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Pix4Dmapper Exercise 2: Additional Steps for Processing UAS Imagery

Introduction

Pix4Dmapper is a photogrammetry software suite compatible with UAS (unmanned aircraft system) 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 take a closer look at some of the settings and explore the additional tools found in Pix4Dmapper. As you work through this exercise, please refer to the Pix4Dmapper 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.

Objective

- Add to pre-existing knowledge of Pix4Dmapper by classifying and editing point clouds.
- Generate additional outputs such as digital terrain models (DTMs).
- Measure distance and volume using Pix4Dmapper tools.

Prerequisites

- Download and unzip exercise data of the abandoned Bluebird mine in Oregon: Bluebird.zip.
- Install and activate Pix4Dmapper (please see Pix4Dmapper Installation Guide for details).

NOTE: *Check your hardware specifications before beginning this exercise. Search the keyword* ***Settings*** *in your start menu, then navigate to the* ***System*** *tab, and then click on* ***About****. If you have less than 16GB RAM or a slower processor, we recommend selecting* ***3D Maps – Rapid/Low*** *Res for Part 1. C. 1., rather than* ***3D Maps – Standard****. This will decrease processing time.*

If you experience cursor misalignment throughout this exercise, open your ***File Explorer*** *and navigate to your* ***Program Files*** *folder on the Drive you installed Pix4Dmapper. 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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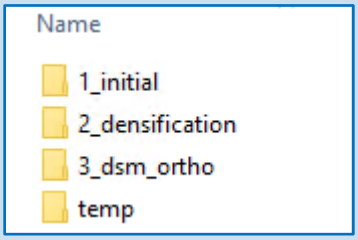
Part 1: Getting Started

In this first part of the exercise, you will navigate the project creation wizard, which consists of five windows, to configure important settings and options for your Pix4Dmapper project. This section will acquaint you with folder directories where the project outputs will be stored, where you can manage the camera model's parameters, select coordinate systems, and select your processing options template.

A. Create a Project

1. Launch Pix4Dmapper by searching Pix4Dmapper in the Start menu bar and click **New Project**.
2. Name the project Bluebird and set your file directory. Make sure the radio button for New Project is selected and click **Next**.

NOTE: *Structured subfolders will be generated within your project folder along with your LOG file, which you can use to review your settings and accuracy once your project is finished. You can locate your generated reports in* ***1_initial****, your point clouds in* ***2_densification*** *and your digital surface model and orthomosaic in* ***3_dsm_ortho****.*



If you leave the file directory as the default pathway, your project folder will be created at ***This PC****,* ***Documents****,* ***Pix4D****. If you want to save the project folder elsewhere, you can specify a desired directory upon creating a new project. After you finish processing, you can go to this folder to access the products and to import them into other GIS software, such as ArcGIS Pro, for further investigation and use.*

B. Add the imagery

1. In the Select Images window, click on **Add Images** and browse to the unzipped folder for Bluebird in which the imagery is stored. Select all 114 images and click **Open**, then **Next**. It may take a moment for Pix4Dmapper to read the geotag data.
2. In the **Image Properties** window, leave the following parameters as their default values:
   i. Coordinate System: WGS 84 (EGM 96 Geoid)
   ii. Geolocation Accuracy: Standard
   iii. Selected Camera Model: GRII_GRLENS_18.3_4928x3264 (RGB)

NOTE: *If your camera model is not included in Pix4Dmapper's camera model database, or if you want to use internal parameters that more accurately represent your camera, you can add a calibrated camera model of your own to a Pix4Dmapper project. To create an accurate camera calibration file, the project*

must include a minimum of 50 images that contain objects at varying distances from the camera, heterogenous textures, a high amount of image overlap and if possible, accurate ground control points (GCPs).

