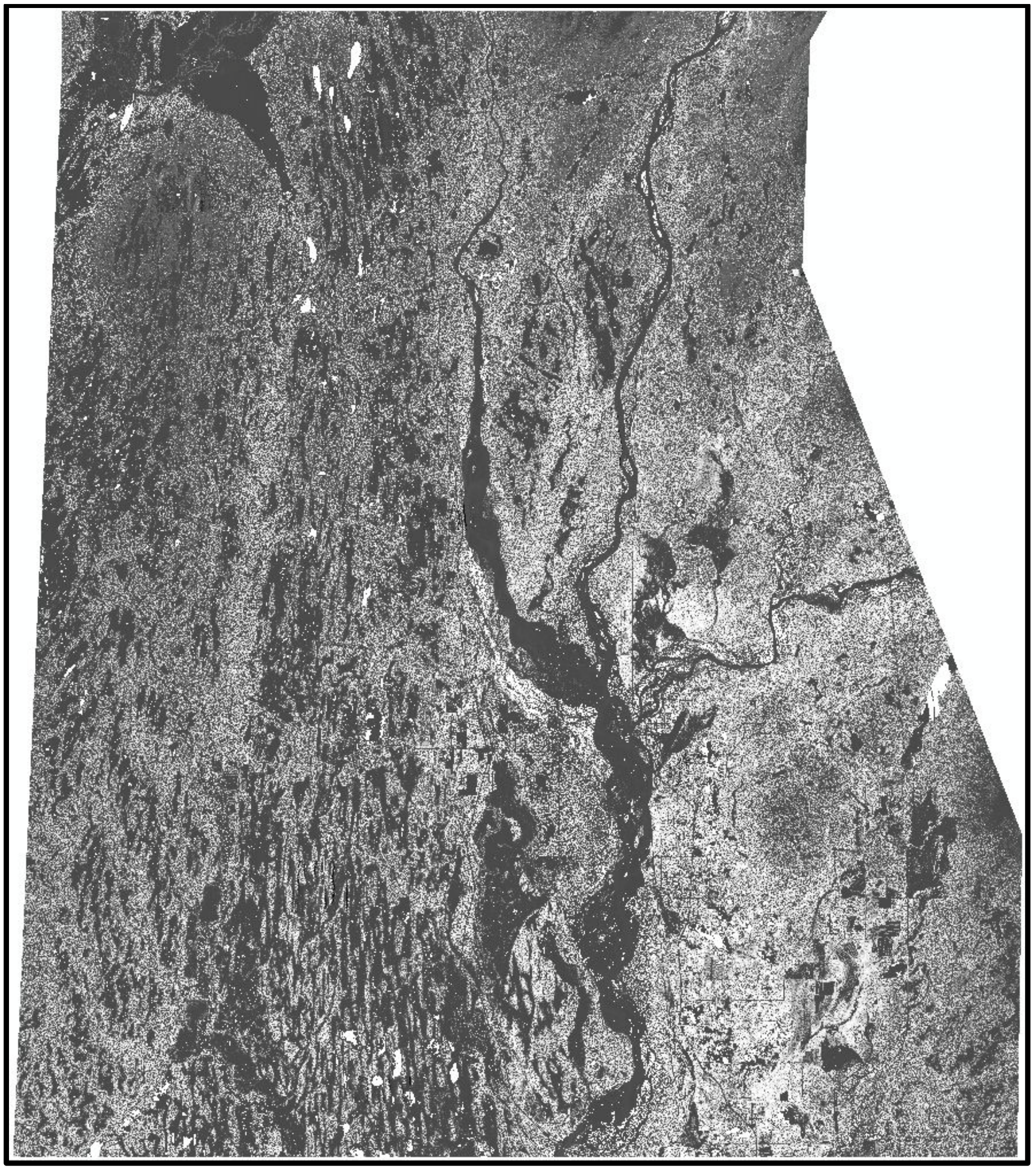


Figure 19, Canopy Height Difference (DSM –DEM).

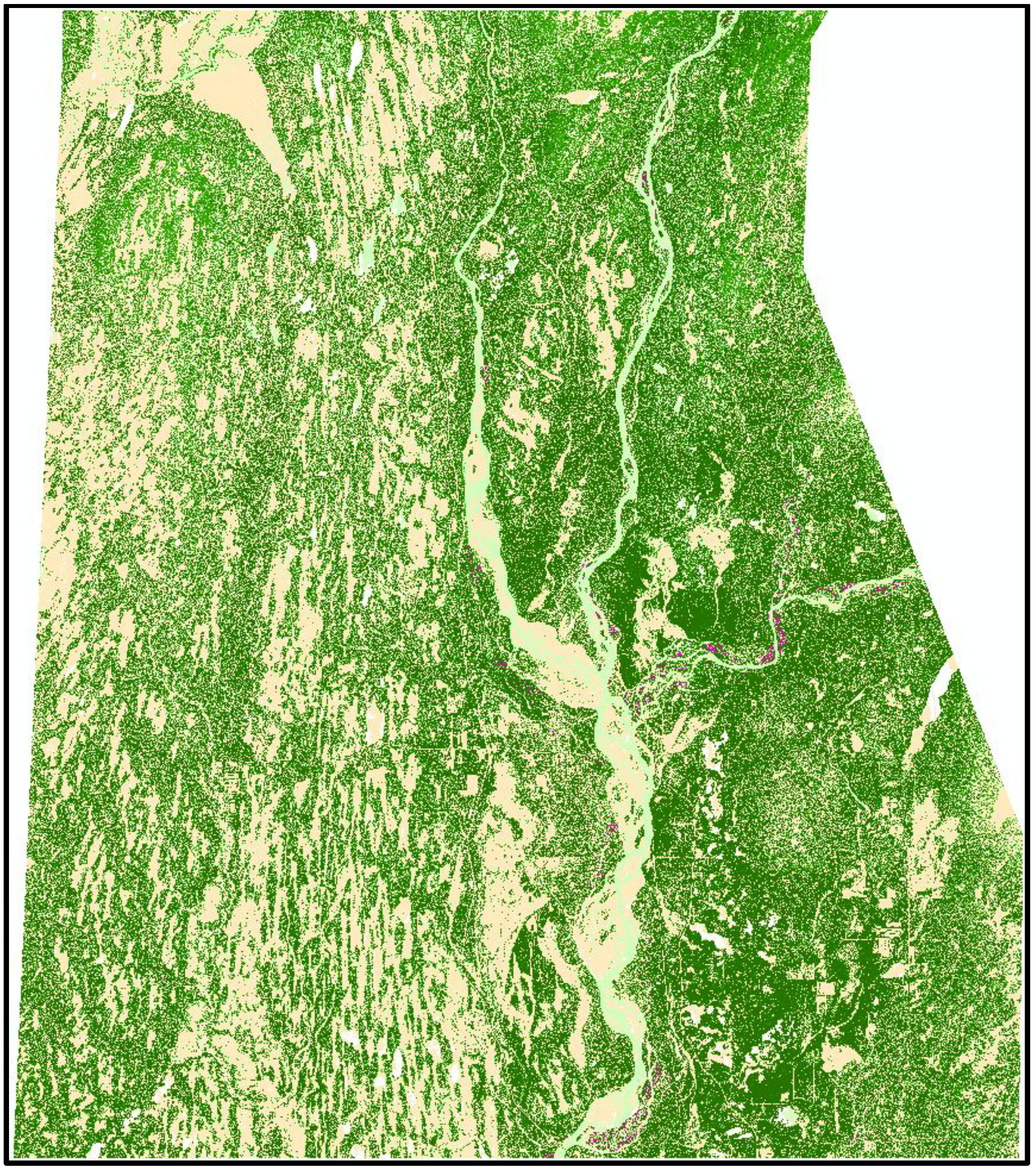


Figure 20, Canopy Height Classification.

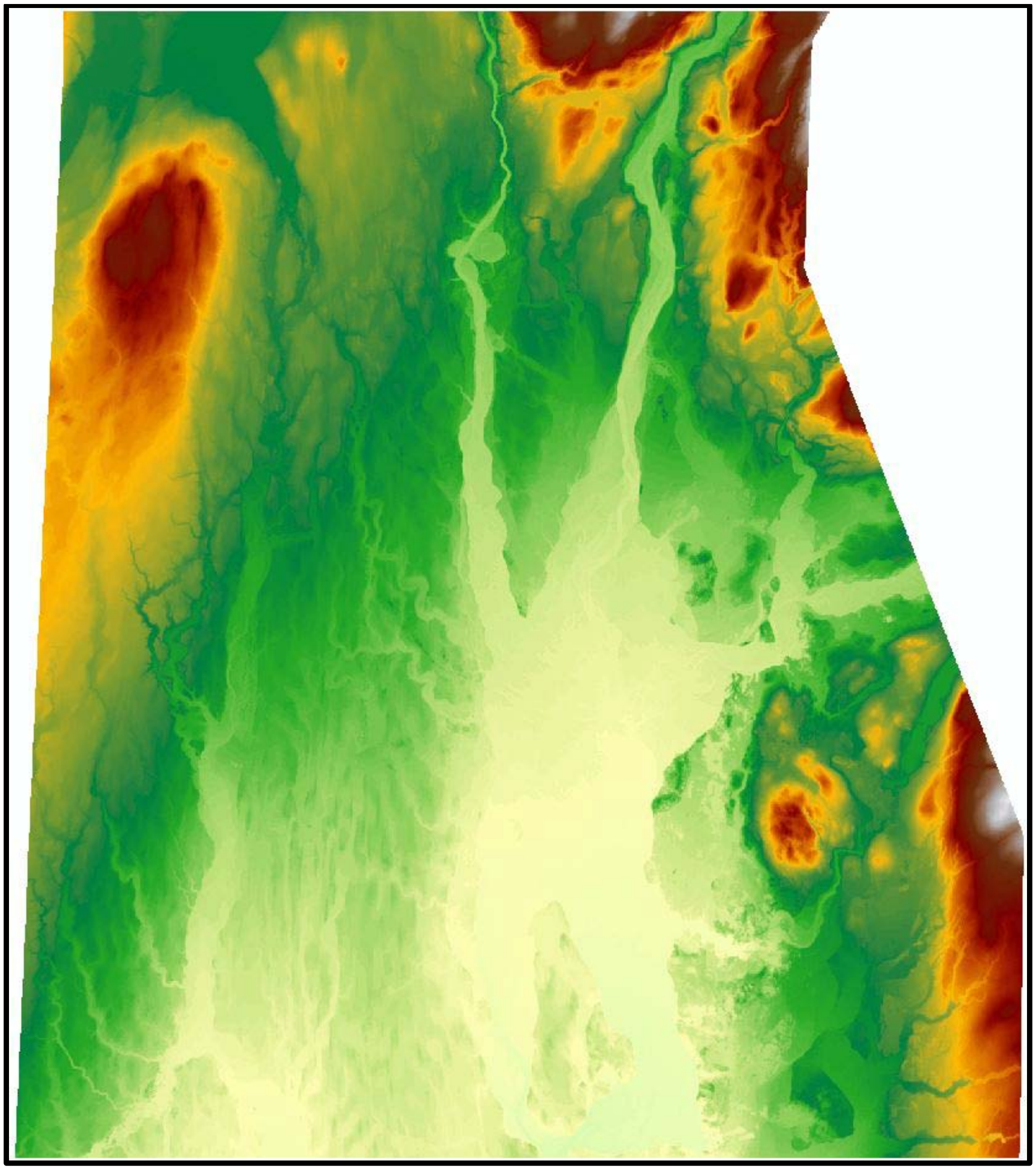


Figure 21, Bare-Earth Gridded DEM.

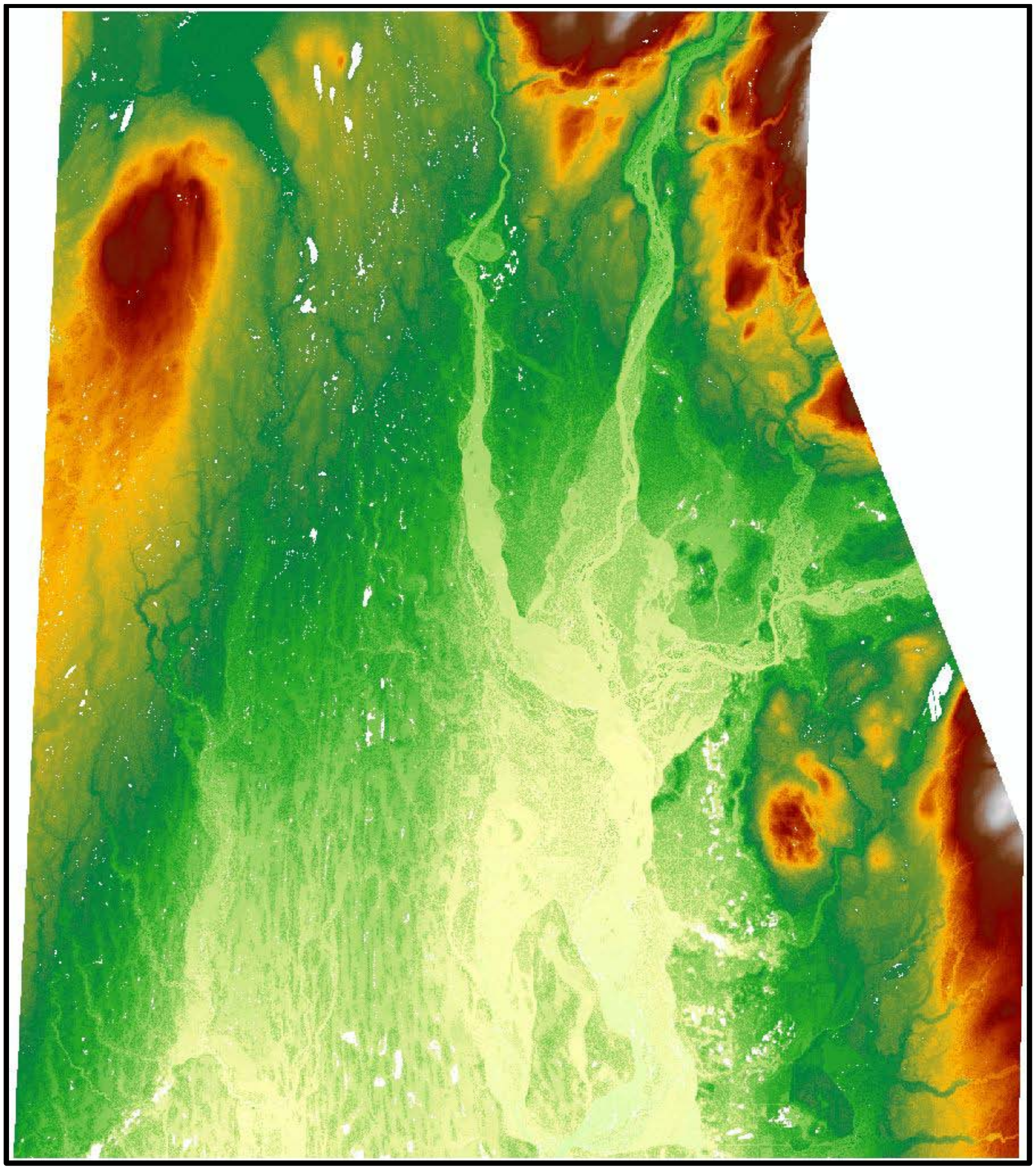


Figure 22, First-Return Gridded DSM.

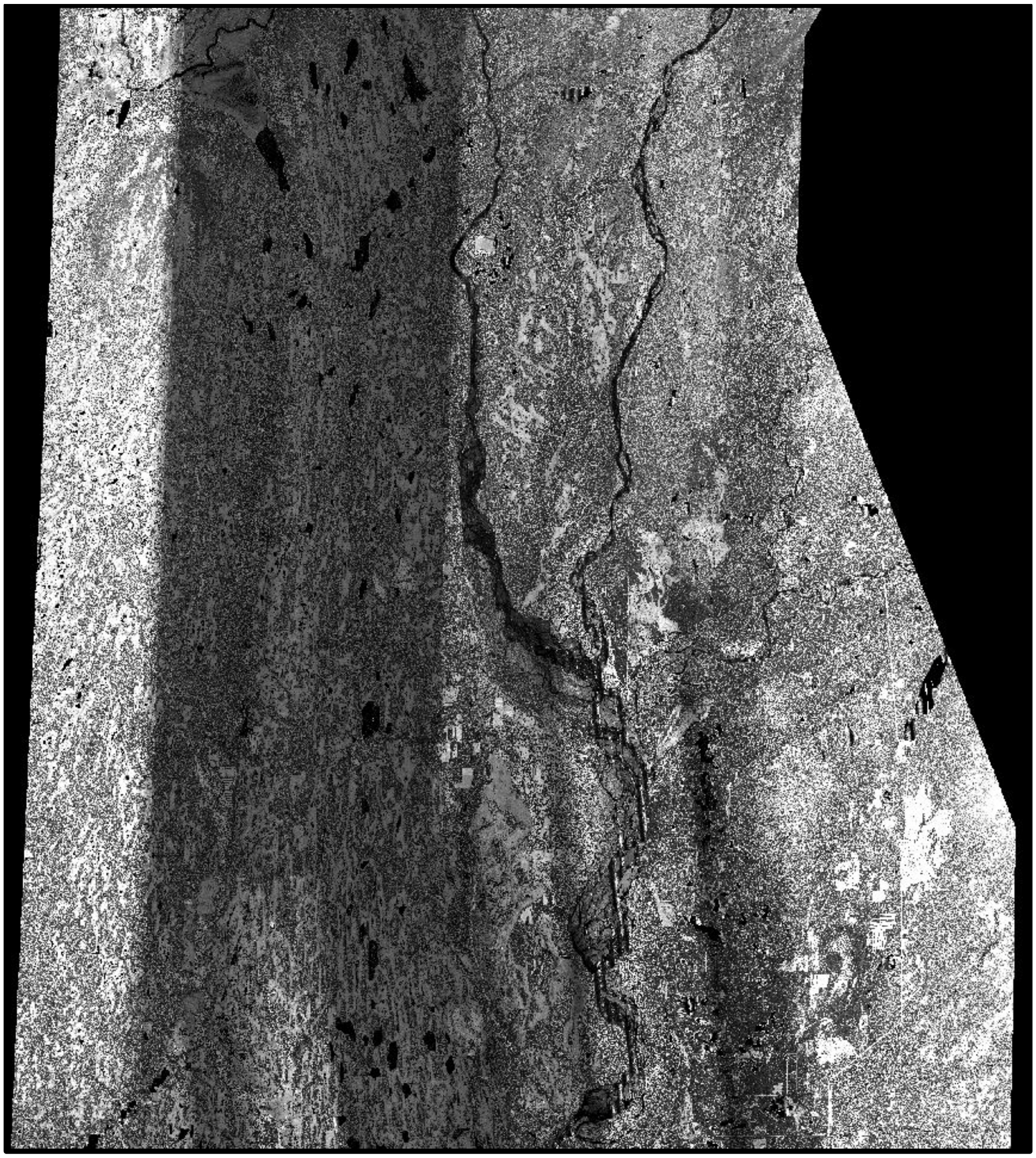


Figure 23, LiDAR Intensity Gridded Mosaic.

