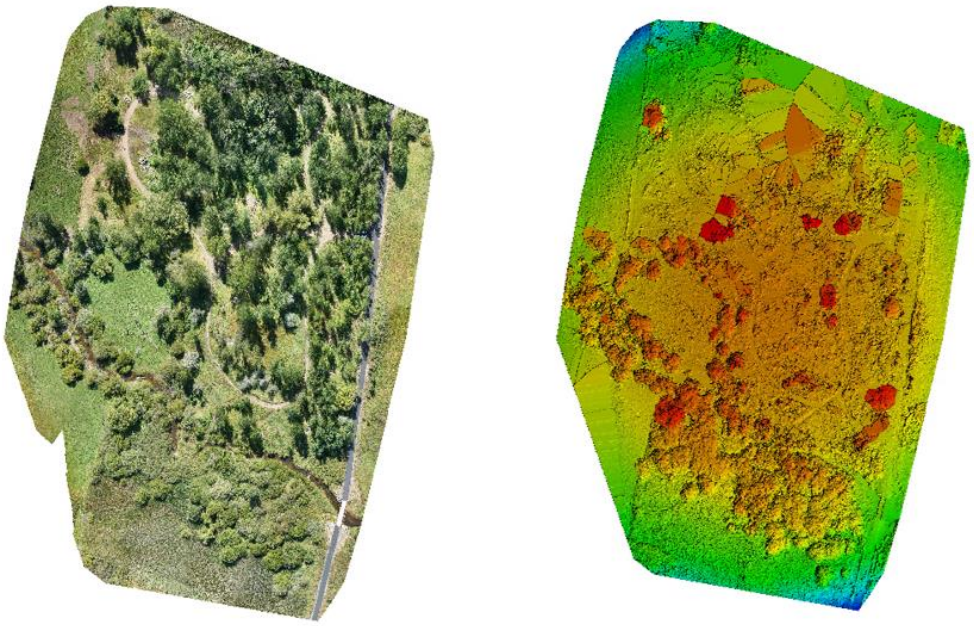
Additional Steps for Processing UAS Imagery in PIX4Dmapper



Introduction

Pix4Dmapper (PIX4D) is a photogrammetry software suite compatible with unmanned aircraft system (UAS) that enables you to define areas of interest, select processing options, add ground control points (GCPs), and create and edit point clouds, digital surface models (DSMs), meshes, and orthomosaics. Default templates provide automatic processing for new projects and can be customized for more control over data and output product quality.

Exercise 1 introduced the general workflow for processing UAS imagery. In this exercise, we'll continue to explore other tools that are available to us in PIX4D. As you work through this exercise, please refer to the PIX4D Help Documentation for additional information about each of the steps. The help documentation can be found on the PIX4D website or by clicking the **Help** tab within the software interface.

Objectives

- Add to pre-existing knowledge of PIX4D by classifying and editing point clouds.
- Generate additional outputs such as digital terrain models (DTMs).
- Measure distance and volume using PIX4D tools.

Required Data:

- Exercise 1 PIX4D project.

Prerequisites

- Install and activate PIX4D (please see PIX4D Installation Guide for details).
- Review the Appendices of this document to familiarize yourself with PIX4D's graphical user interface and Ground Control Points (GCPs).
- Have completed Exercise 1 and have it saved to your chosen folder.

Note: If you experience cursor misalignment throughout this exercise, open your **File Explorer** and navigate to your **Program Files** folder on the Drive you installed PIX4D. Right click on the pix4dmapper.exe file and in the **Properties** window, select the **Compatibility** tab. Enable **Disable display scaling on high DPI settings** and click **OK**. You may need to close and reopen Pix4Dmapper for the cursor to be recalibrated.