*To add a custom camera model to your database, select **Image Properties Editor** under the **Project** tab. Under Selected Camera Model, click **Edit**. Under Camera Model, click **New** and enter a unique name. Under Camera Model Parameters, click **Load Optimized Parameters**. Once you have entered the camera model information, click **Save to DB** under Camera Model and then click **OK**. Click **No** for **Save as default assignment**, then click **OK** again. Save your project once you have entered your camera model's information into Pix4Dmapper's database.*

3. Click **Next**.
4. In the Select Output Coordinate System window, ensure that the Unit is specified as meters (m) and that the Auto Detected coordinate system is WGS 84 / UTM zone 11N.

***NOTE:** You can check Advanced Coordinate Options to further explore and set alternative vertical coordinate systems if you want to adjust the geoid height but for this exercise, we recommend using the default setting, EGM 96 Geoid.*

5. Click **Next**.

C. Select Template

1. Under Processing Options Template, navigate to the Standard tab, then select **3D Maps**.
2. Check **Start Processing Now.**

***NOTE**: In this exercise, we will rely on the coordinates from the geotagged images to georeference the products instead of placing ground control points (GCPs). Just keep in mind that your products may be shifted up to a couple meters when compared to other geospatial data. For more information about placing GCPs, please see exercise 1 or the Pix4D help documentation.*

3. Click **Finish** to finalize the initial project setup and begin image processing. You can expect this to take up to and possibly over one hour in terms of run time.
4. When this step is complete, navigate to the **Project** tab and hit **Save**.

***NOTE:** Depending on what outputs your project requires and what imagery you are loading, you can opt for different templates. For producing Point Clouds, DSMs, 3D Meshes and Orthomosaics from aerial imagery, you will select either Standard or Rapid **3D Maps**. Rapid will produce lower quality results more quickly so we will use rapid for this exercise. These options are also good for measuring volumes, digitizing houses and roads, and generating contour lines. For producing Point Clouds and 3D Meshes from ground-based imagery, you will select either Standard or Rapid **3D Models**. This option is good for 3D models of buildings, statues, and other objects. If you opt to use Standard processing for larger image files, you may want to consider running the process overnight.*

Part 2: 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.*

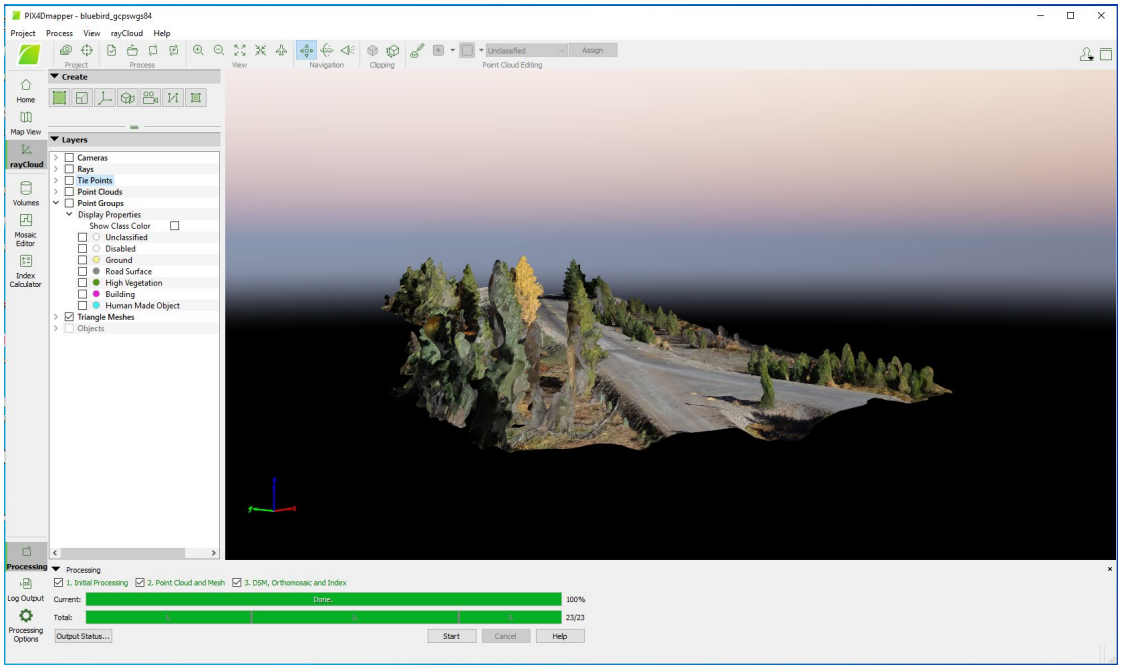
6. In the **Mosaic Editing** sidebar, click on the projection that best fits your needs to view new area representations.
   i. Select **Planar Projection** if your object is close to the ground (e.g.: a moving vehicle) or that does not need to be geometrically accurate.
   ii. Select **Ortho Projection** 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.
10. Under **Project**, click **Save Project**.