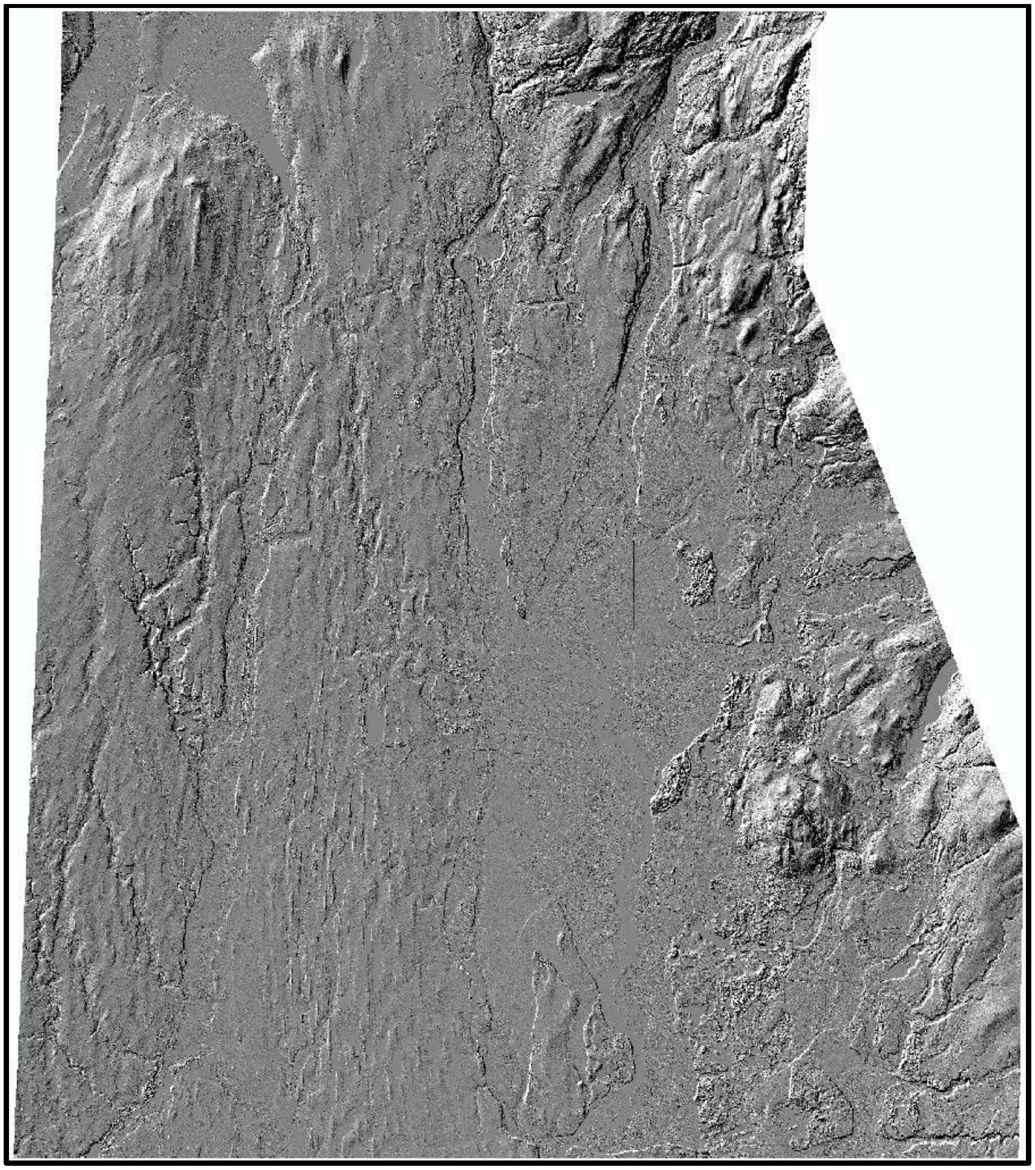


Figure 24, Shaded Relief Bare-Earth Gridded DEM.

Figure 25, Shaded Relief First-Return Gridded DSM.

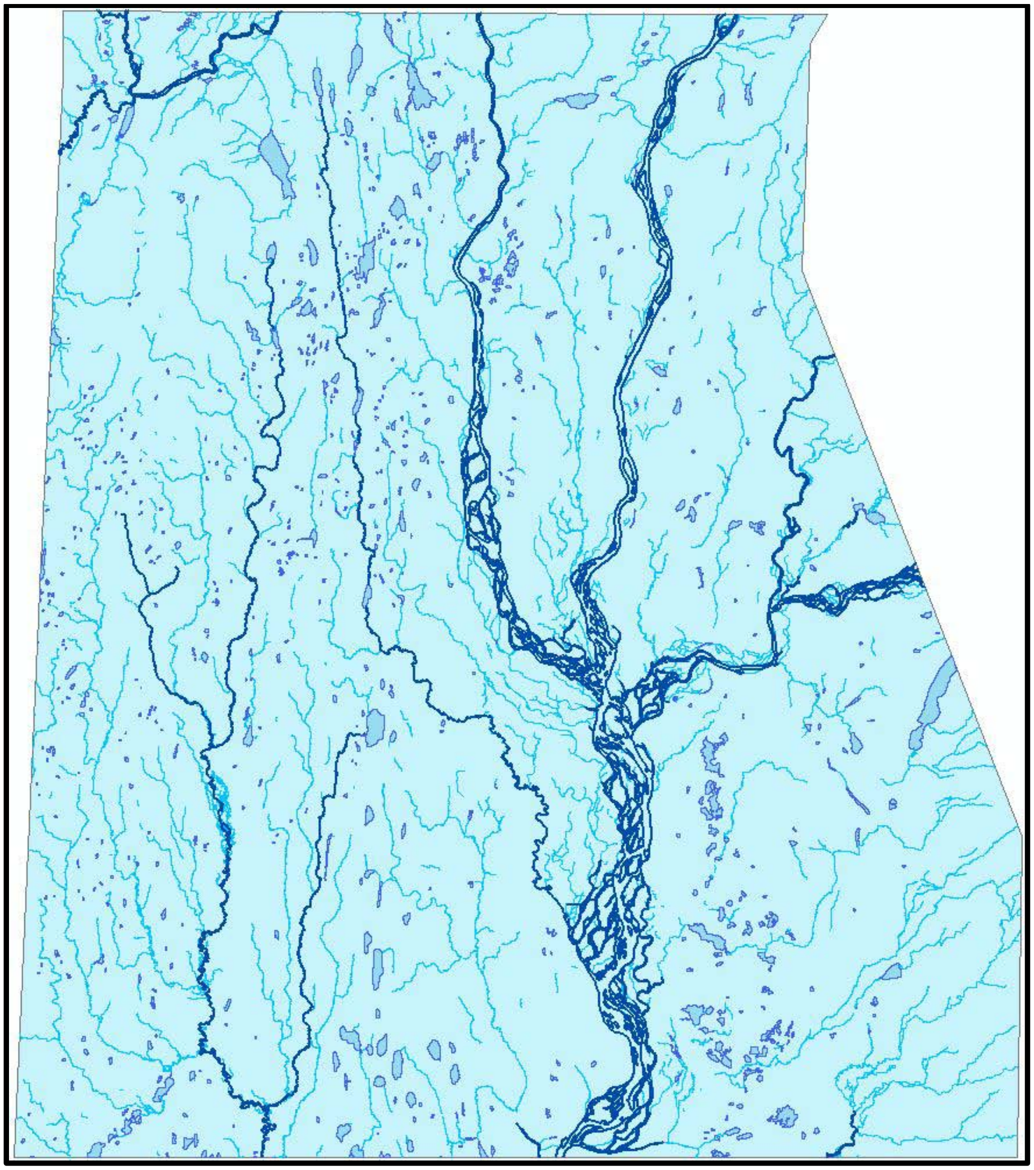


Figure 26, Contractor Supplied Hydro GIS Layers.

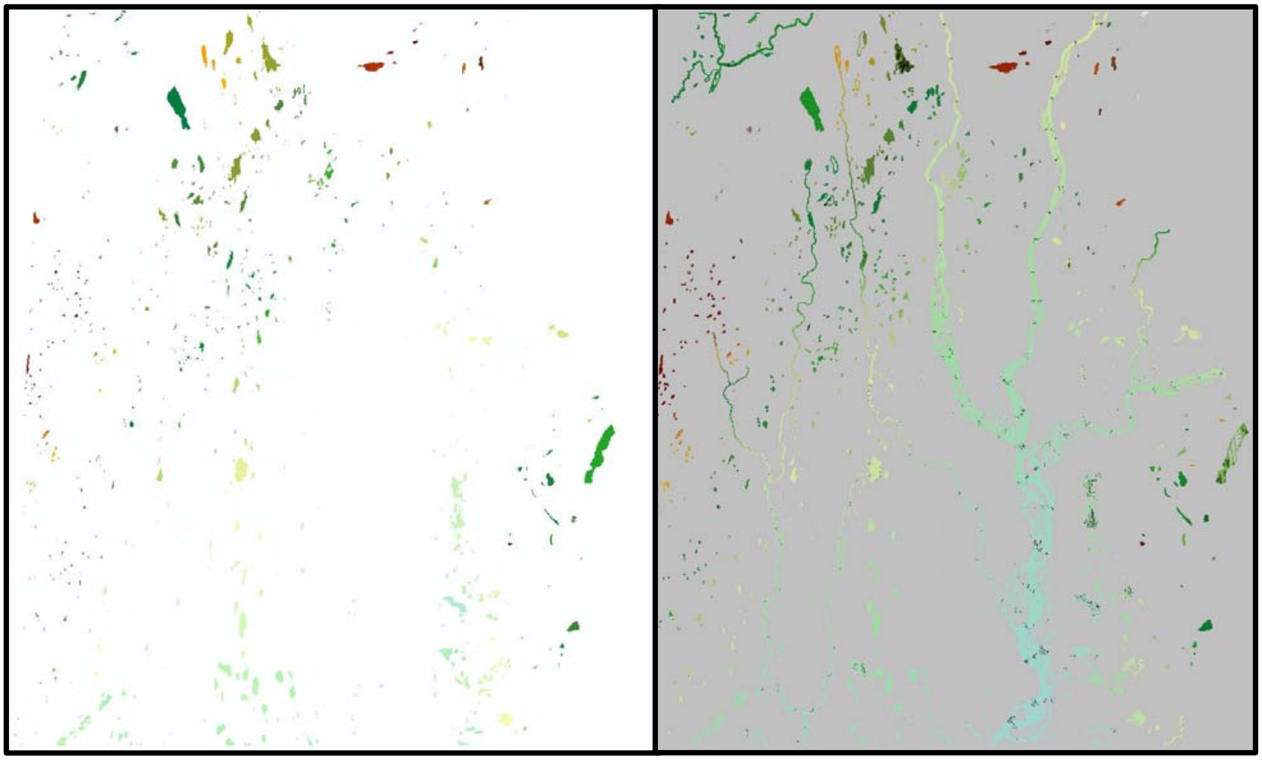


Figure 27, Lake Elevation Comparison (left Hydro Flattened DEM, right LiDAR Point Cloud).

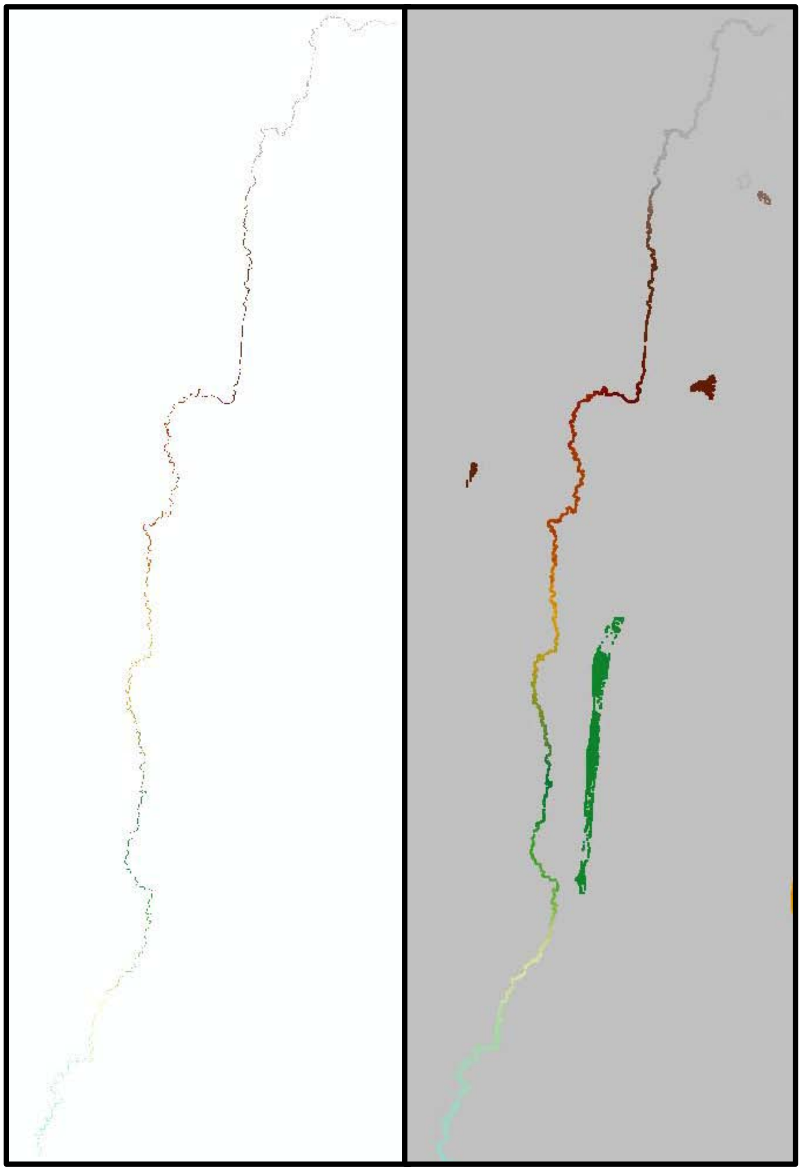


Figure 28, Ninemile Creek (North End) Elevations (left Hydro Flattened DEM, right LiDAR Point Cloud).

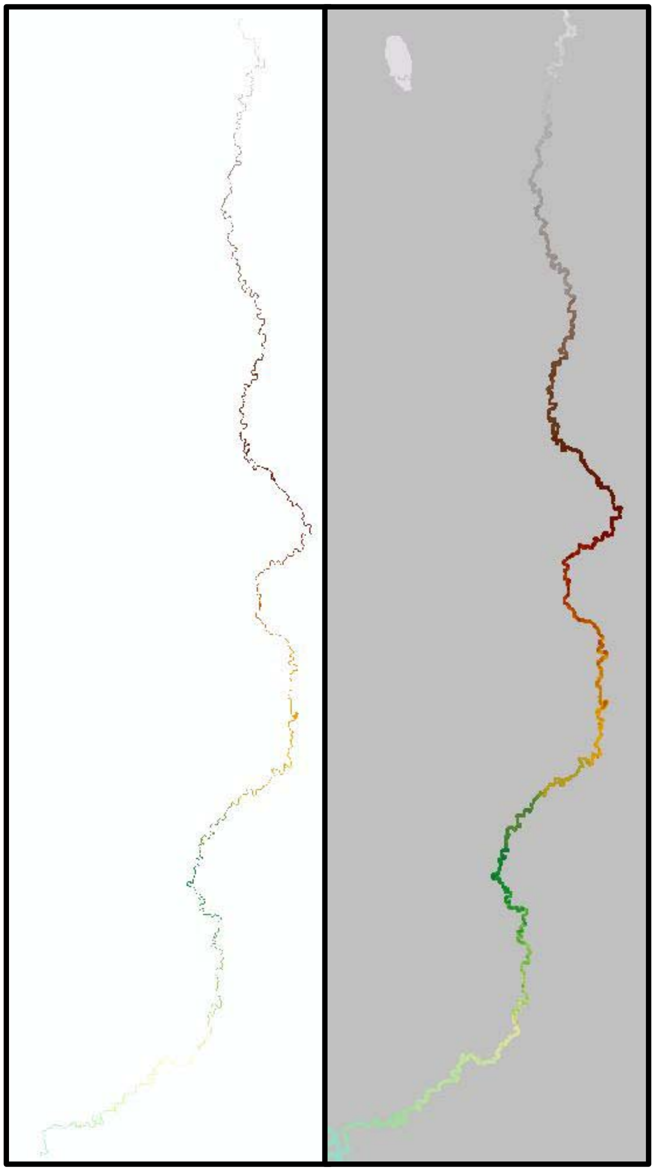


Figure 29, Ninemile Creek (South End) Elevations (left Hydro Flattened DEM, right LiDAR Point Cloud).