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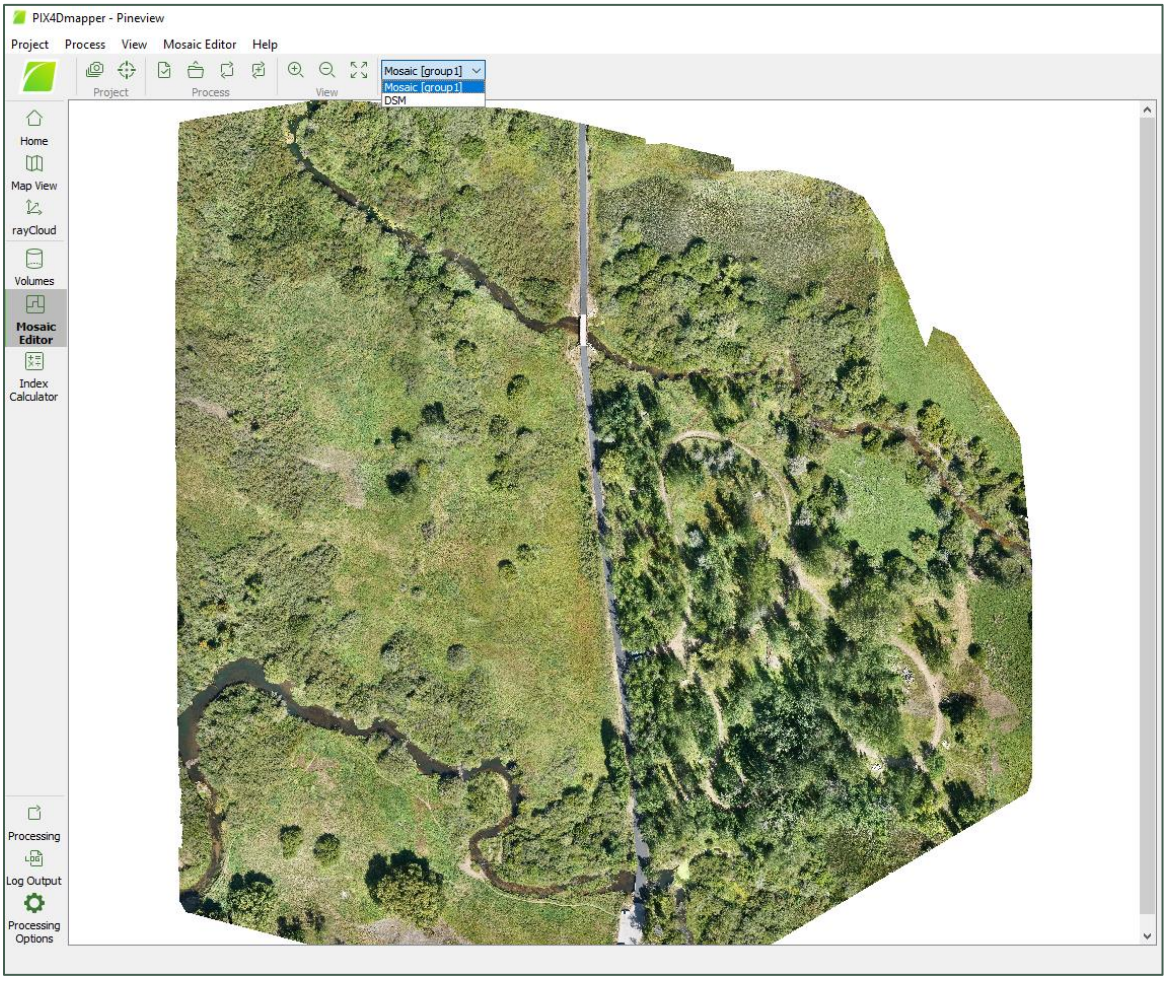
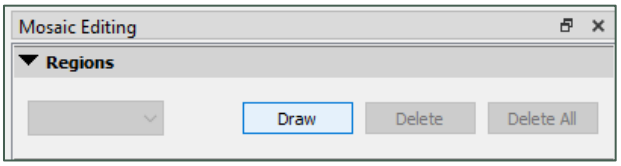
Part 1: Editing an Orthomosaic

Sometimes distortions may occur in an orthomosaic due to errors in the surface model and features not fully visible in overlapping images, especially if there is a lot of tall vegetation. You may wish to edit your existing orthomosaic to improve your output if there are relatively low number of distortions.

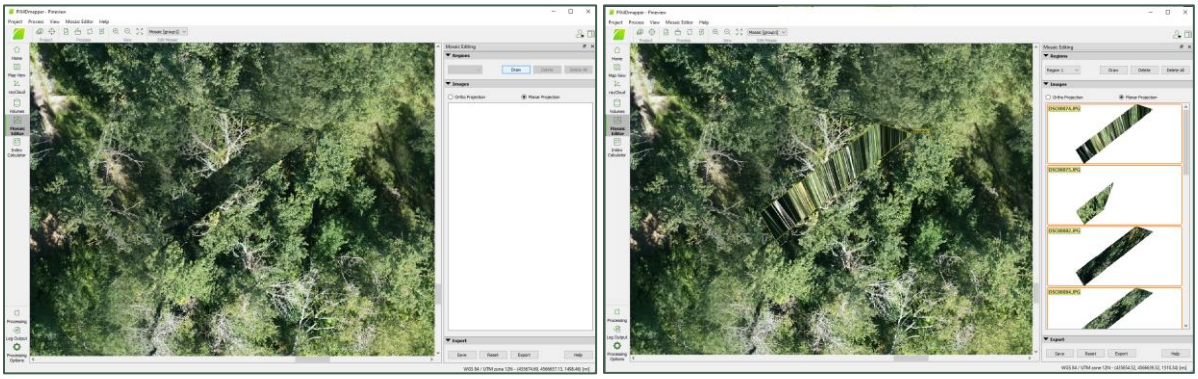
1. On the left-hand side menu, select **Mosaic Editor**.
2. Under **View**, click **Processing** to see the processing bar and ensure that **Step 3 – DSM, Orthomosaic and Index** is green.
3. Select **Mosaic** from the dropdown menu in the toolbar to view your orthomosaic and navigate around it, left clicking and holding to move it and zooming in and out using your mouse and scroll wheel or trackpad.