Part 3: 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.

Adding a Surface to Improve a 3D Textured Mesh

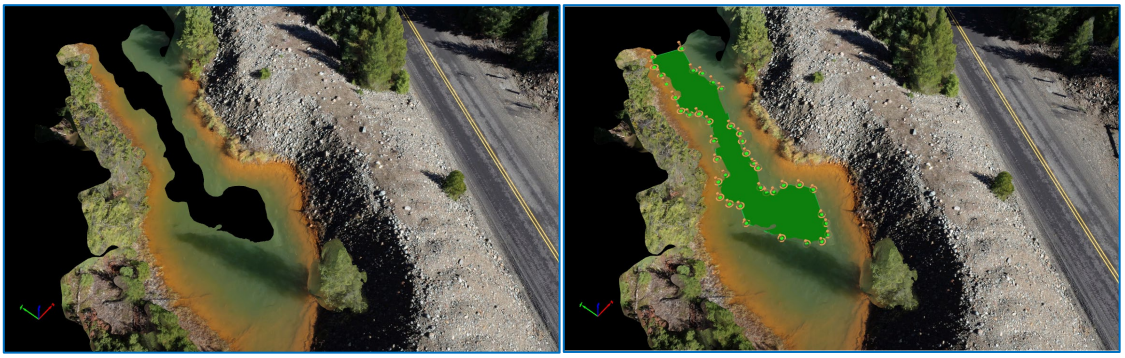
1. In rayCloud, under **Layers**, uncheck all but **Triangle Meshes**.
2. Click **OK** on any warning messages regarding the first time loading of your mesh products.



3. Navigate around your mesh and identify an object in the project area, perhaps an area within the waterbody 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.