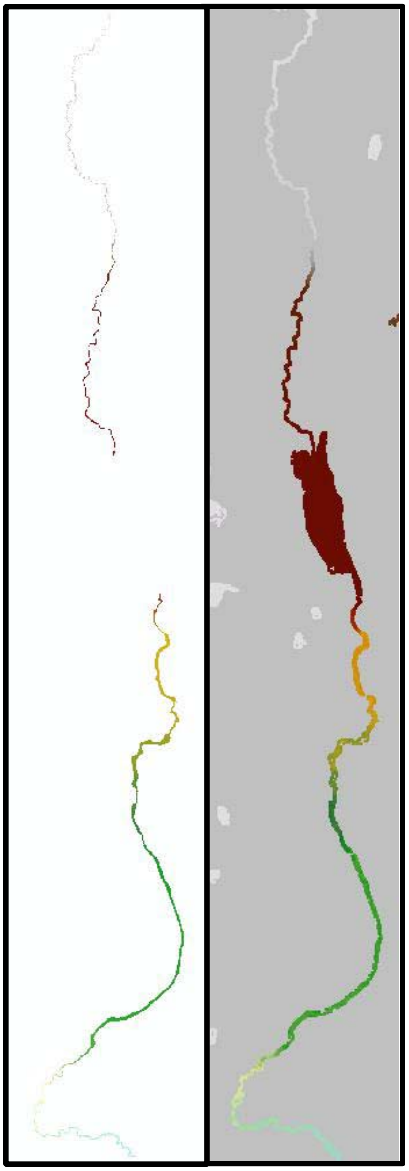


Figure 30, Moose Creek (North End) Elevations (left Hydro Flattened DEM, right LiDAR Point Cloud).

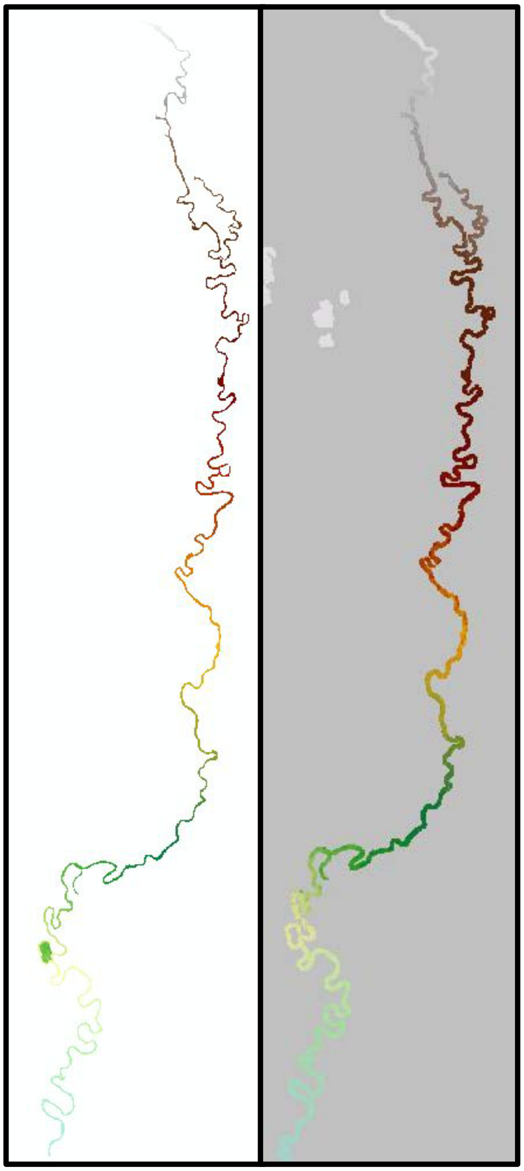


Figure 31, Moose Creek (Middle Section) Elevations (left Hydro Flattened DEM, right LiDAR Point Cloud).

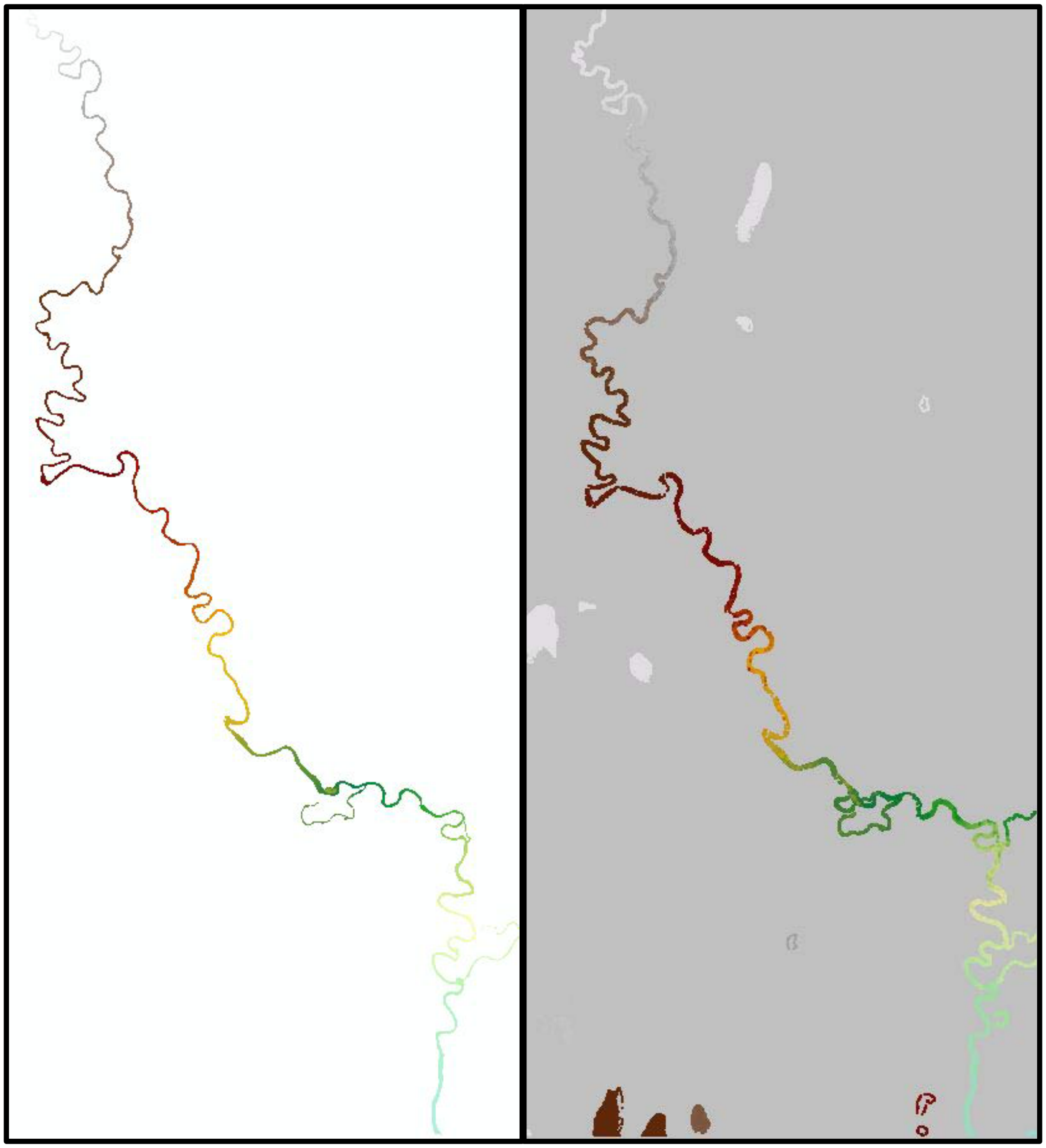


Figure 32, Moose Creek (South End) Elevations (Left Hydro Flattened DEM, Right LiDAR Point Cloud)

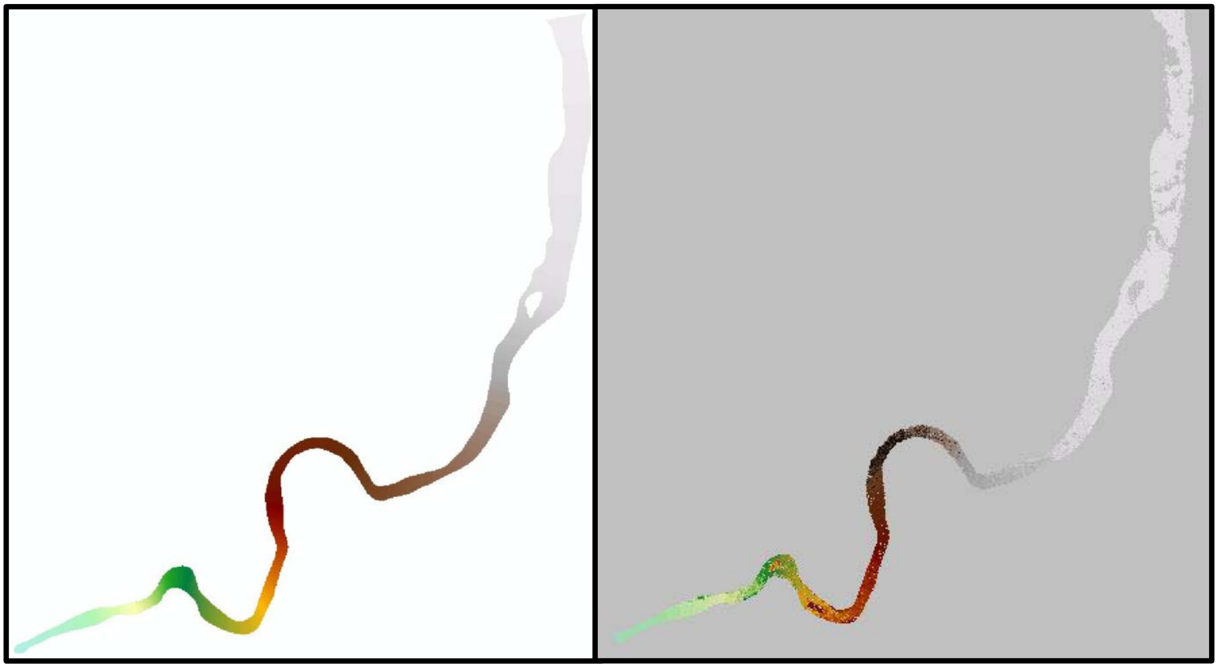


Figure 33, Papa Bear Creek Elevations (Left Hydro Flattened DEM, Right LiDAR Point Cloud)

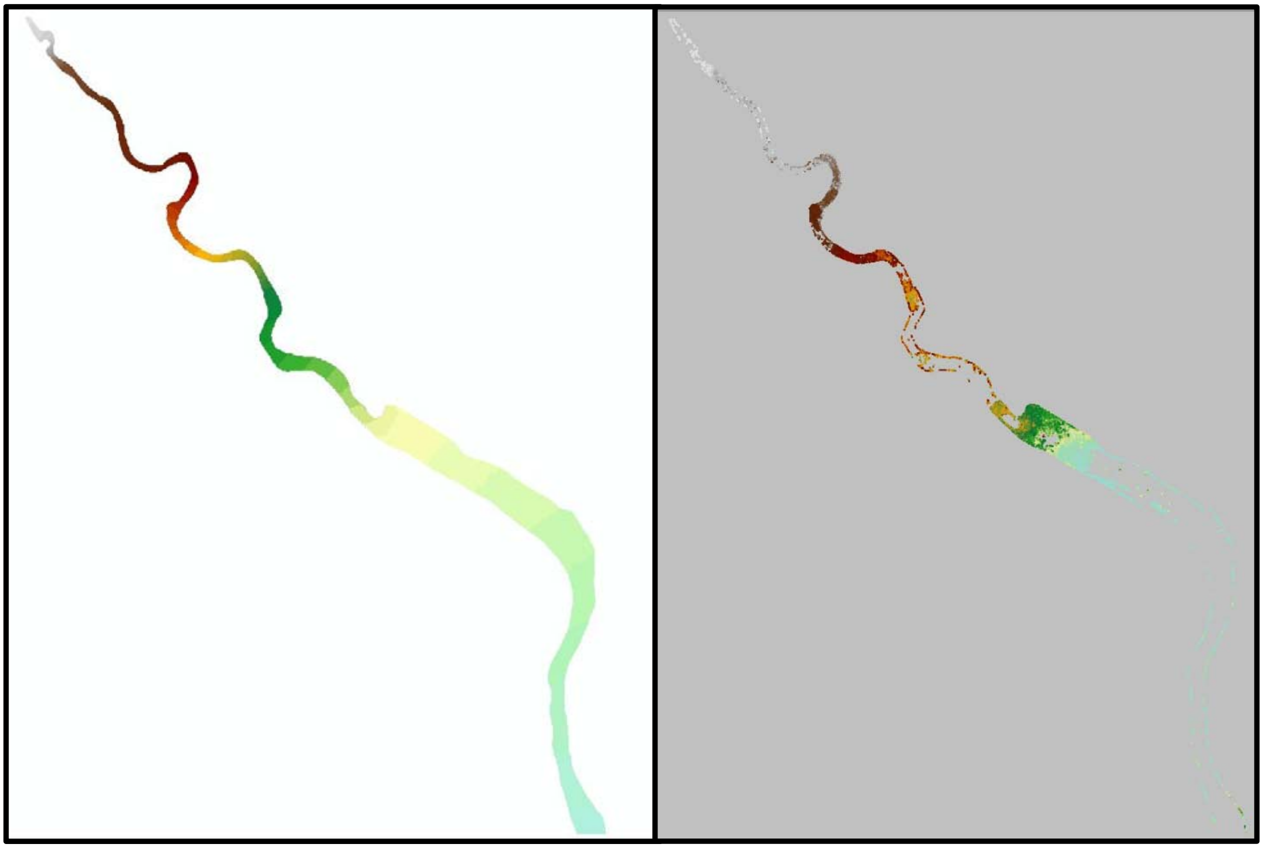


Figure 34, Rabideux Creek Elevations (Left Hydro Flattened DEM, Right LiDAR Point Cloud)

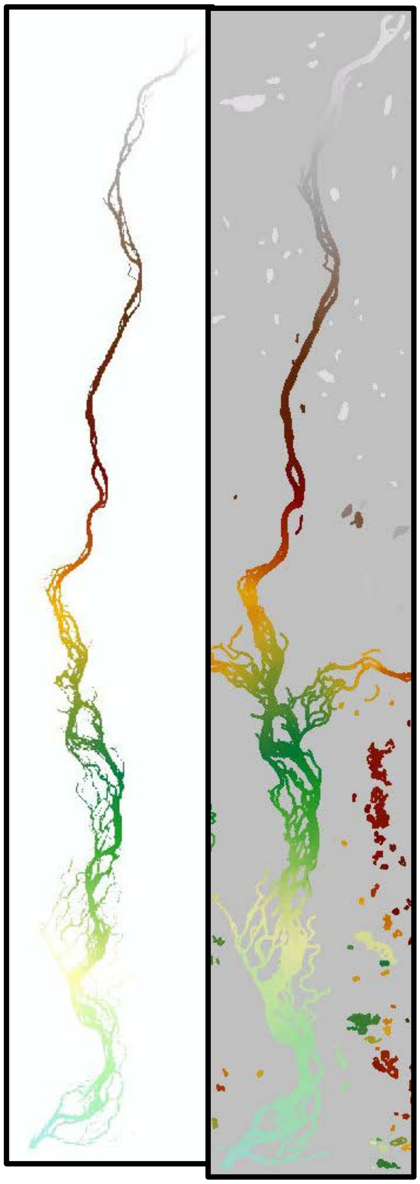


Figure 35, Susitna River Elevations (Left Hydro Flattened DEM, Right LiDAR Point Cloud)