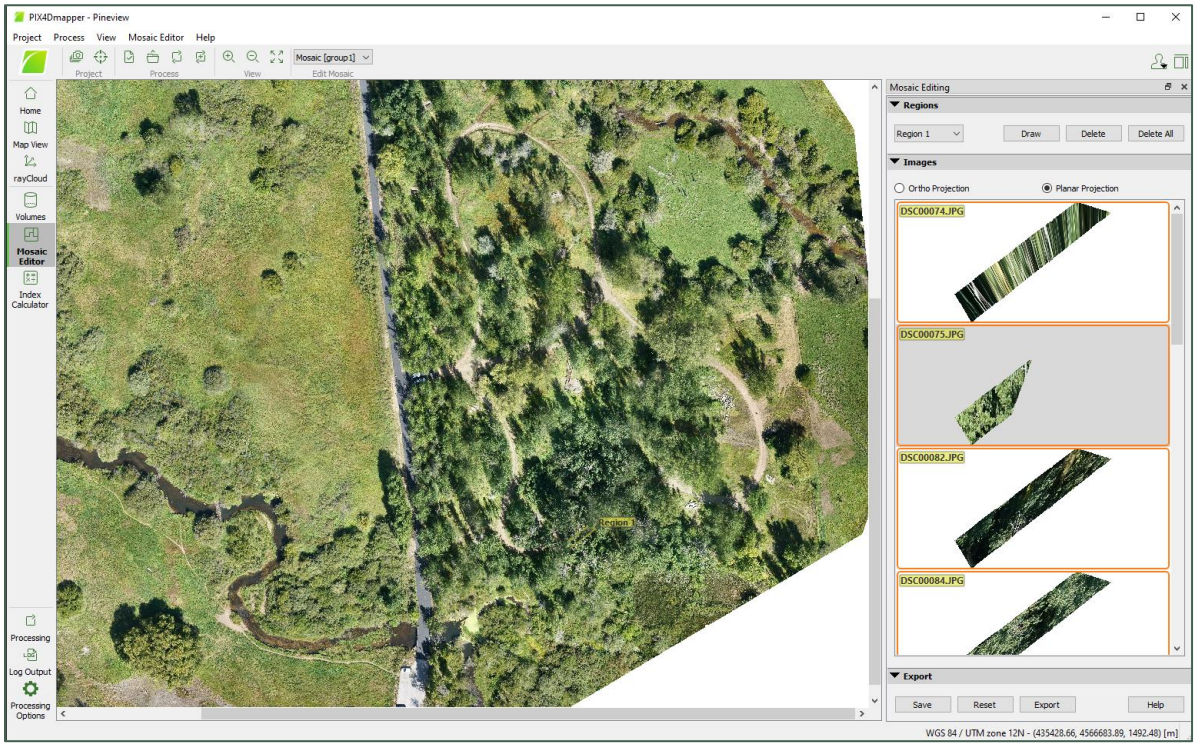


4. Remove distortions in the orthomosaic caused by objects by firstly clicking the **Draw** button in the **Mosaic Editor** menu.



5. Draw a region around the object and, if applicable, it's shadow, by left-clicking to place the first vertex and additional vertices, and then right-clicking to place the final vertex and closing the region. Try to keep the region as small as possible.

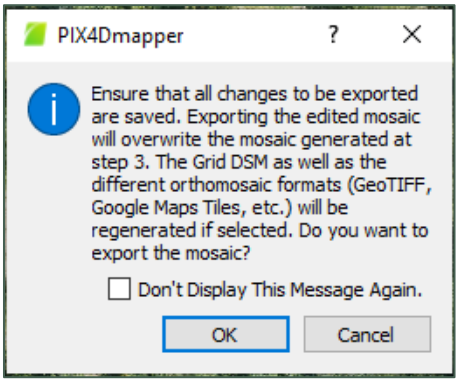




Note: You can reposition any misplaced vertices by left clicking on them and dragging them into a new position or delete them to draw a new region.

6. In the **Mosaic Editing** sidebar, click on the projection that best fits your needs to view new area representations.
   i. Select **Planar Projection** if your object is close to the ground (e.g.: a moving vehicle) or that does not need to be geometrically accurate.
   ii. Select **Ortho Projection** if your object is causing distortion because of differences in height (e.g., a relatively tall roof) or that need to be geometrically accurate.
7. Click on the image in the list that best represents the region.

8. If necessary, continue drawing additional regions around other features that appear to be transparent or distorted.
9. Export your newly edited orthomosaic by clicking on **Export** in the **Mosaic Editing** window. Any old version of the orthomosaic will be overwritten. Click **OK** on any warning messages like the one shown below.



10. Under **Project**, click **Save Project**.

Part 2: Adding a Surface

Since water is homogenous and oftentimes moving, points matched in water bodies contain a lot of error. This can cause holes and irregularities in the products. Adding a planar surface for such areas can make a 3D textured mesh or DSM more accurate in terms of representing the geometry of your project area or can improve aesthetic qualities of your products.

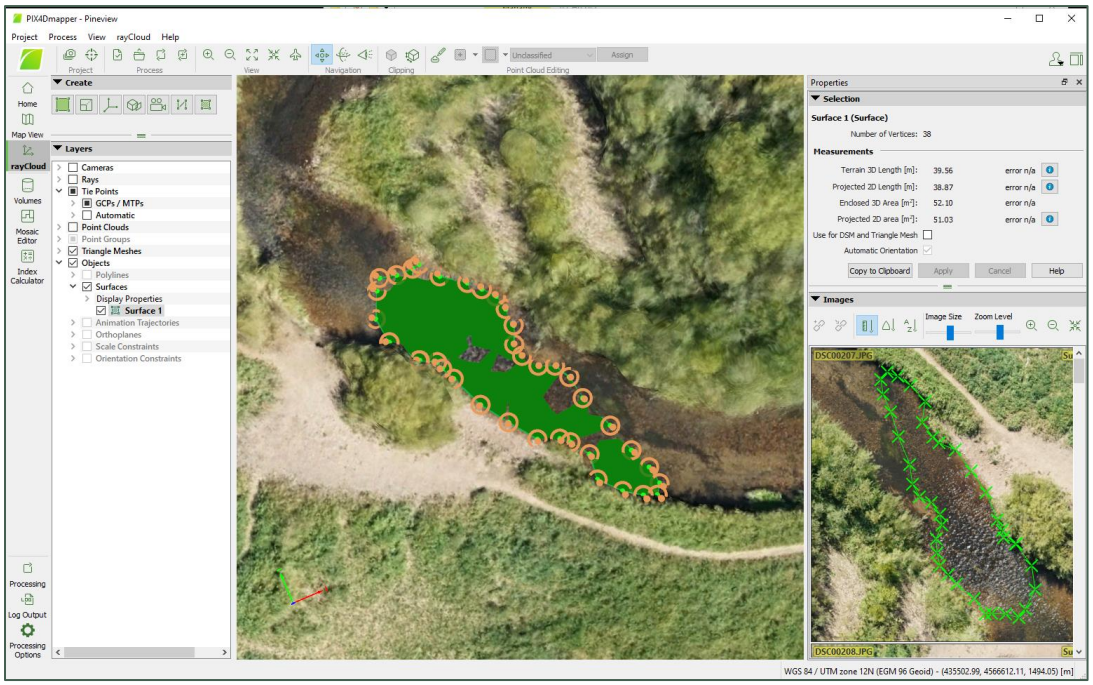
A. Adding a Surface to Improve a 3D Textured Mesh