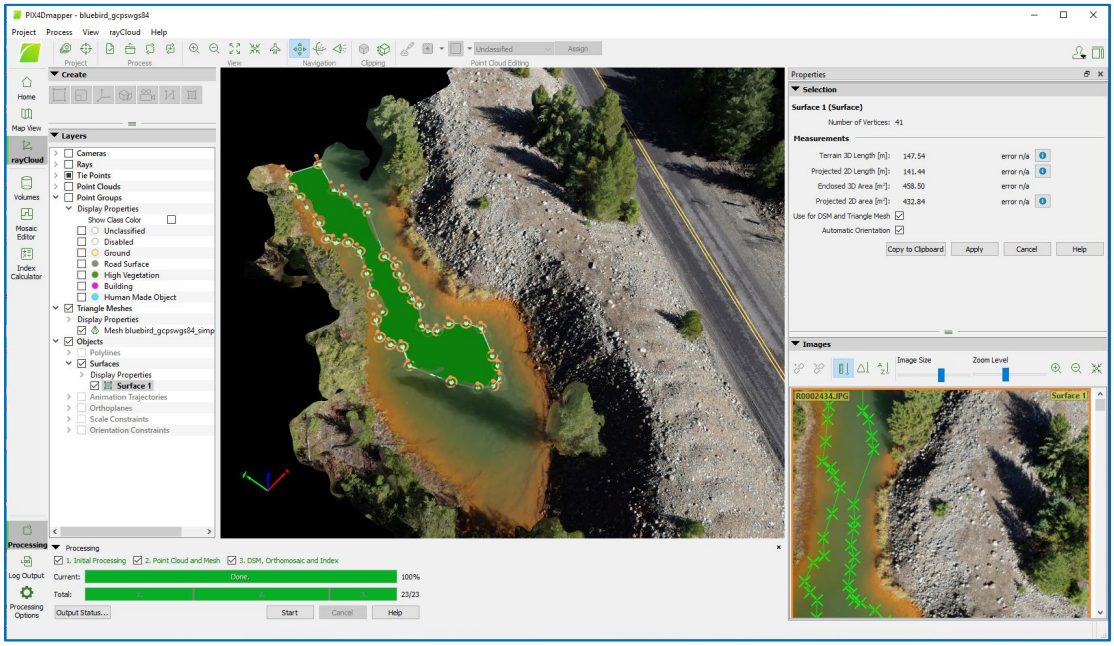
NOTE: *To tilt view your dense point and mesh, hold shift as you left click on your mouse or trackpad and move in the direction you would like to view the generated products from. Use the scroll wheel to zoom in and out. Left click to move horizontally. Click and hold the scroll wheel to orbit. To view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

4. In the main menu, click **rayCloud**, then click **New Surface**.
5. 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.*

6. Under **Layers**, then **Objects**, ensure that the name of the surface is checked.
7. 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**.



8. 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

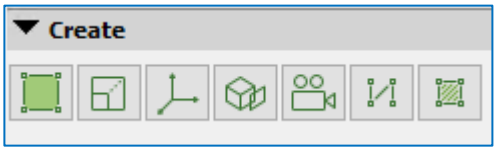
take a short while. When the process is complete the progress bar will show **3D Textured Mesh generated**.

9. 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 5.
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 8 to complete digitizing and saving your new surface.
4. Under **Project**, click **Save Project**.

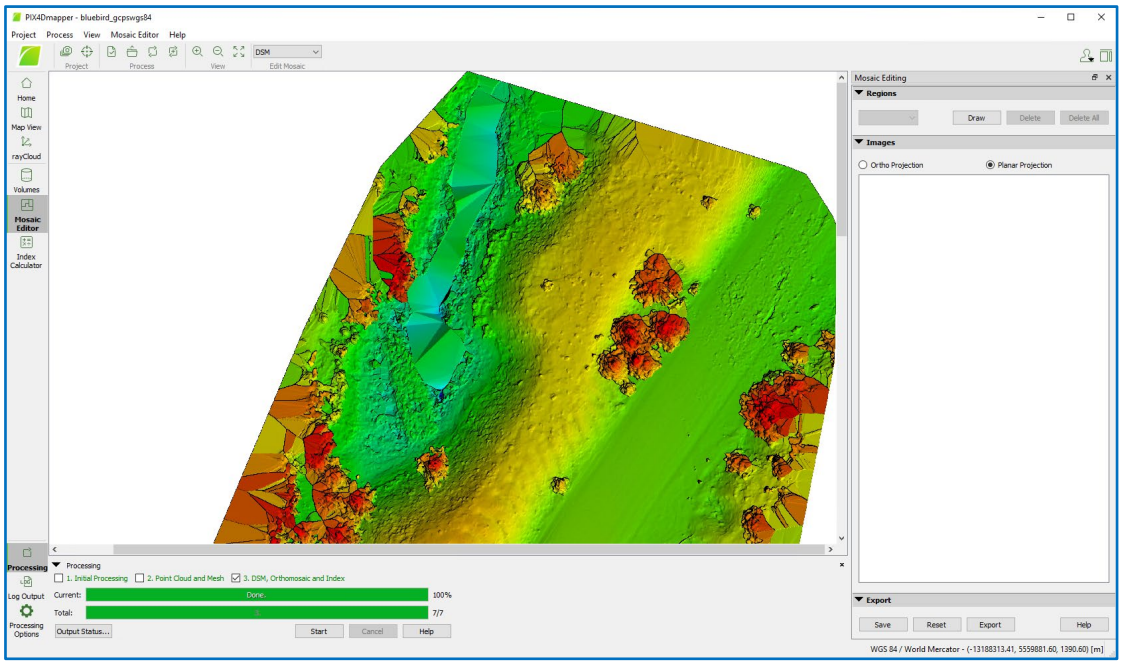
Part 4: Classifying Point Cloud, Updating DSM, and Creating DTM