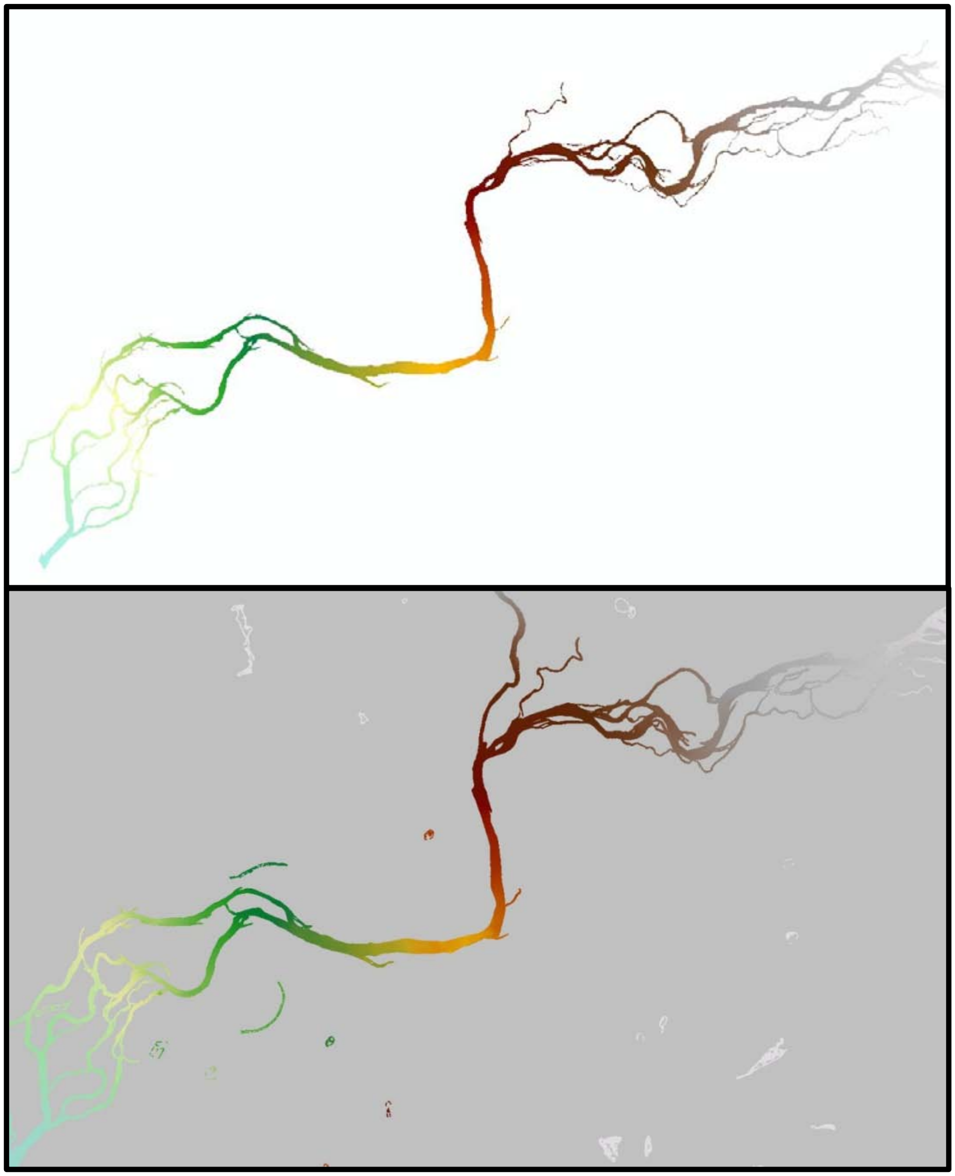


Figure 36, Talkeetna River Elevations (Top Hydro Flattened DEM, Bottom LiDAR Point Cloud)

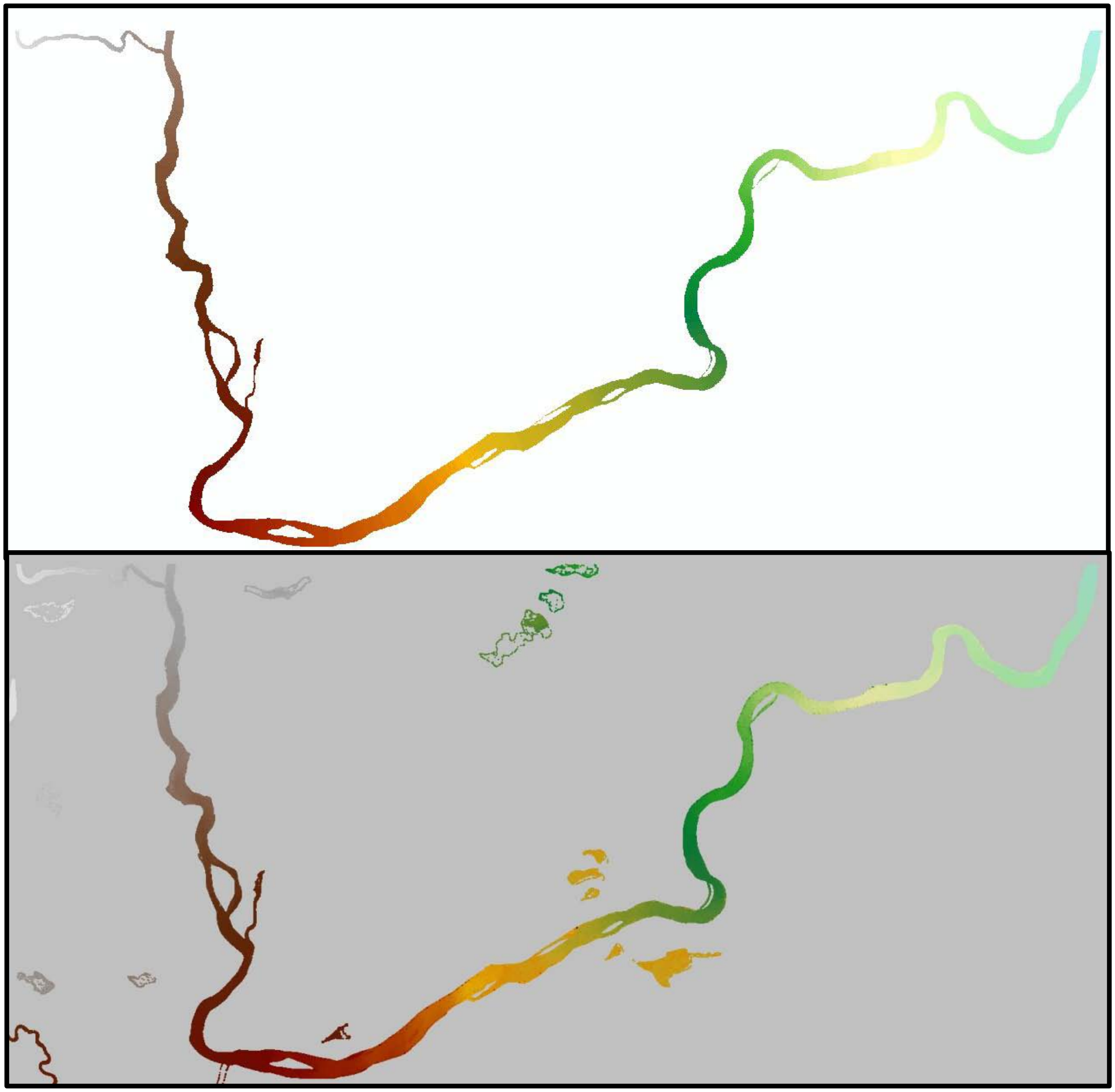


Figure 37, Tokositna River Elevations (Top Hydro Flattened DEM, Bottom LiDAR Point Cloud)

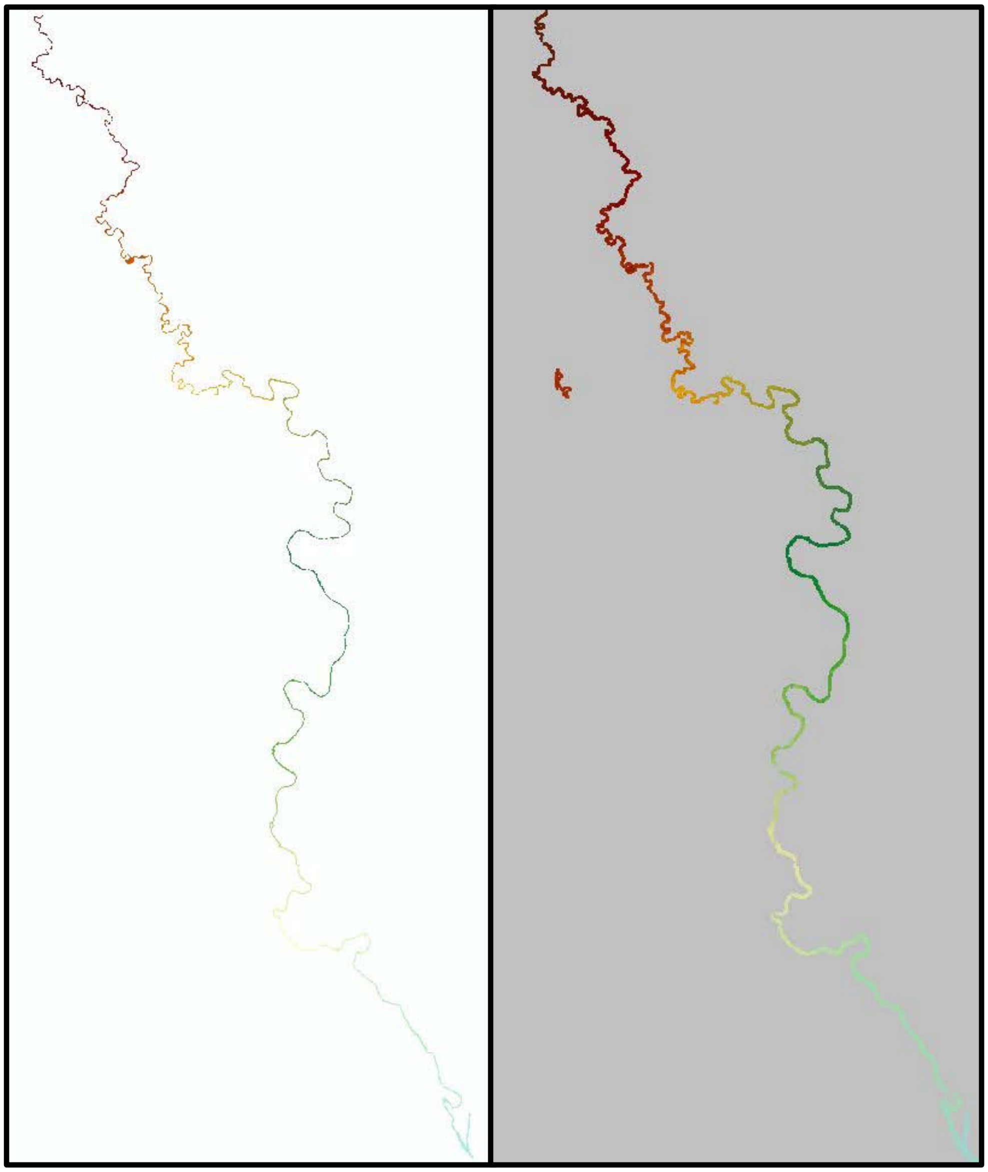


Figure 38, Trapper Creek (South End) Elevations (Left Hydro Flattened DEM, Right LiDAR Point Cloud)

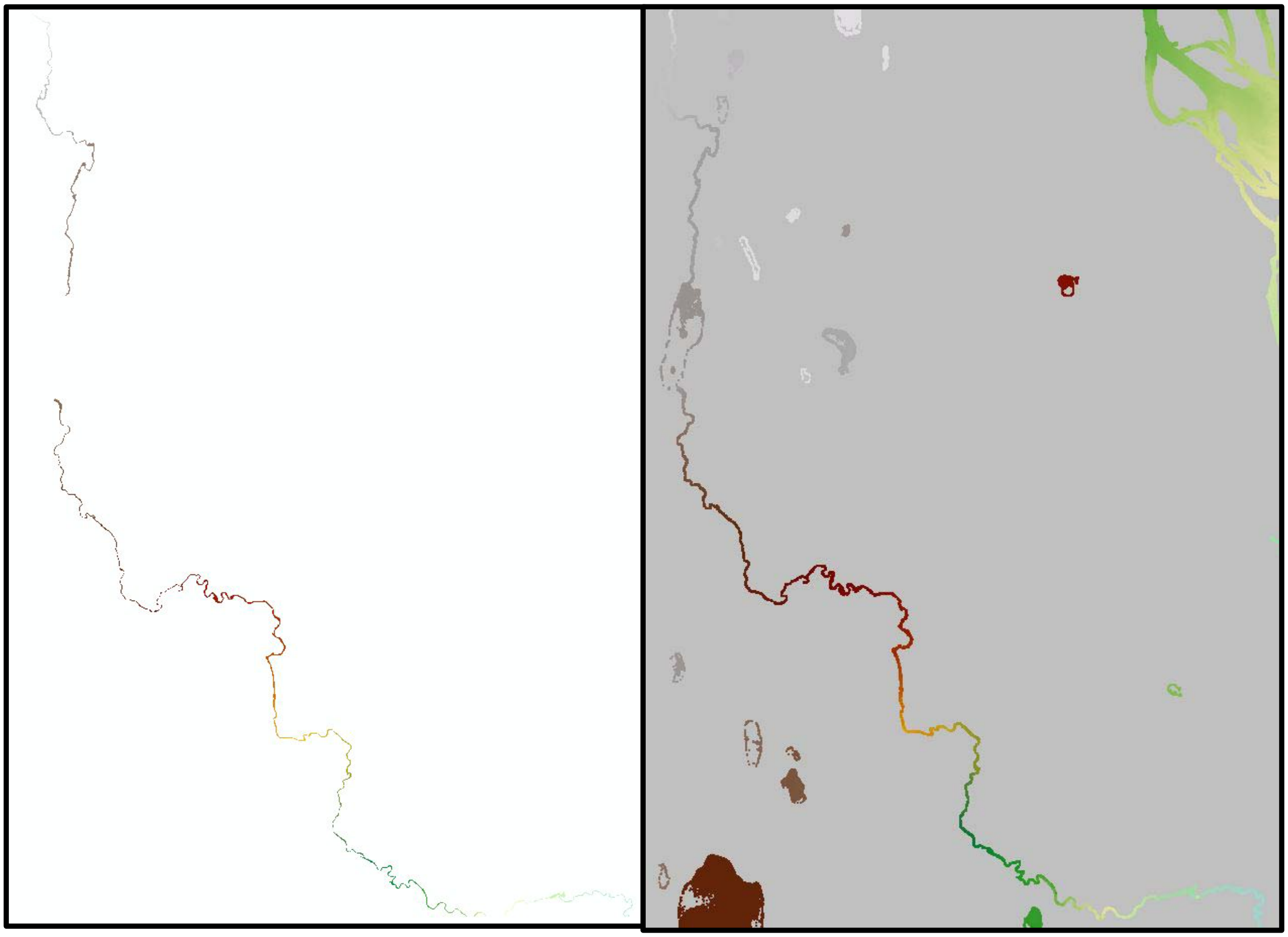


Figure 39, Trapper Creek Elevations (Left Hydro Flattened DEM, Right LiDAR Point Cloud)

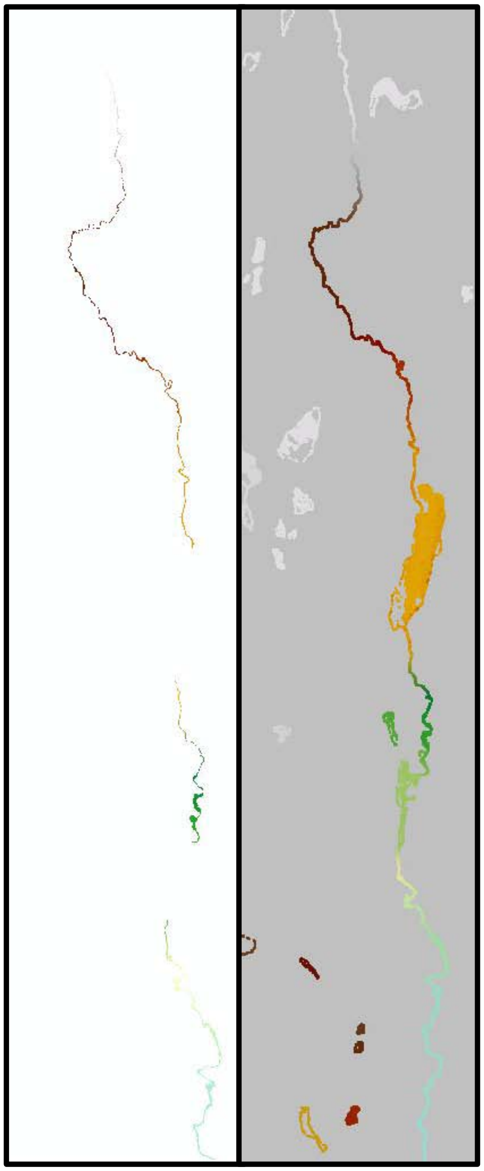


Figure 40, Trapper Creek Elevations (Left Hydro Flattened DEM, Right LiDAR Point Cloud)