1. In rayCloud, under **Layers**, uncheck all but **Triangle Meshes**. Click **OK** on any warning messages regarding the first time loading of your mesh products.
2. Navigate around your mesh and identify an object in the project area, perhaps an area within part of the water that appears more uneven than it should, and that you think would be more accurately represented in the 3D textured mesh as a planar surface.

Note: To tilt view your dense point and mesh, hold shift as you left click on your mouse or trackpad and move in the direction you would like to view the generated products from. Use the scroll wheel to zoom in and out. Left click to move horizontally. Click and hold the scroll wheel to orbit. To view all points within your dense point cloud, hit the **View All** button on the View toolbar.

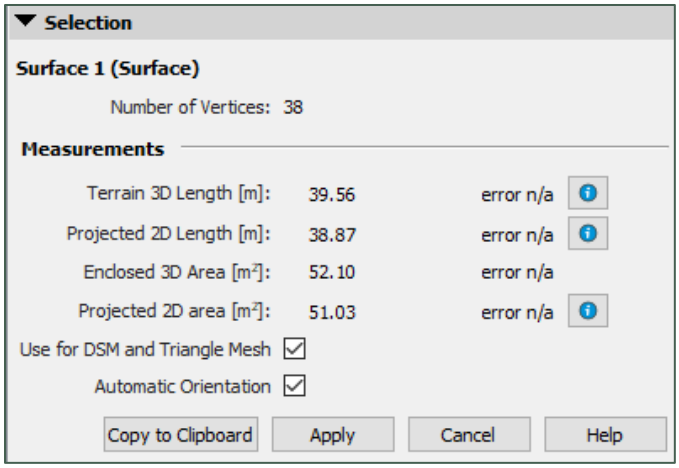
3. In the main menu, click **rayCloud**, then click **New Surface**.

4. Click the surface of the 3D textured mesh to add the first vertex. Continue clicking the surface of the 3D textured mesh to add more vertices, right clicking on the last one to finish digitizing the surface.



Note: If you make a mistake when placing a vertex, you have two options to correct its placement. Right click to stop drawing vertices, then in the **rayCloud** tab on the left-hand side, under **Objects**, right click on your **New Surface** and select **Remove**. You can then begin to draw your surface again. Otherwise, you can continue to place your vertices. When complete, navigate to your surface in the dense point cloud and edit the vertices that have been misplaced. Click on the vertex you want to edit. In the right-hand side **Sidebar**, the images in which the vertex is present will generate (if these do not display, try minimizing and reopening the **Images** dropdown tab). Locate and click on the correct location of the vertex in an image and then click **Apply** under the Selection dropdown. In the **Images** dropdown, confirm the new location by continuing to click on the updated location in each image. Then click **Apply** again to save your changes.

5. Under **Layers**, then **Objects**, ensure that the name of the surface is checked.
6. If the sidebar menu is not displayed, enable **Show Sidebar** under **View** in the main menu. Then, in the sidebar, locate **Selection** and check **Use for DSM and Triangle Mesh** and click **Apply**.



7. In the main menu, under **Process**, click **Generate 3D Textured Mesh**. Click **Save** if prompted to do so. Monitor the progress bar at the bottom left of the screen for status updates, it may take a short while. When the process is complete the progress bar will show **3D Textured Mesh generated**.
8. Under **Project**, click **Save Project**.

B. Adding a Surface to Smooth a DSM (Optional)

Here, we'll explain another method for removing incorrect elevation values, such as for water bodies or other homogenous features that contain errors due to mismatched pixels.

1. In the View Toolbar on the left-hand side, click on **Mosaic Editor**. It may take a few minutes to initially load the DSM and orthomosaic.
2. In the main menu, click **Mosaic Editor** then **View**, and check **Show DSM**.
3. Identify one or more parts of the project area where the DSM appears to be noisy or have erroneous elevation values.
4. In the rayCloud tab on the left-hand side of the interface, locate the **Create** bar as seen in the following figure, and click on the end icon, **New Surface**.
5. Digitize a surface around the part of the project area you have identified, as done in Part 2, A, step 4.
6. Under **Layers**, locate **Objects**, and ensure the new surface has been checked.
7. In the sidebar, locate **Properties** and check **Use for DSM and Triangle Mesh** and click **Apply**.
8. Under **Project**, click **Save Project**.

C. Adding a Surface to Remove an Object from a DSM (Optional)

In some situations, you may want to remove elevation values from the DSM. For example, if you had a vehicle parked within the acquisition area or capture people in the imagery, you'll end up with elevation values representing those features. These elevation values can be interpolated by the surrounding area by using the following steps.