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. In the **Processing** menu, 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.



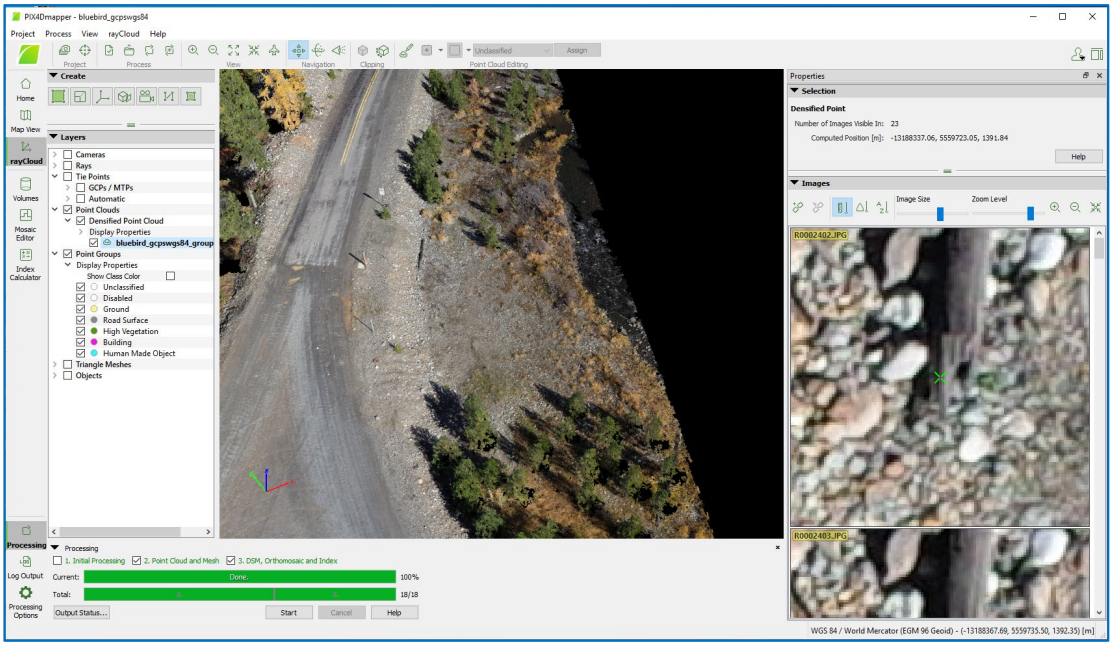
8. To view the DTM, click **Mosaic Editor** in the main menu, then **View**, and then click **Show DTM**. You can also confirm that the DTM represents the geometry of the ground and not above ground objects including structures or vegetation if you made such changes.
9. Under **Project**, click **Save Project**.