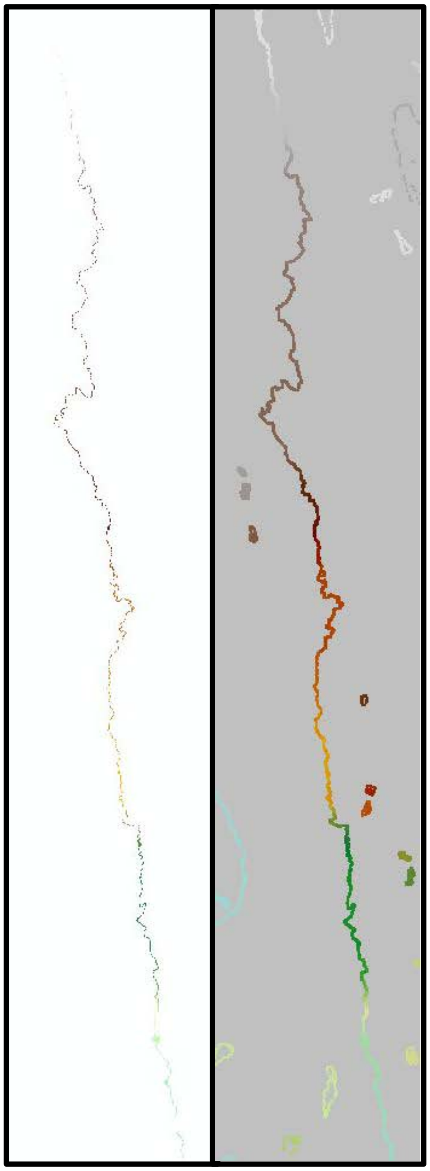


Figure 41, Trapper Creek (North End) Elevations (Left Hydro Flattened DEM, Right LiDAR Point Cloud)

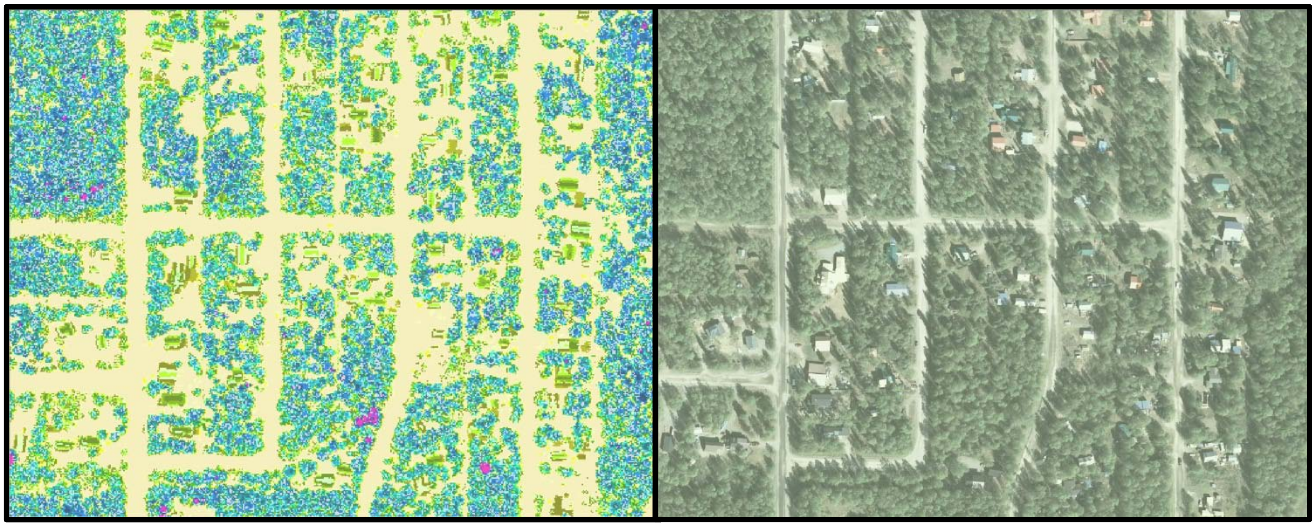


Figure 42, Building Analysis – Ortho vs. Canopy Height Classification.

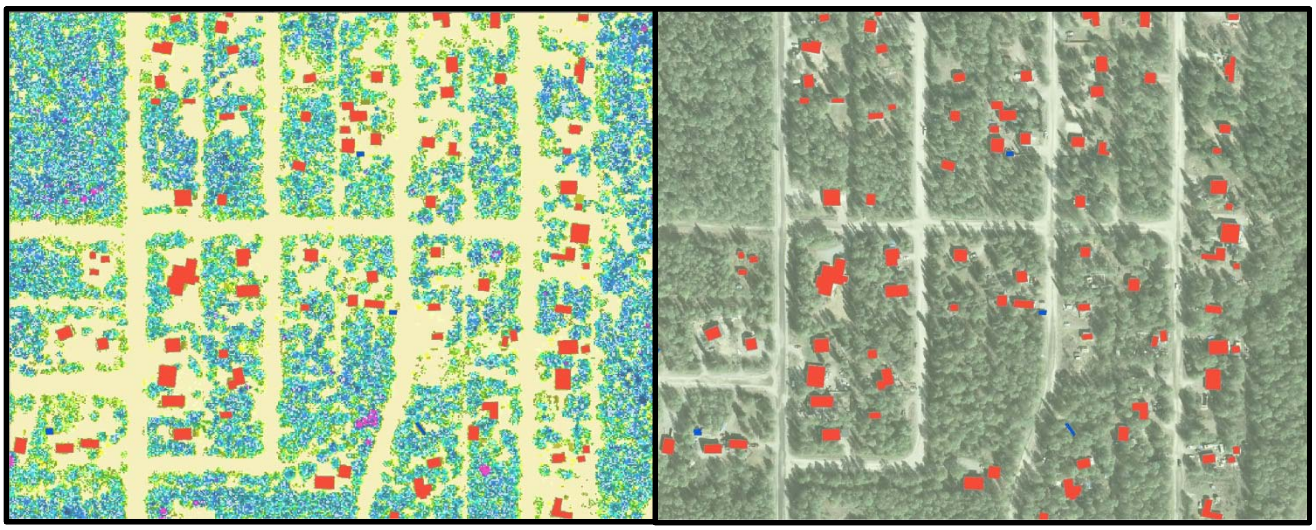


Figure 43, Building Analysis – Ortho vs. Canopy Height Classification with Building Footprint.

Figure 44, Building Analysis Results (Lt. Blue – Correct, Red – Incorrect, Dark Blue – Added)

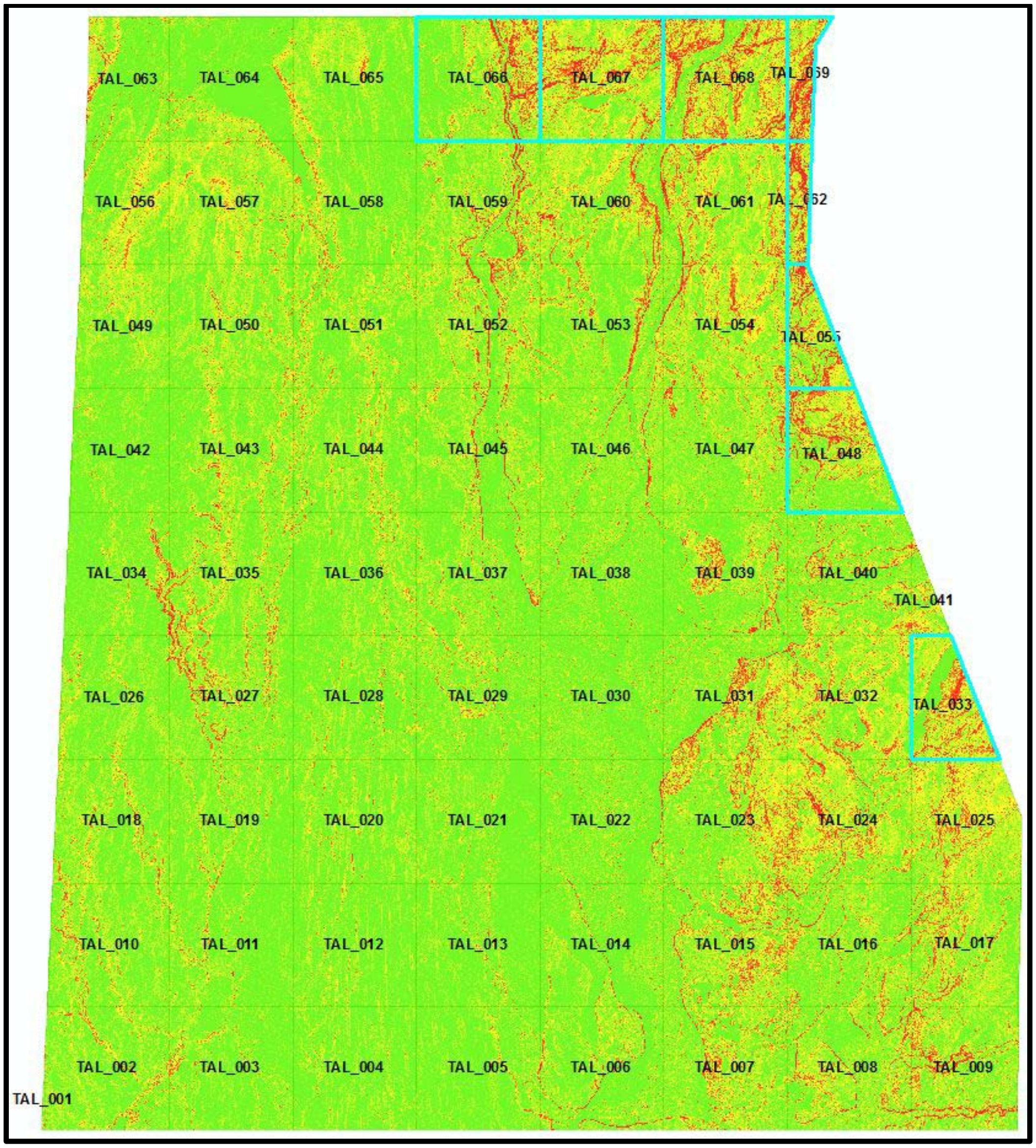


Figure 45, Degree Slope Selected Contour Tiles for Topology Testing.

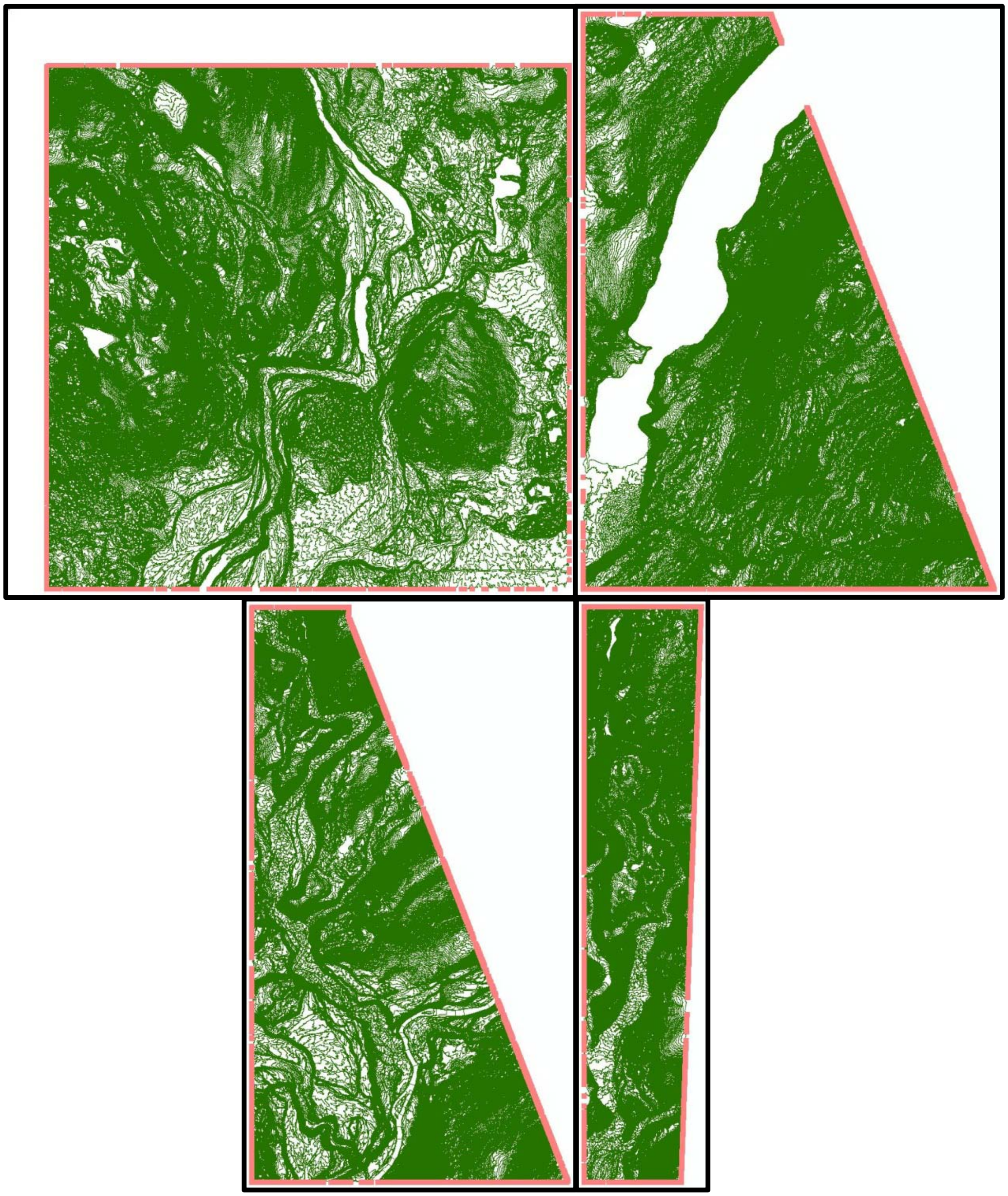


Figure 46, First Four Topology Checks.

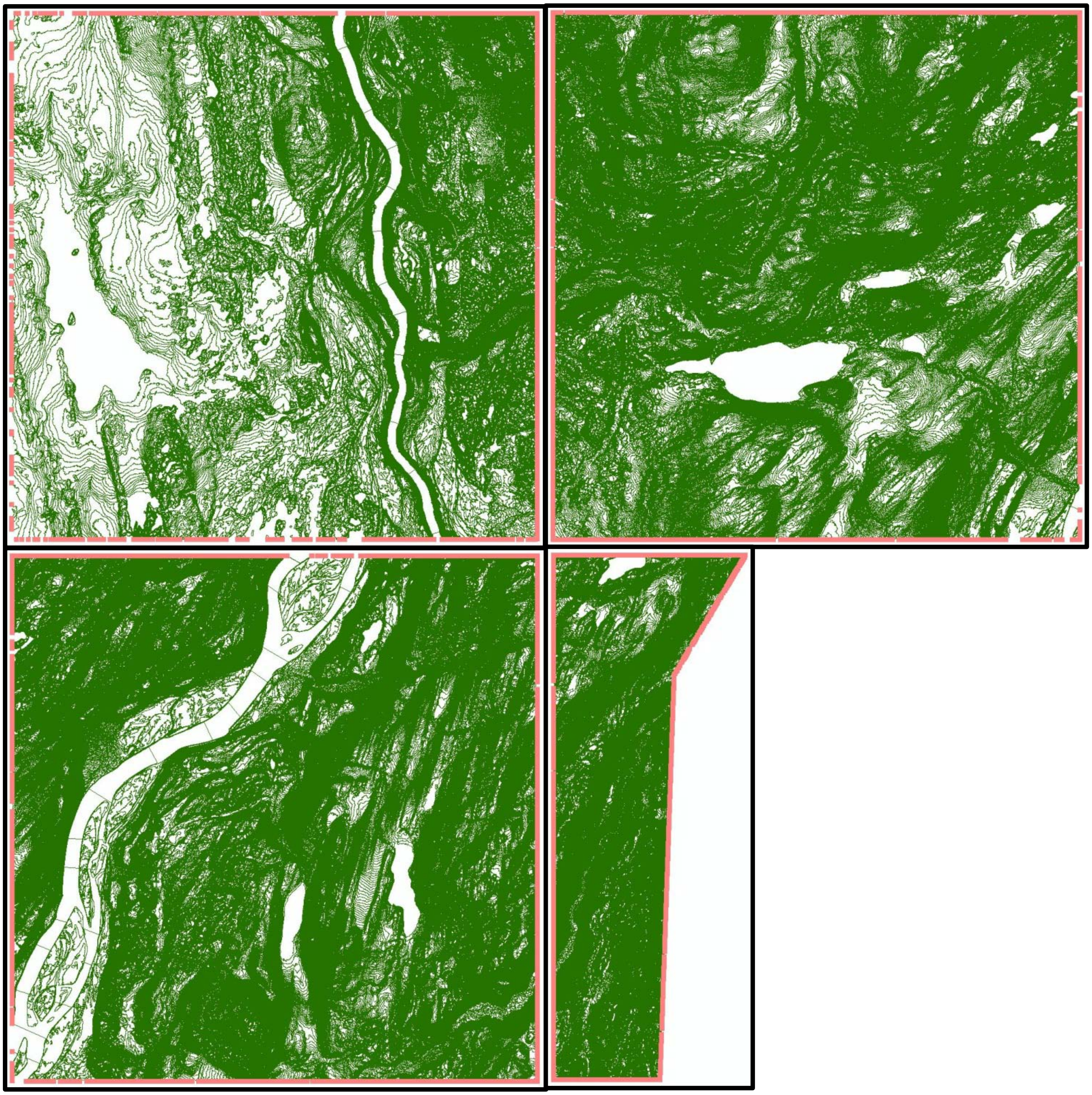


Figure 47, Second Set of Four Topology Checks.