1. Under **View**, click **Mosaic Editor**.
2. Identify an object that is above the ground and irrelevant to the project.
3. Follow Part 2, B, steps 5 through 7 to complete digitizing and saving your new surface.
4. Under **Project**, click **Save Project**.

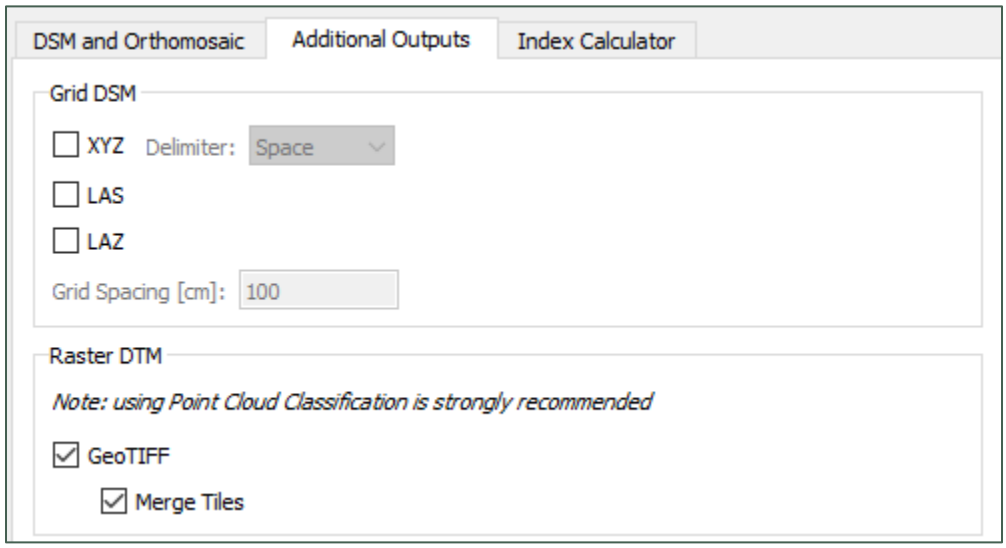
Part 3: Classifying Point Cloud, Updating DSM, and Creating DTM

Unlike a digital surface model (DSM) that includes elevations for objects on the surface, a digital terrain model (DTM) only includes ground elevations. If vegetation is sparse for your site, it is possible to classify the ground points in the dense point cloud and interpolate the area where trees were to create a DTM. In this part, we'll change some settings to have PIX4D classify the points while rerunning step 2. We will then update the DSM with the newly added adjustments made in the previous parts.

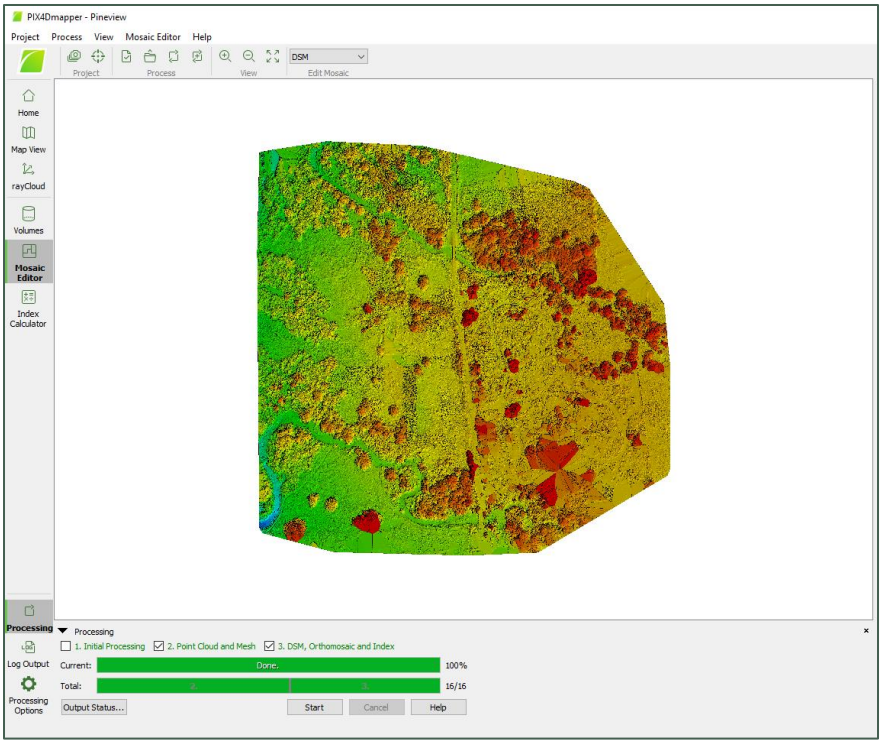
A. Updating the DSM & DTM

1. Click on **Processing Options** on the bottom left-hand corner of the screen. Uncheck **Step 1 - Initial Processing.**
2. Place a check next to **Step 2 - Point Cloud and Mesh** and navigate to Point Cloud Classification under the first tab, Point Cloud. Check **Classify Point Cloud**.