Part 5: Measuring Distance

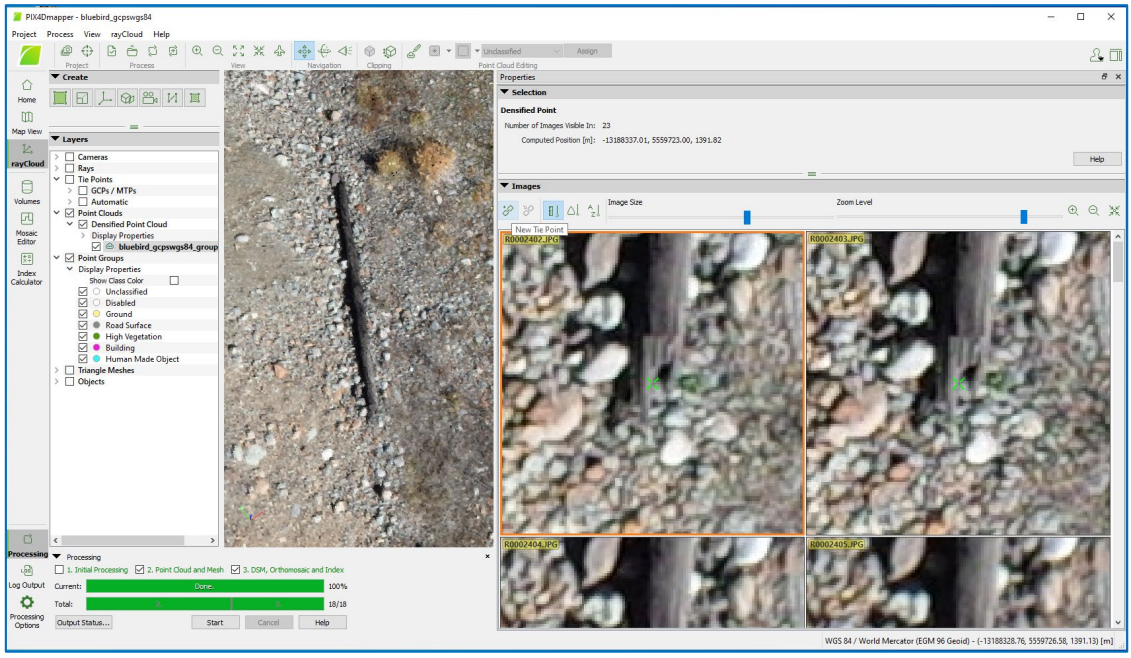
There is more than one way to perform measurements with Pix4Dmapper once *step 2* has been completed. One method is to digitize a polyline in the rayCloud's 3D environment, then mark each of the vertices in a sufficient number of images. Another method is to mark each of the features you want to serve 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**.
2. In the main menu, under **View**, enable **Show Sidebar** if it is not already showing.
3. Locate the downed tree trunk towards the mid-south-west portion of the project area as seen in the following figure.



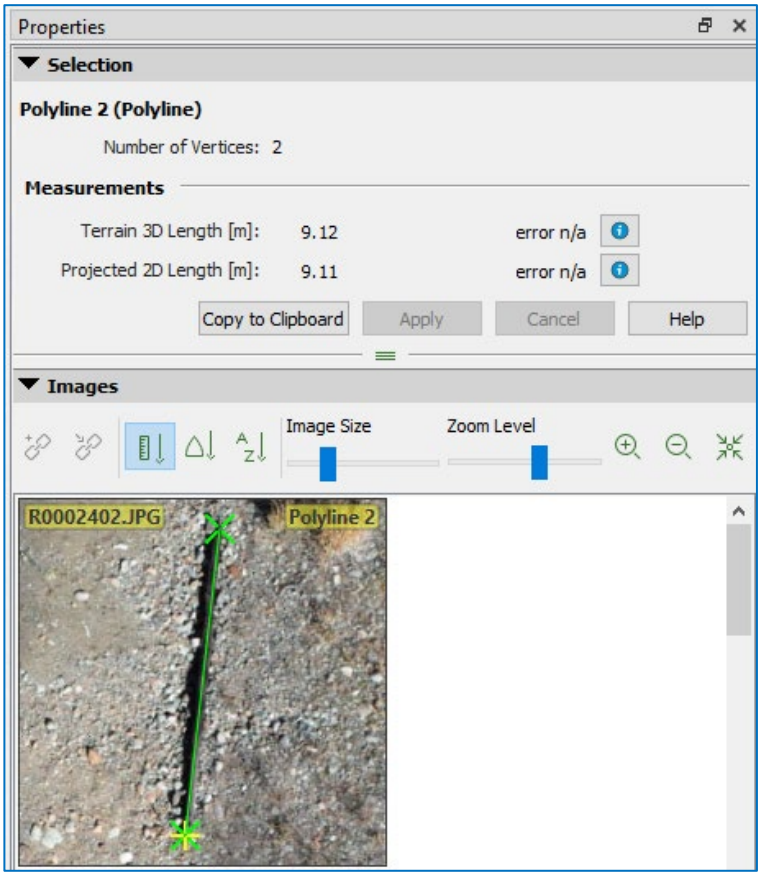
4. Left click on a point in the dense point cloud that represents the chosen feature.
5. Drag the edge of the sidebar to the left to allow for more space for viewing the images and adjust the size of your image thumbnails by changing the Image Size slider.
6. In the **Images** section, click **New Tie 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, one end of the downed tree, 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 downed tree trunk.
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 6: Measuring Volume