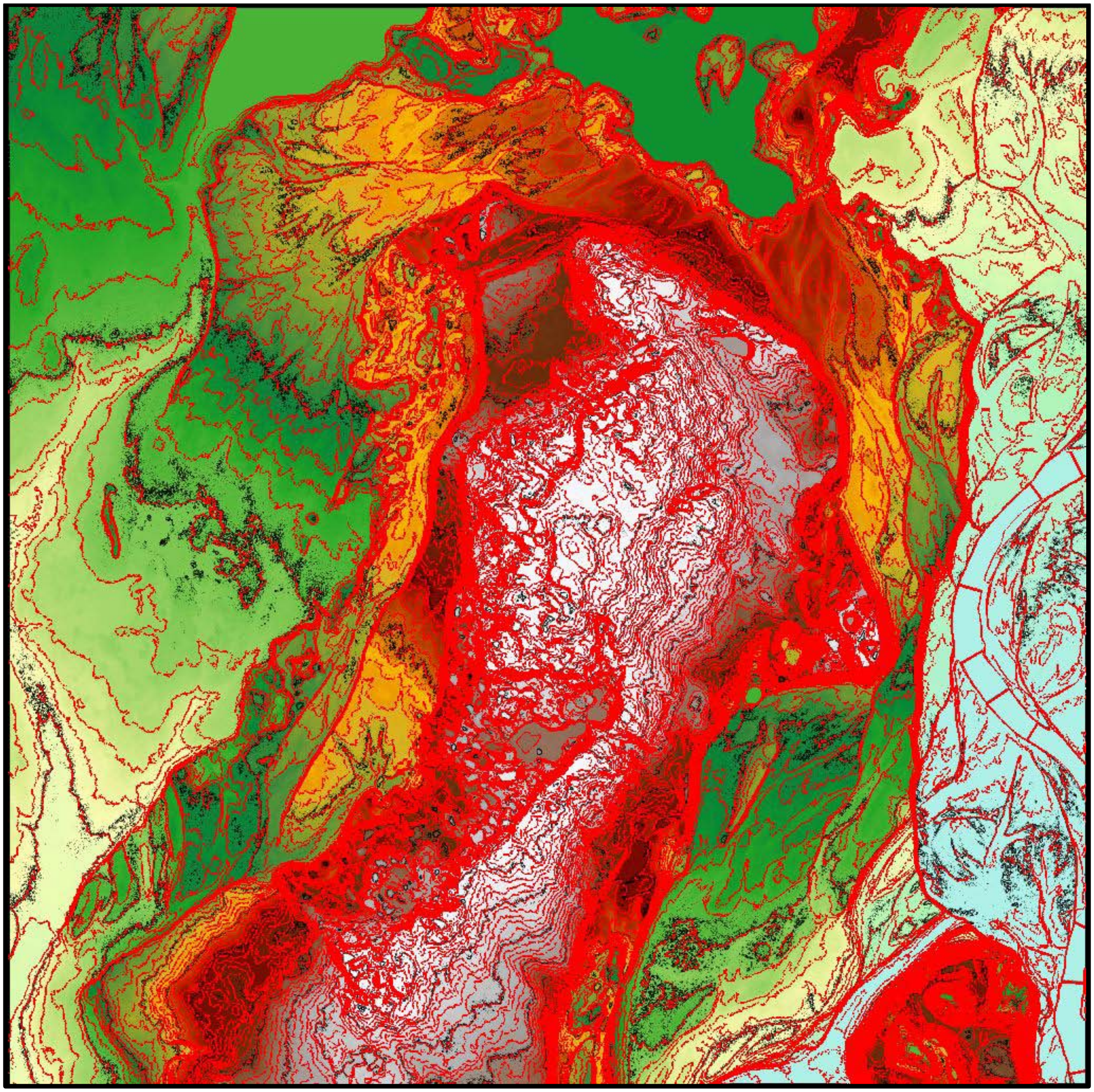


Figure 48, DXF Contour 2D Drape in QTM.

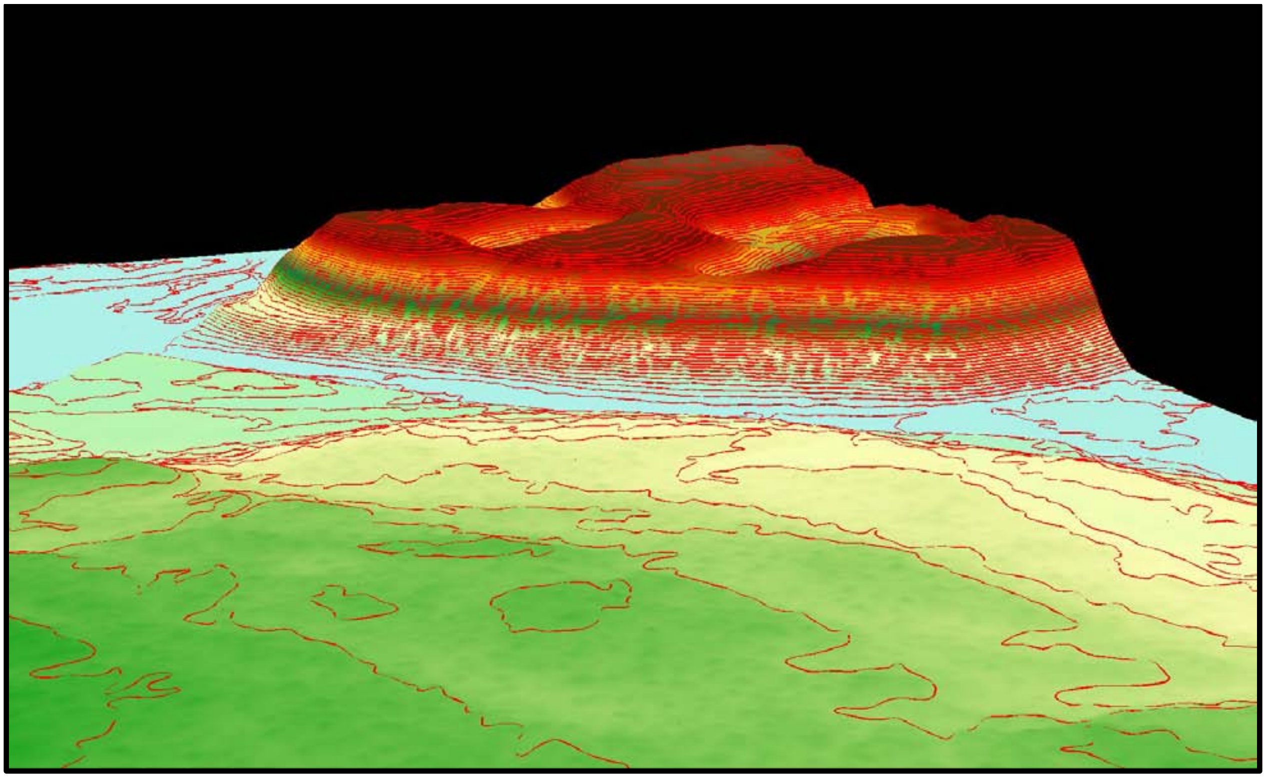


Figure 49, DXF Contour 3D Drape in QTM.

Delivery History and Reported Data Quality Issues

Delivery 1 - Aerometric delivered to UAF the first complete Talkeetna block on 3/14/2012.UAF began its review a few days later, reporting quality issues as problems were discovered. The following provides a brief description of each quality issue found in the data provided in the first delivery and when they were reported.

UAF requested Talkeetna block boundary shapefile – On 3/21/2012, UAF noticed that the delivery disk did not include the Talkeetna block boundary with its other GIS layers in Geodatabase. This is needed in support of the QA process.

UAF reported problems in Talkeetna first return DSM – On 3/27/2012, UAF noticed eight regions of negative height differences in a canopy height assessment of the Talkeetna first-return DSM and bare-Earth DEM. Screen shots of each region of error was provided (see Figure 50-54).

UAF reported topology errors on four Talkeetna contour tiles – On 3/29/2012, UAF noticed topology errors on four contour tiles. Tiles failed "must be single part" rule in checks. Screen captures were provided showing errors (see Figure 55-56).

UAF reported unhandled exception in running LAS Tool – On 3/29/2012, UAF encountered an unhandled exception while running LAS Tools to assess LiDAR return density on one tile of LAS point cloud data. This was determined to be due to point outliers in the data which can be identified and removed.

UAF reported cross calibration swaths present in unclassified class 1 point cloud data – On 4/11/2012, UAF noticed the presence of cross calibration swaths in Talkeetna unclassified point cloud data. To remain consistent with previously delivered blocks, UAF requested these to be removed (see Figure 57).

UAF requested Talkeetna low vegetation class be masked for water - On 4/11/2012, UAF requested that Aerometric check the Talkeetna low vegetation class to be consistent over water with other blocks. Some sections of the Susitna River braded stream are obscured (see Figure 58).

UAF reported large number of segmentations of Goose Creek – On 4/11/2012, UAF noticed that Goose Creek was broken into several segments as defined in the double breakline drainage. Aerometric later reported these were due to the presence of beaver dams. MSB staff requested these to remain in the data with no change needed as the data accurately represents what is on the ground.

UAF reported holes over water in Bare Earth DEM – On 5/1/2012, UAF reported observing holes over water in Bare Earth DEM (see Figure 59).

UAF reported missing tile and seams in Talkeetna LiDAR Intensity – On 5/7/2012, UAF reported missing tile and visible tile seams in LiDAR Intensity data (see Figure 60).

Delivery 2 – On 5/30/2012, Aerometric delivered to UAF a second complete delivery of corrected LiDAR deliverables for Talkeetna block. The disk also contained a second delivery of corrected data for North Susitna block.

UAF reported elevation anomalies in hydro flattening of Papa Bear Creek – On 6/1/2012, UAF reported elevation anomalies in bare-Earth DEM associated with hydro flattening of Papa Bear Creek. It appeared an island was omitted from the double breakline drainage leaving higher elevations in the delineated stream channel than should be (see Figure 61).

UAF reported possible issue with lack of LiDAR returns of Rabideux Creek – On 6/5/2012, UAF noticed significant difference between water Class point cloud data and stream channel as defined by the double breakline drainage and clipped bare-Earth DEM. The southern extent of the Creek where void of LiDAR data making it difficult to compare. This was later attributed to a deep clear water channel at the Southern end of the Creek. It is difficult to get LiDAR returns over clear water bodies.

Delivery 3 – On 6/11/2012, Aerometric included Talkeetna bare Earth DEM fixes. The disk also included a redelivery of North Susitna LiDAR deliverables.

UAF reported between block seams still present – On 6/25/2012, UAF reported testing results of the recently delivered data. There were between block seams still present in the data. Screen captures were provided.

Delivery 4 – On 7/16/2012, Aerometric included Talkeetna bare-Earth DEM fixes.

UAF reported power transmission line included in bare-Earth DEM – On 7/23/2012, UAF reported that power transmission lines were included in some tiles of latest bare-Earth DEM fixes. There were also related height anomalies over water where lines crossed (see Figure 62).

Delivery 5 – On 7/25/2012, Aerometric staged Talkeetna bare-Earth DEM fixes for seven tiles on their FTP.

UAF recommended Talkeetna block acceptance – On 8/72012, UAF recommended acceptance of Talkeetna block confirming that all data quality issues had been addressed and verified.

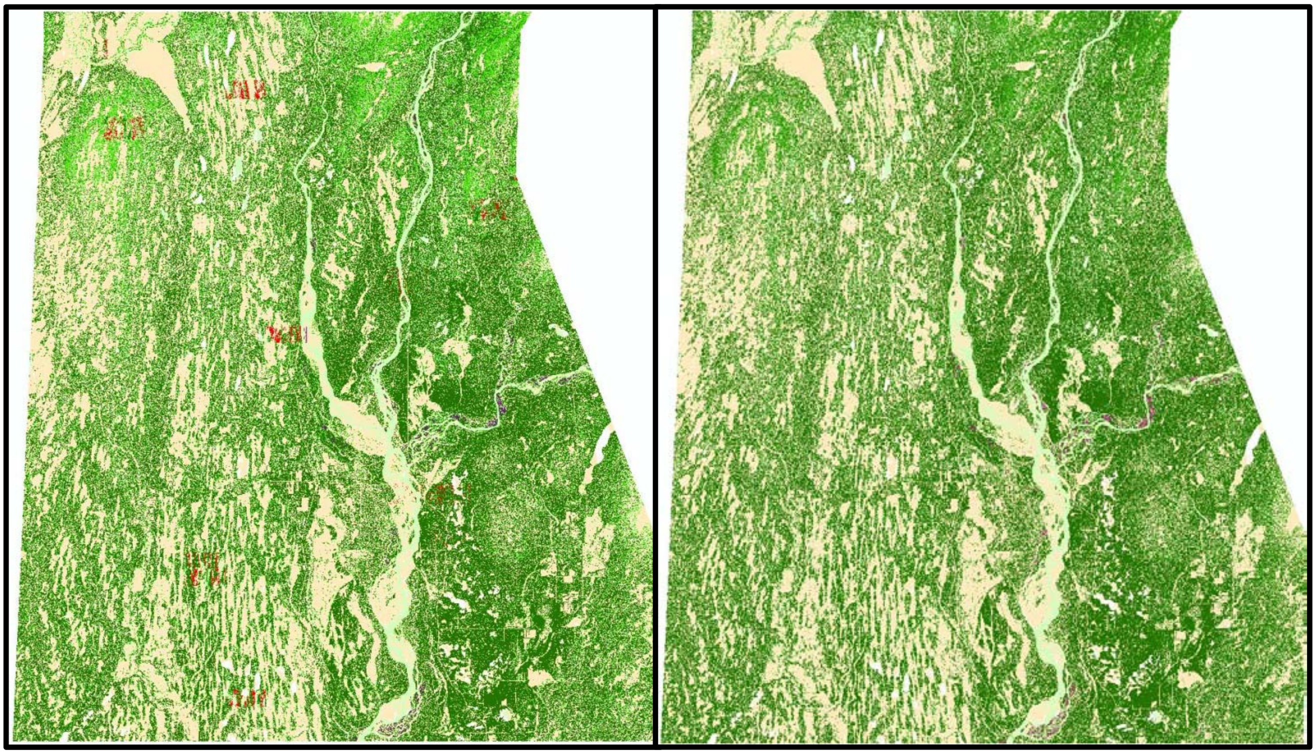


Figure 50, Fix elevation anomalies in first-return DSM that cause negative heights in canopy height estimate produced by subtracting bare-Earth DEM from first-return DSM (block view).

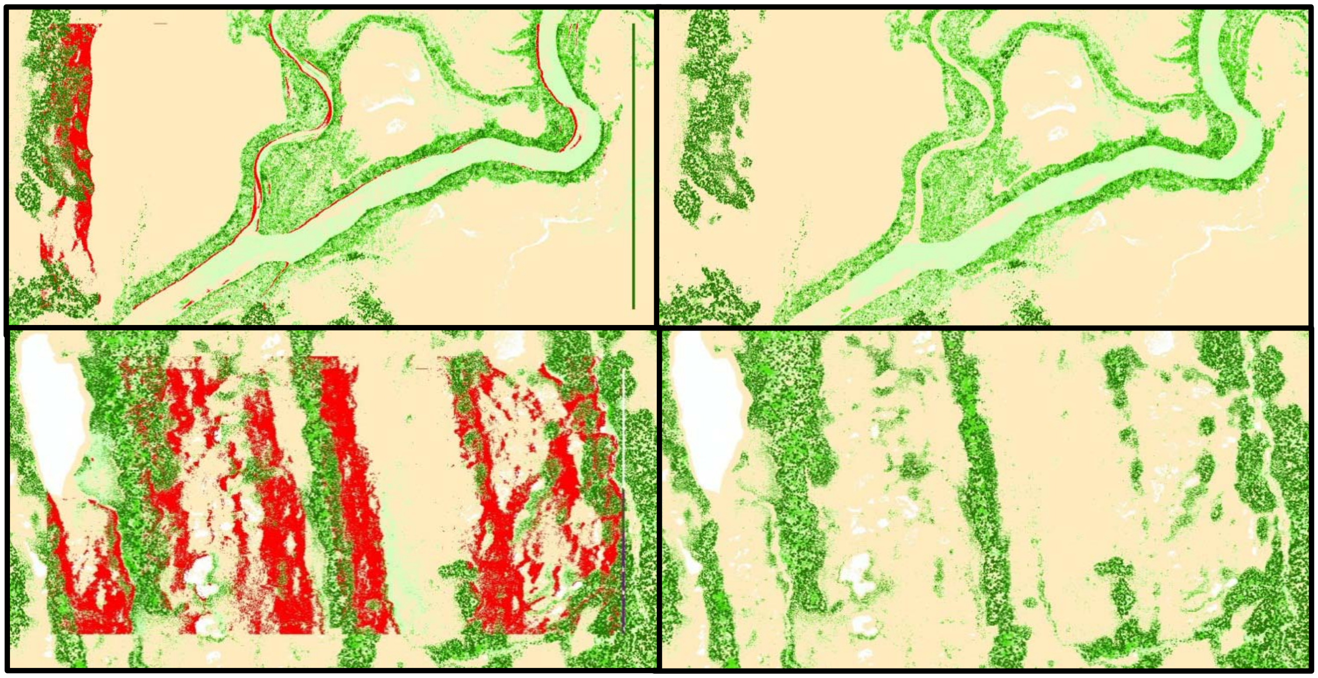


Figure 51, Fix elevation errors in first return DSM (Zoom 1 & 2).