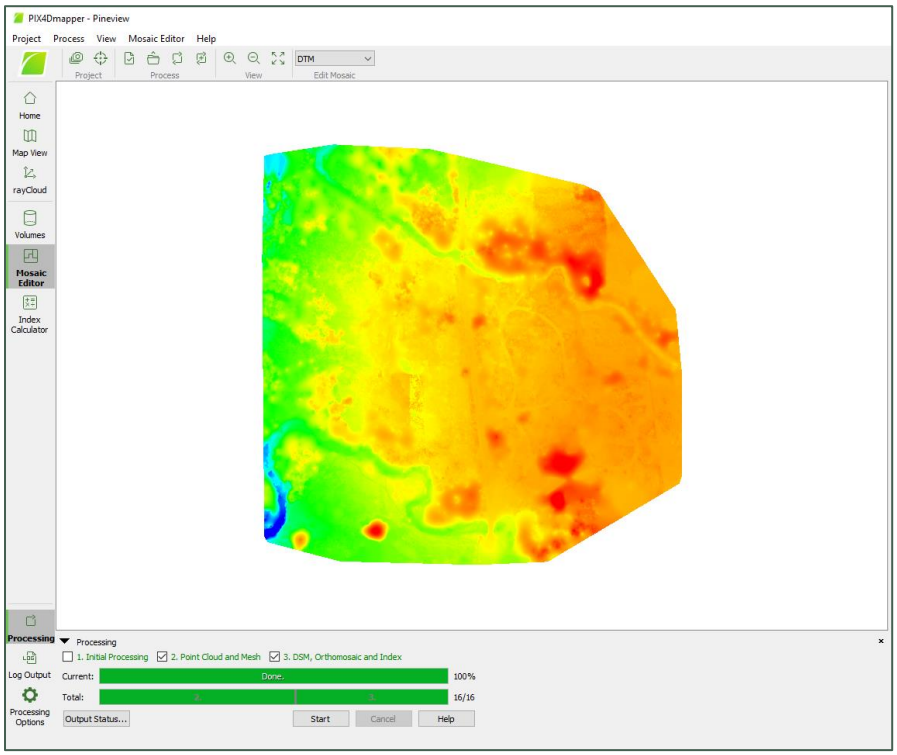
3. Place a check next to **Step 3 - DSM, Orthomosaic and Index** and navigate to Raster DTM under the second tab, Additional Outputs. Check **GeoTIFF**, then click **OK**.



4. Click OK to close the Processing Options window. In the **Processing** menu in the bottom left of the screen, click **Start**. Click **OK** in response to any warning messages that pop up.
5. Once the processing is complete you can access the Mosaic Editor. In the main menu, under **View**, click **Mosaic Editor**. Wait for your DSM and orthomosaic to load by keeping watch on the progress bar under the Processing section at the bottom of the screen.
6. In the main menu, under **Mosaic Editor**, click **View** then check **Show DSM**. As an alternative, select **DSM** from the dropdown menu under the **Edit Mosaic** section of the toolbar located under the main menu.



7. Confirm that the corresponding parts of the DSM have been derived from your new surfaces by inspecting the new output.
8. To view the DTM, click **Mosaic Editor** in the main menu, then **View**, and then click **Show DTM**. You can also confirm that the DTM represents the geometry of the ground and not above ground objects including structures or vegetation if you made such changes.



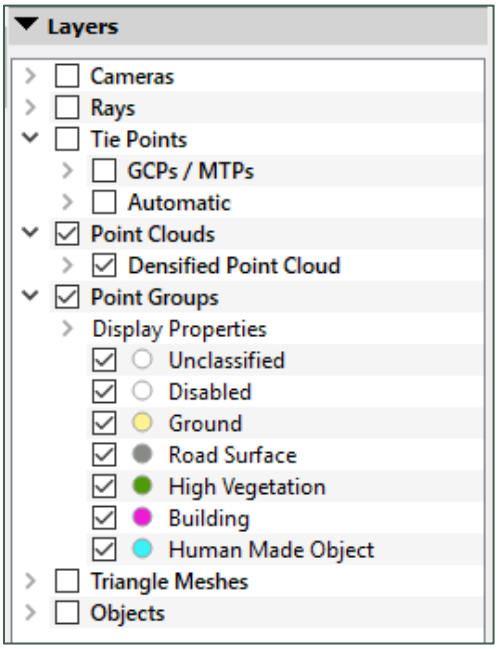
9. Under **Project**, click **Save Project**.