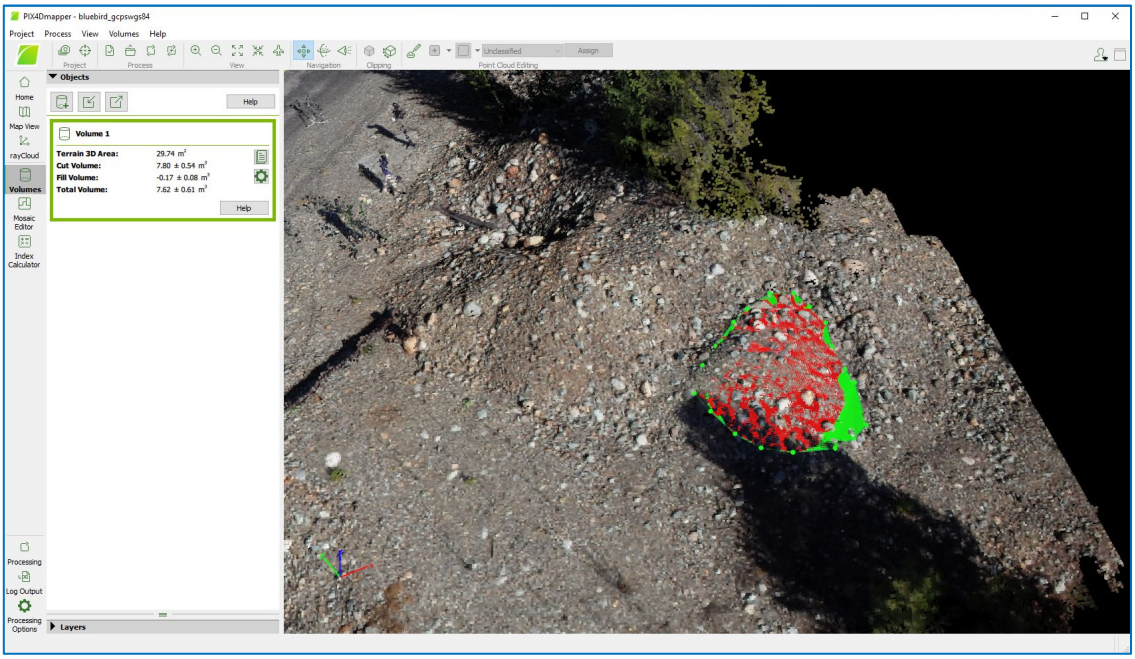
A. Measuring Volume

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 a stockpile, an accumulated reserve of dirt or rocks, 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 Pix4Dmapper Additional Steps for Processing UAS Imagery! 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.