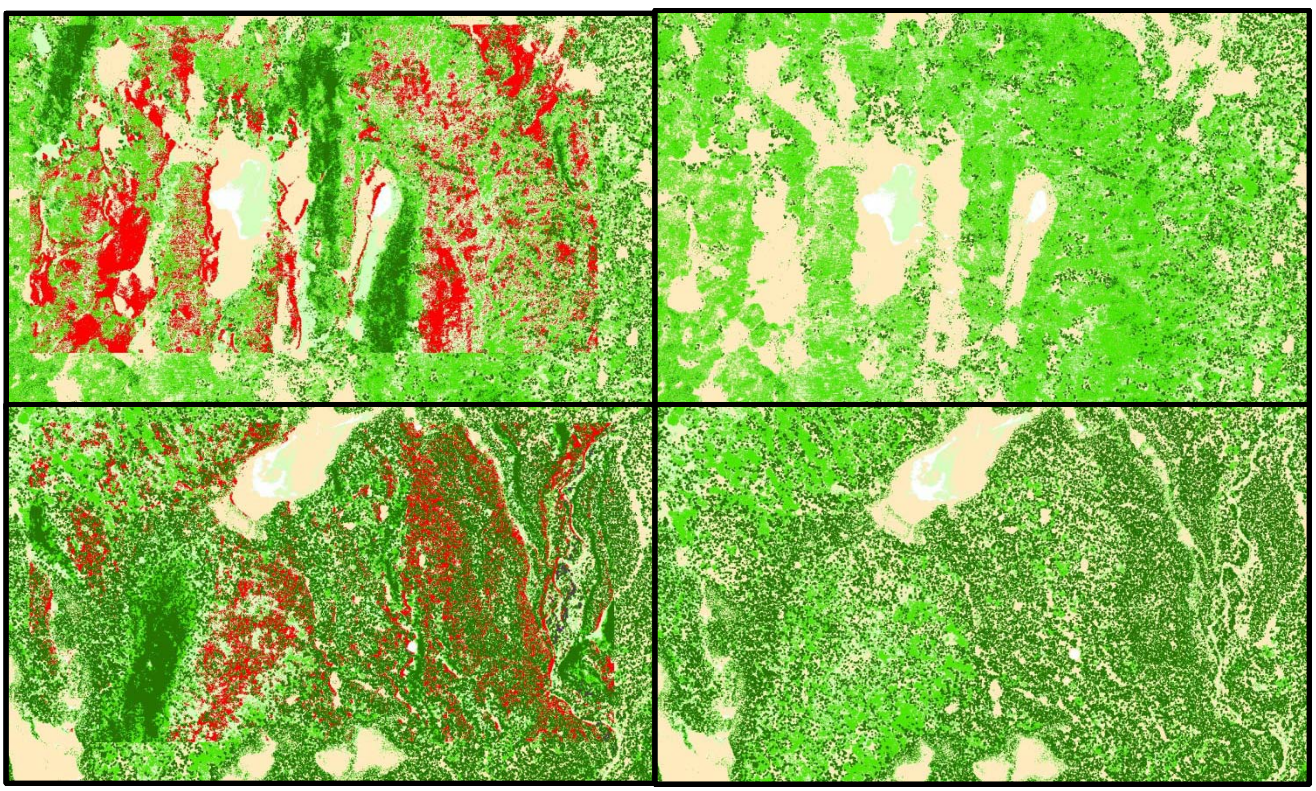


Figure 52, Fix elevation errors in first return DSM (Zoom 3 & 4).

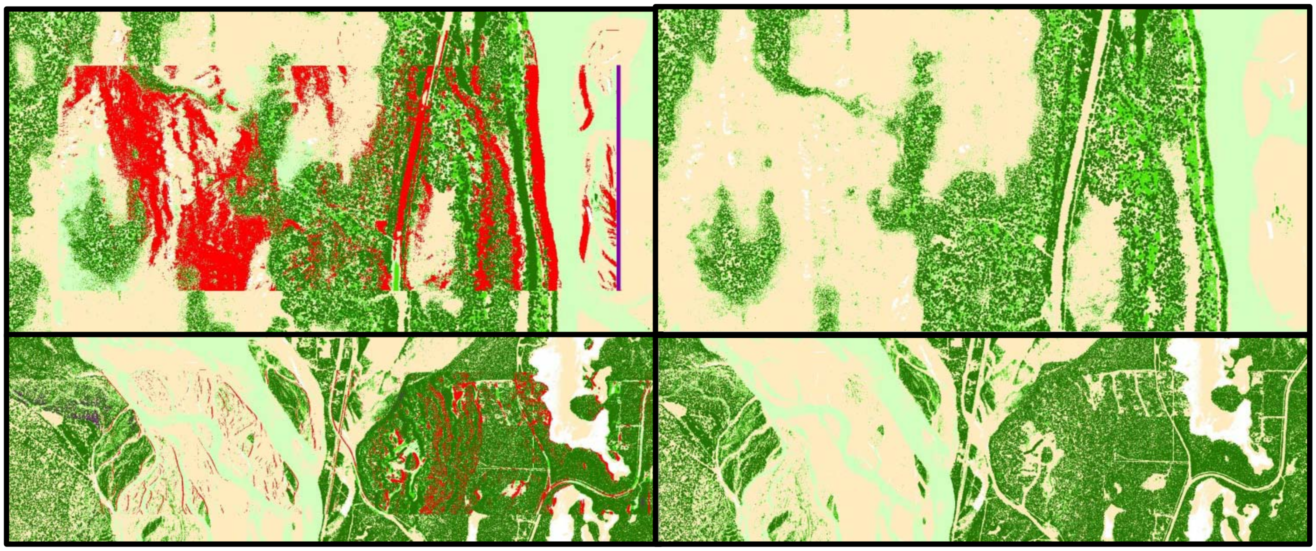


Figure 53, Fix elevation errors in first return DSM (Zoom 5 & 6).

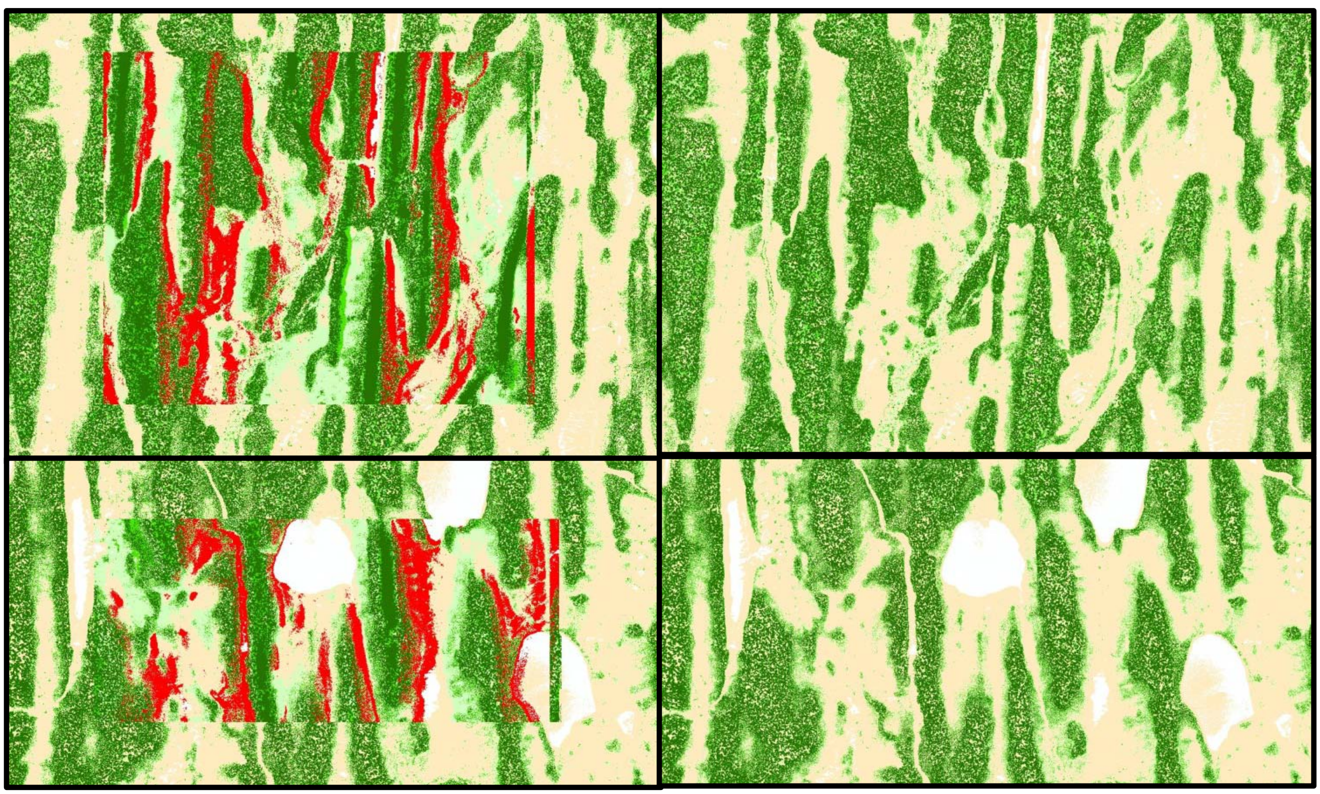


Figure 54, Fix elevation errors in first return DSM (Zoom 7 & 8).

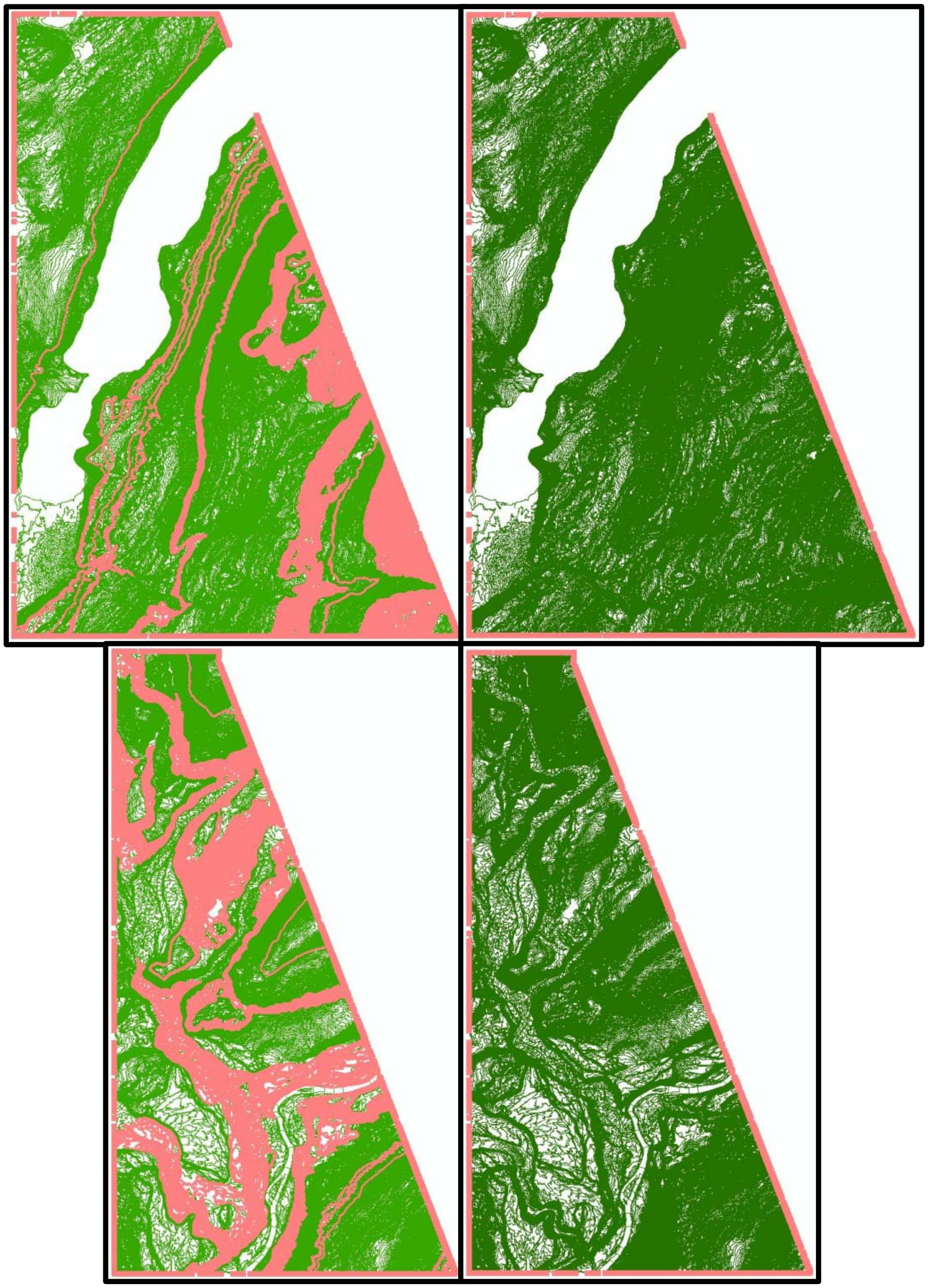


Figure 55, Topology Errors in Elevation Contours (first set of 4 tiles checked)

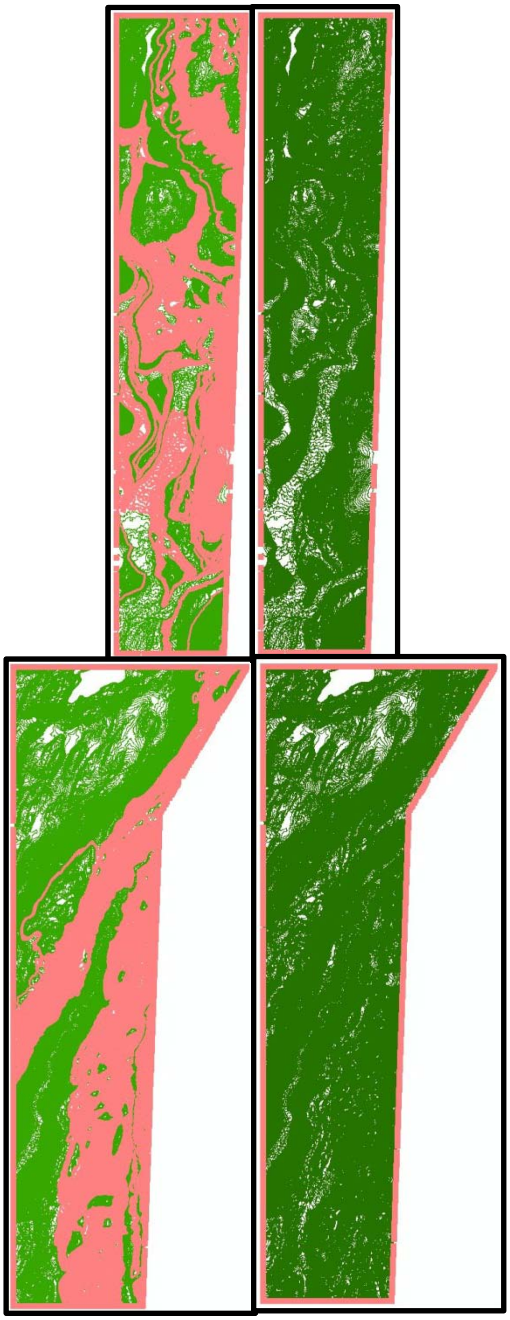


Figure 56, Topology Errors in Elevation Contours (second set of four tiles checked)

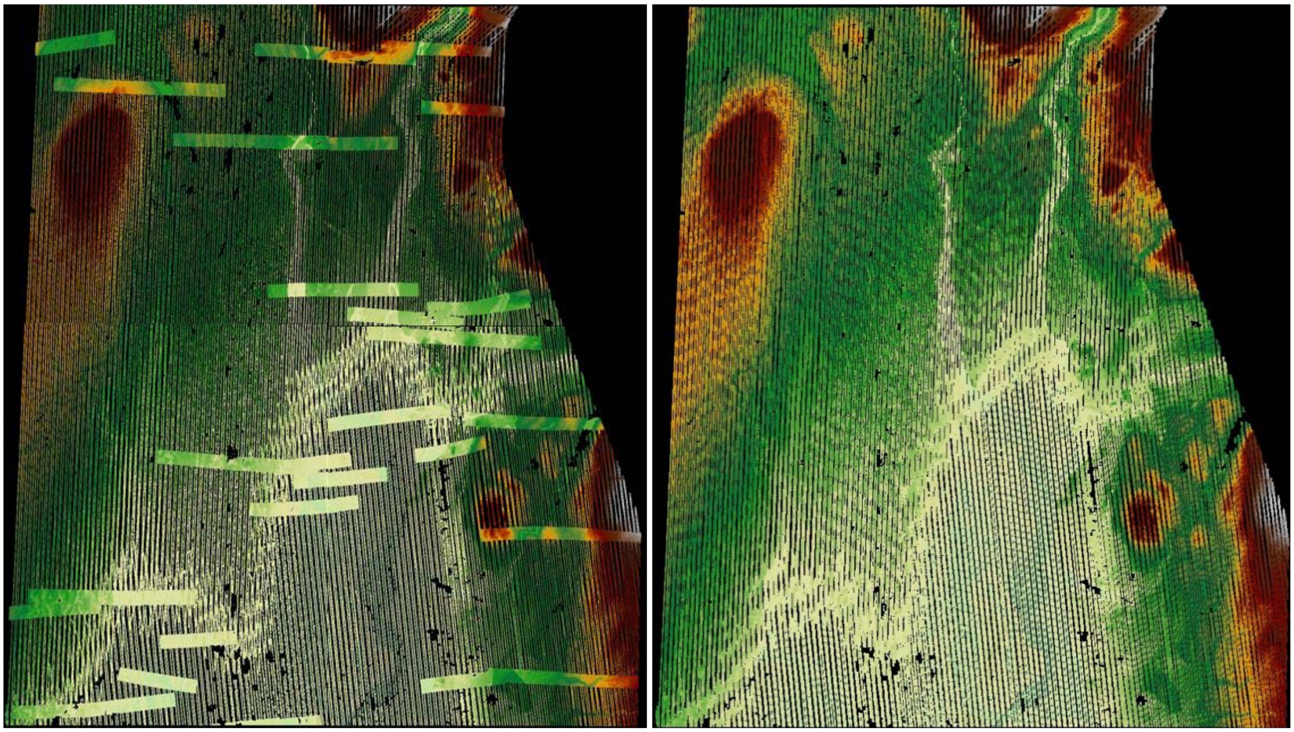


Figure 57, Removed cross calibrations swaths from unclassified (class 1).