Part 4: Measuring Distance

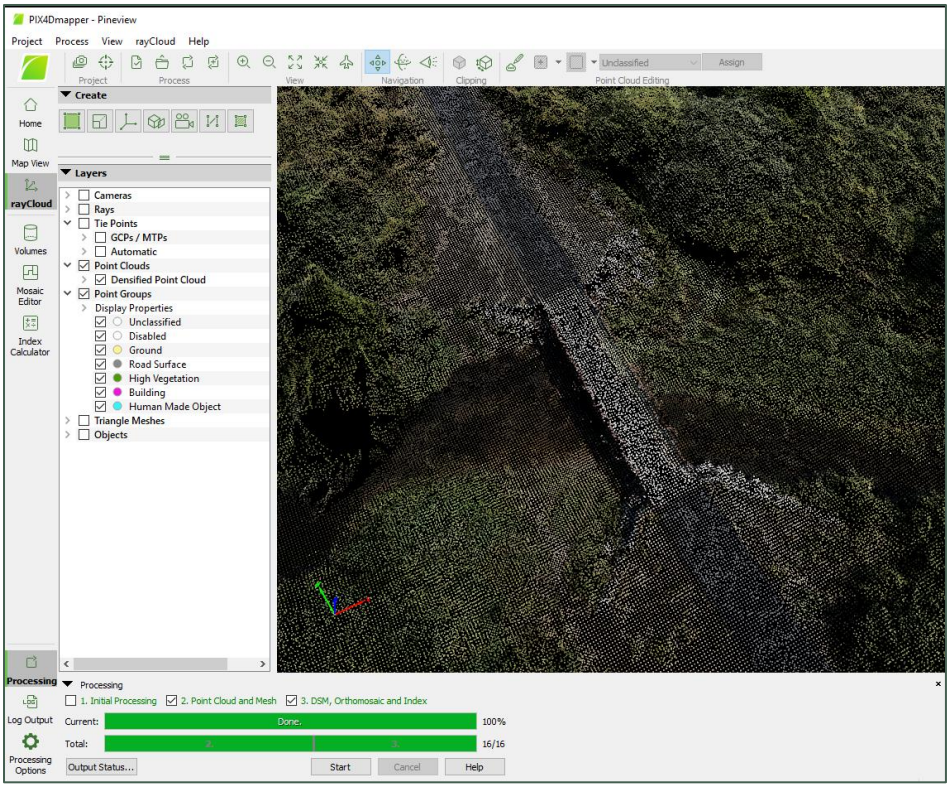
There is more than one way to perform measurements with Pix4Dmapper once *step 2* has been completed. One method is to digitize a polyline in the rayCloud's 3D environment, then mark each of the vertices in a sufficient number of images. Another method is to mark each of the features you want to serve as the polyline's vertices, to features marked in images. Each method has trade-offs, such as accidentally snapping vertices to incorrect features and overall processing time. To avoid snapping errors, be sure to select the correct features in each image – precision is key for accurate measurement calculations.

A. Measuring Distance

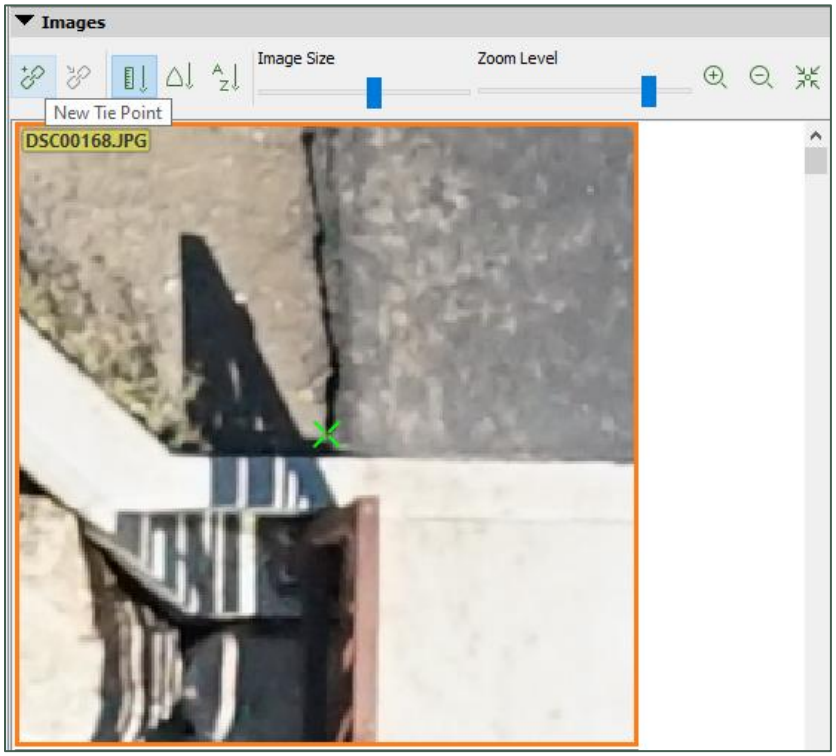
1. Click on **rayCloud** in the left-hand side menu. Under **Layers**, uncheck everything but **Point Clouds** and **Point Groups**.



2. In the main menu, under **View**, enable **Show Sidebar** if it is not already showing.
3. Locate the bridge towards the north central portion of the project area as seen in the following figure.



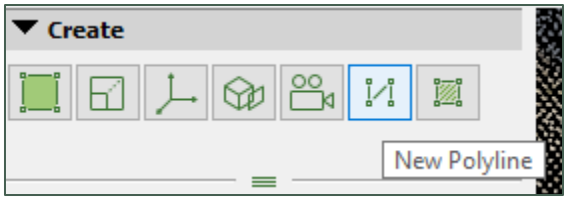
4. Left click on a point in the dense point cloud that represents the chosen feature.
5. Drag the edge of the sidebar to the left to allow for more space for viewing the images and adjust the size of your image thumbnails by changing the Image Size slider.
6. In the **Images** section, click **New Tie Point** as seen in the following figure.



7. In the sidebar, minimize the **Selection** section to collapse the manual tie point's (MTP) details.
8. Place your cursor on the first image in the list and locate your feature by zooming in or out and panning using your scroll wheel or trackpad.
9. Click on your feature, the north-western corner end of the bridge, then locate it in the next image and click on it once again.
10. In the **Images** section, click on **Focus on Selection**, the far button to the right.