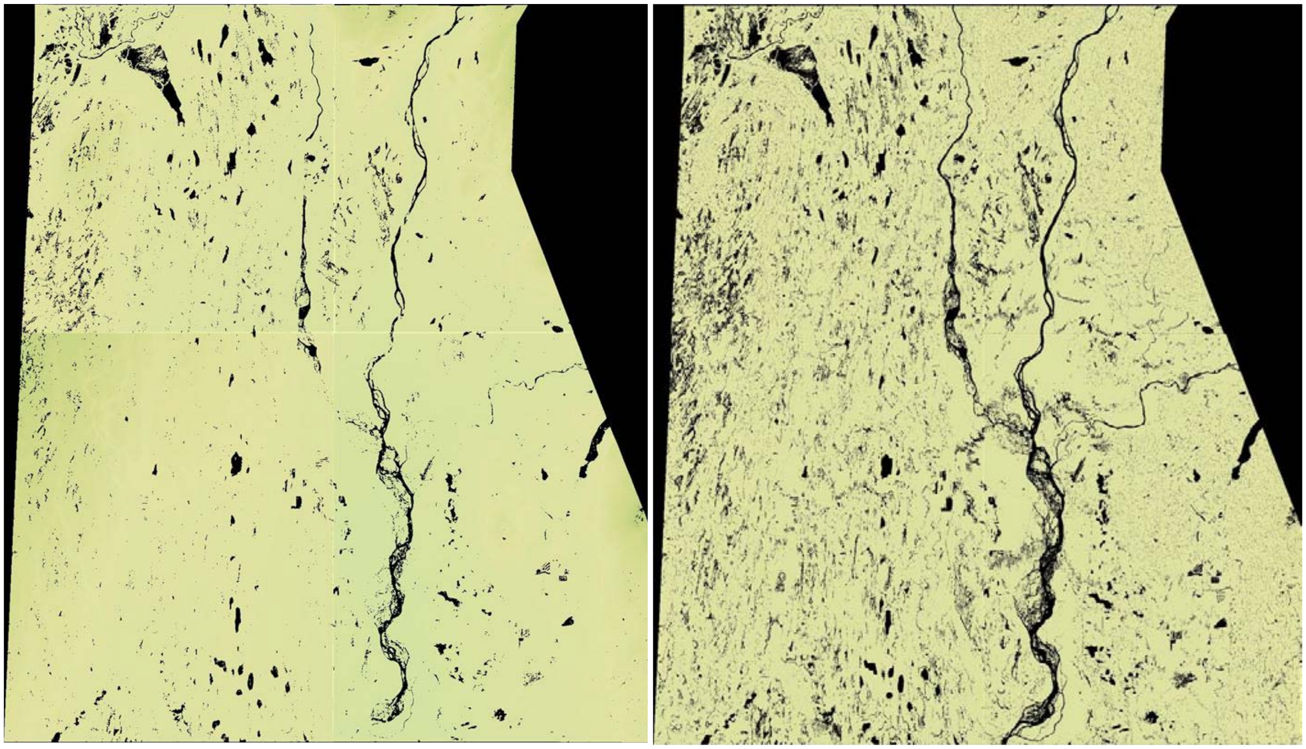


Figure 58, Removing low vegetation class points over water (class3).

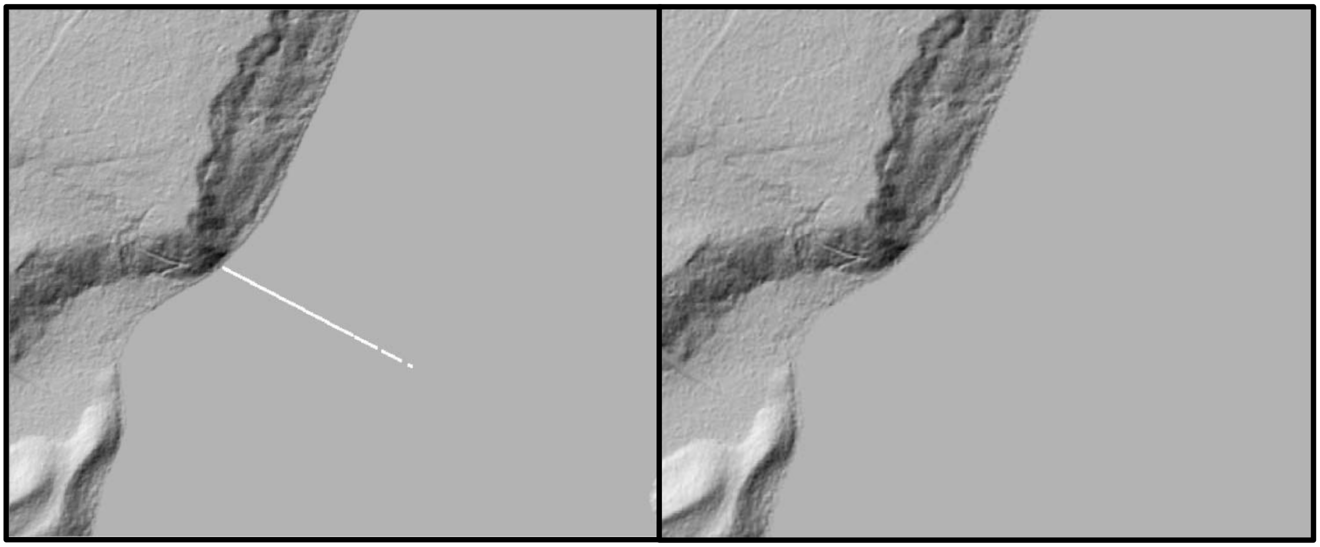


Figure 59, Holes over water in bare-Earth DEM (top shaded relief, bottom bare-Earth DEM).

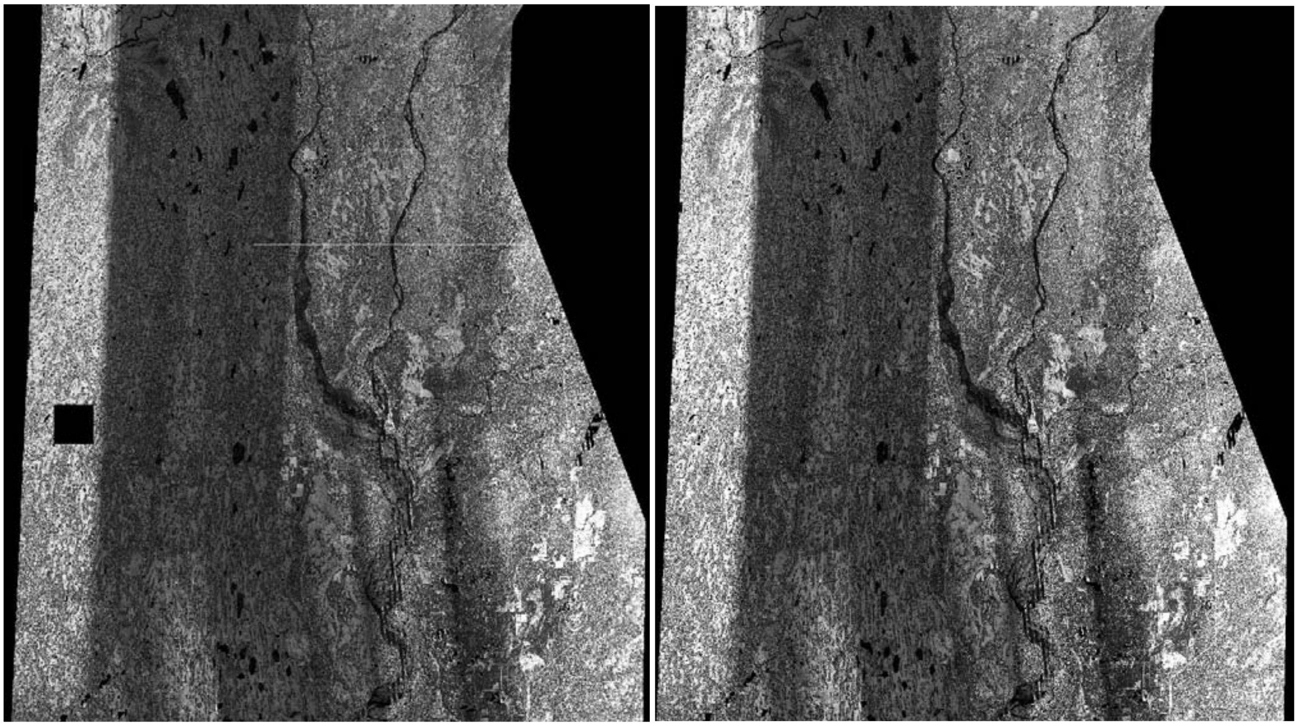


Figure 60, Fix missing tile and seam in LiDAR Intensity data

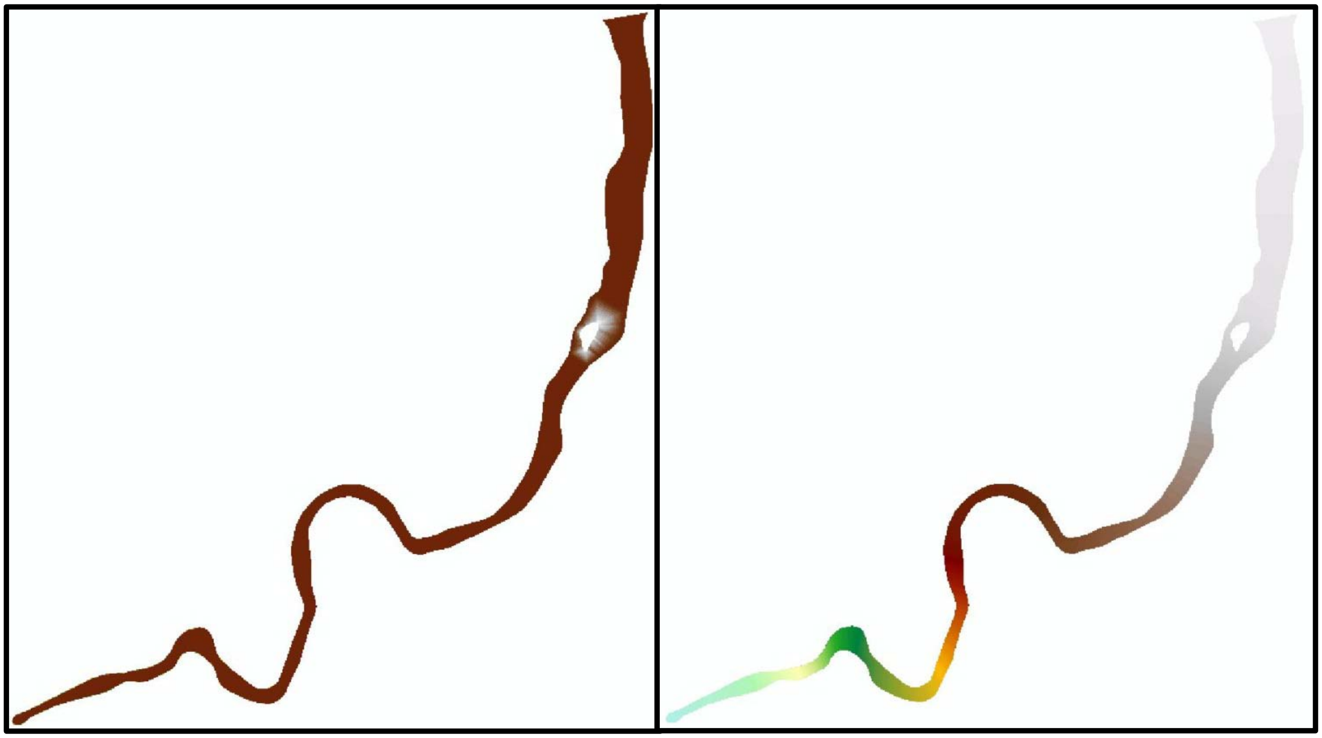


Figure 61, Fix elevation anomaly in Papa Bear Creek hydro flattening of Bare-Earth DEM.

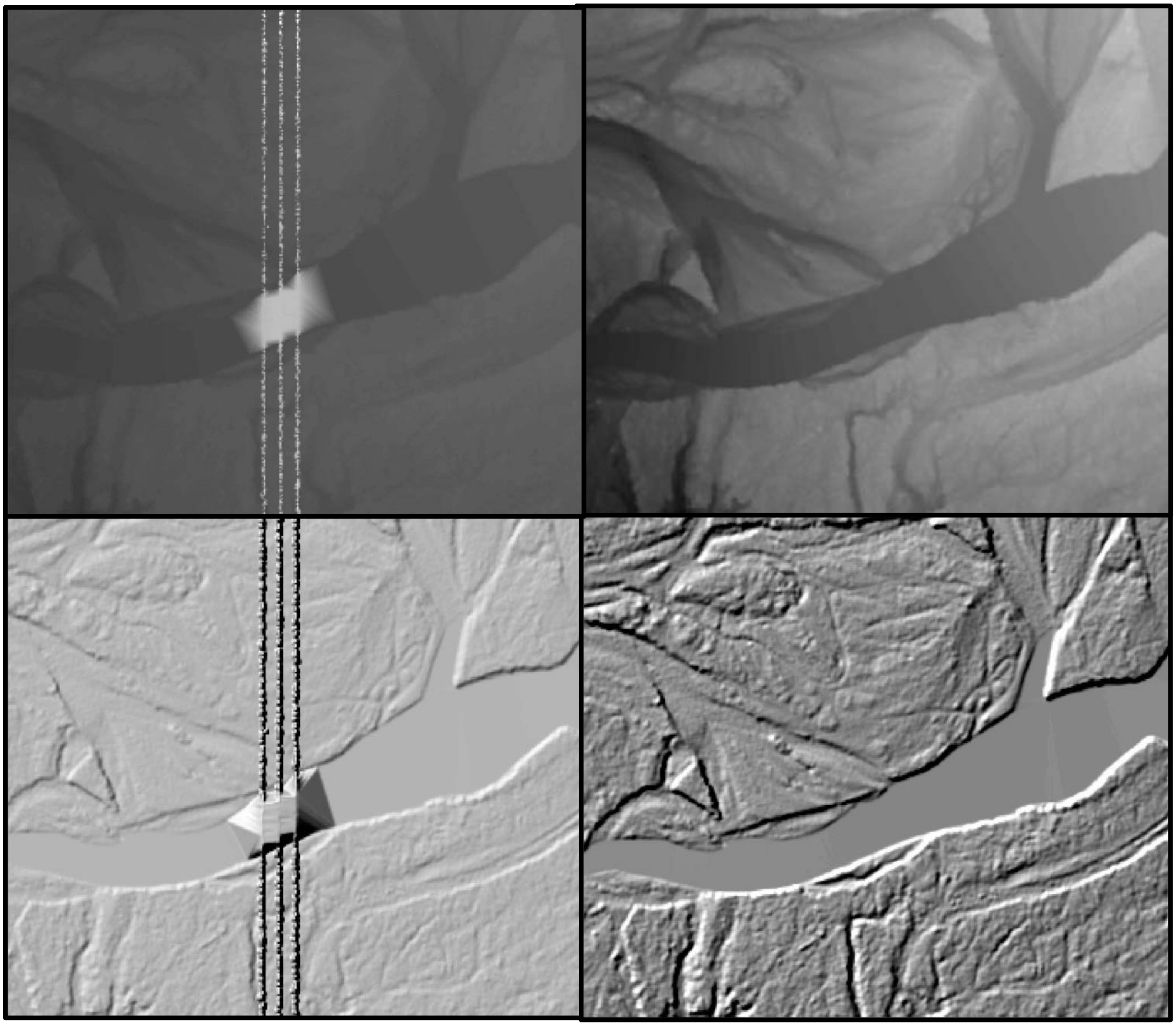


Figure 62, Remove power transmission lines and related height anomalies in Bare-Earth DEM (top) and shaded relief image (bottom).