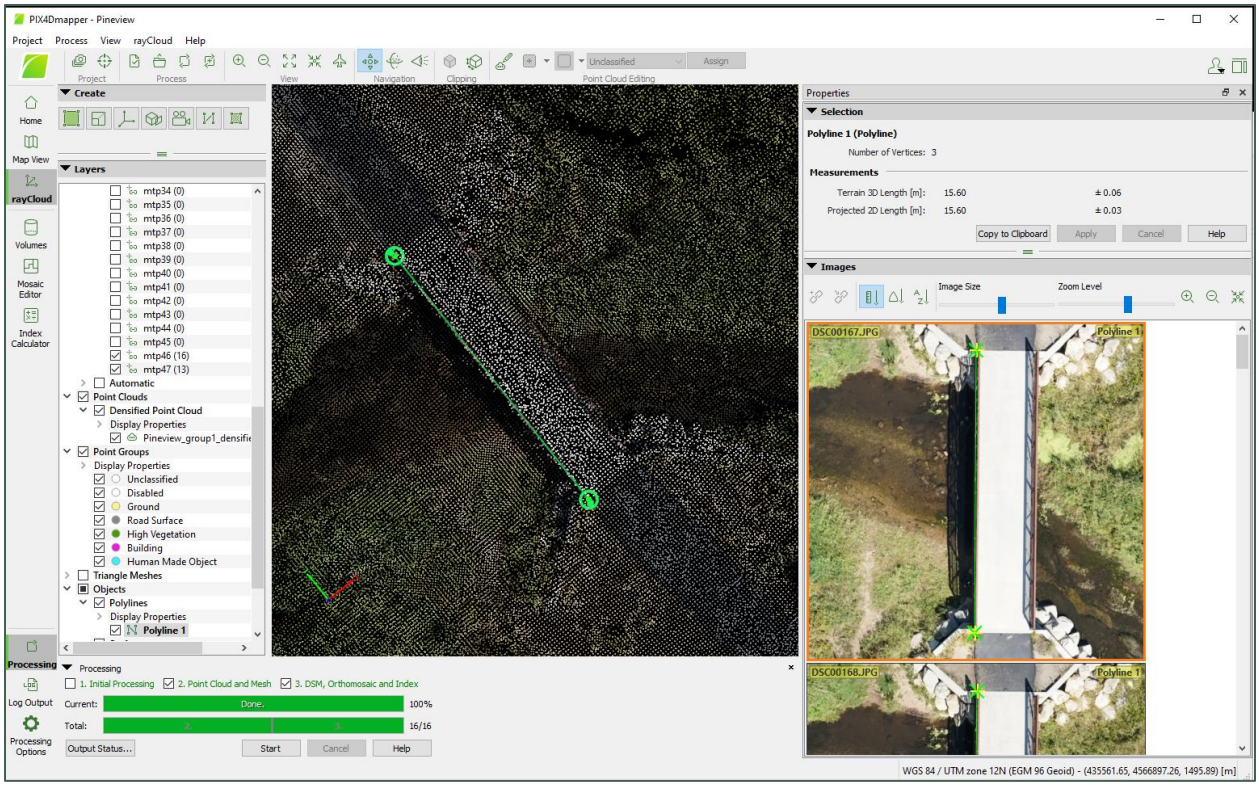
11. To improve measurement accuracies, mark the feature in other images in the list and then click **Apply** in the **Selection** section of the sidebar to save your changes. Continue until no new images display.
12. Repeat steps 4 through 11 to create a second MTP on your other feature of interest, at the opposing end of the bridge, in the middle of the ground target.

13. In the main menu, under **rayCloud**, click **New Polyline** (see following note).



Note: It is possible to quickly get measurements by going straight to step 13 and placing a polyline in the rayCloud. However, it may be more difficult to accurately place the polyline on desired features in the dense point cloud. Adding MTPs will certainly give you more accurate measurements.

14. In your 3D environment, left click on your first MTP and right click on your second. Note the dimensions of the polyline in the sidebar as seen in the following figure.



15. Under **Project**, click **Save Project**.

Part 5: Measuring Volume

A. Measuring Volume

1. Under **View**, click **Processing** if your Processing menu is not already displayed, and confirm that **step 1**, **step 2**, and **step 3** are green. Under the **View** tab, disable **Processing** and enable **Volumes**.
2. Locate n object, such as an accumulated reserve of dirt or rocks or a vegetation shrub, where the base of the entire pile is as flush with the ground as possible and does not encounter another structure.
3. Under **Volumes**, click **New Volume**.
4. Click on a point in the dense point cloud that is at the foot of the stockpile. Continue clicking points around the foot of the stockpile, right clicking on the last one to finish digitizing the base surface.

Note: If you make a mistake when placing a vertex, you have two options to correct its placement. Right click to stop drawing vertices, then in the **Volumes** tab on the left-hand side, under **Objects**, hover over **Volume 1** and hit the **Delete** button to start delineating your volume area again. Otherwise, you can continue to place your vertices. When complete, in the **rayCloud** tab, navigate to your volume in the dense point cloud and edit the vertices that have been misplaced. Click on the vertex you want to edit. In the right-hand side **Sidebar**, the images in which the vertex is present will generate (if these do not display, try minimizing and reopening the **Images** dropdown tab). Locate and click on the correct location of the vertex in an image and then click **Apply** under the Selection dropdown. In the **Images**

dropdown, confirm the new location by continuing to click on the updated location in each image. Then click **Apply** again to save your changes.

5. To compute the volume of your object in the Volumes tab, under **Objects**, and **Volume 1**, click **Compute**.
6. Confirm that the volume measurement measures the total cut volume of the stockpile.
7. Under **Project**, click **Save Project**.

Conclusion: Congratulations! You have completed Additional Steps for Processing UAS Imagery in PIX4D! In this exercise, we learned how to use Pix4Dmapper to add surfaces and enhance our DSM and DTM outputs from aerial imagery and measure distances and volumes. Additional resources, including a few tutorials and a very helpful user forum, can be found on the PIX4D website.