Lab 10: Image Coregistration

Objective

The main goals of this lab exercise are to familiarize students with:

- Why image coregistration is necessary when working with imagery from multiple epochs
- Tools in Metashape for image/model coregistration
- Calculating DEM differences to look for change over time

So far we've been working with image sets from single dates (i.e., epochs). We've looked at a lot of tools in Metashape and hopefully you've seen how much information you can get out of just a single set of images. However, for many applications we want to look at change over time using imagery from multiple epochs. When you're working with image sets from multiple epochs, however, having the image sets correctly aligned to each other is critical. This is called coregistration, and if images are not coregistered, then you can 1) miss changes that are happening, or 2) detect false changes that are the result of image misalignment.

Deliverables

Fill out and submit the questions at the end of this document. *No need to submit a Quality Report from Metashape.*

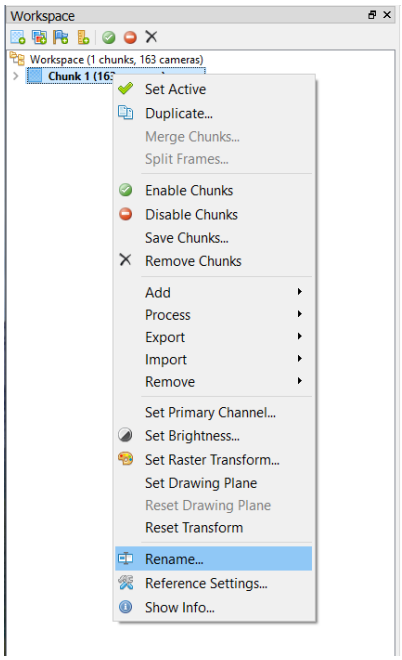
Note: Please refer to the class BBLearn site for lab due dates. You may work together and help each other, but please make sure what you turn in is your own work.

Section 1: Building sparse point clouds for two different dates with Metashape Chunks

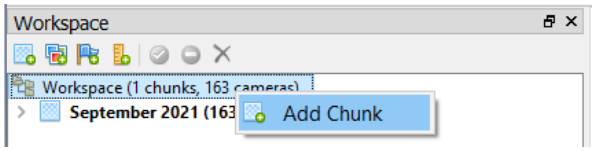
For this lab we'll be working with sets of images of wood-chip piles to calculate volume change between two dates. These images were collected for a paper products company to help them in their operations planning. We'll first load each date's photos into separate chunks in Metashape. Simply put, Chunks allow you to load up different image sets and process them independently.

1. Open a new Metashape project

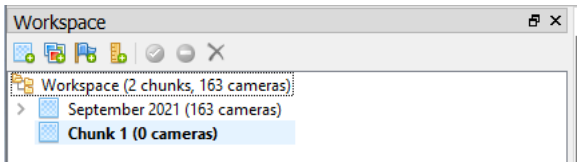
2. Load the September 2021 photos
   Download and unzip the imagery for this lab from: https://vandalsuidaho-my.sharepoint.com/:u:/g/personal/jkarl_uidaho_edu/EVx2OQ9PpVhJkAG6A9SPMmEBGOPMVbdaMd8BVzV5NumCaA?e=NQ4lvG
   Add the September 2021 photos to the project. These will automatically be loaded into Chunk 1. In the Metashape Workspace window, right click on the Chunk 1 name, choose Rename, and rename it to "September 2021"



3. Create a new chunk by right-clicking on the Workspace and choosing Add Chunk.



   a. Notice that the new chunk has a default name and it is shown in bold text. **The chunk that has the bold text name is the active chunk.** *Always make sure you have the right chunk active, or you may end up performing operations on a chunk by accident.*

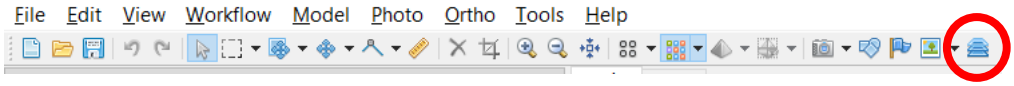


   b. Rename the new chunk “October 2021.” Make sure it is active and load the October 2020 photos into it.

4. For each of the chunks, do the following:
   a. Align the photos. For quicker processing, choose “Medium” accuracy.
   b. Optimize the sparse point clouds
      i. No need to pull out all the stops for optimization, just get rid of the low-quality points.
      ii. Also, no GCPs for this week’s lab to speed things up.
   c. Create a dense point cloud.
      i. For quicker processing, choose “Low” quality.
      ii. To also speed things up, resize the region to just include both of the pads where the wood chips are located (i.e., shrink the analysis area).
   d. Create a DEM (make sure to choose UTM Zone 11N as coordinate system) with default settings.

e. Create an Orthomosaic with default settings.

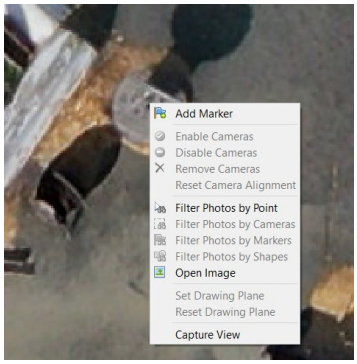
5. Once you have dense point clouds for each chunk, we should take a quick look at point cloud alignment between the two dates.
   a. Activate the September 2021 chunk and view the dense point cloud.
   b. Find the "Show Aligned Chunks" button at the righthand side of the main toolbar. This tool toggles on/off the point clouds from other chunks. It is useful for getting a quick sense of how well aligned two point clouds are.



   c.

Section 2: Aligning the chunks

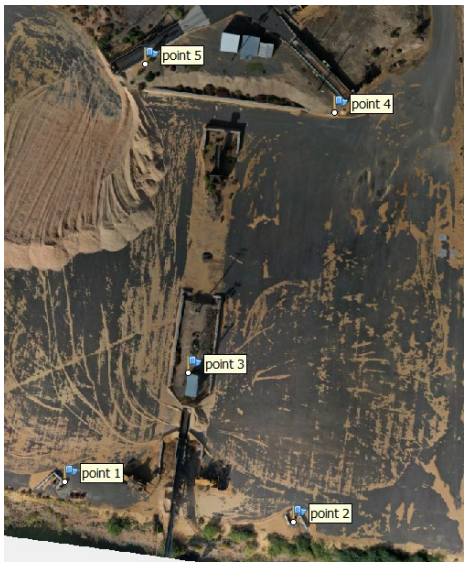
1. Find distinct points in one epoch and create markers
   For this next step, we need to create some pseudo GCP points for one of the epochs. There are a few ways to do this. I'll explain how I did it, but you may want to do it another way
   a. Open the Orthomosaic for the October 2020 chunk.
   b. Zoom in to a portion of the orthomosaic where there is a clearly identifiable feature (see example below).
   c. With your mouse over that feature, right-click and choose Add Marker.
   This will add a marker to the chunk, but you'll need to refine its location to get a good fit.



   d. In the References Tab (where we normally work with GCPs), the new marker will appear in the Markers list. Right-click on it and choose Filter Photos by Marker. Then open a few of the photos

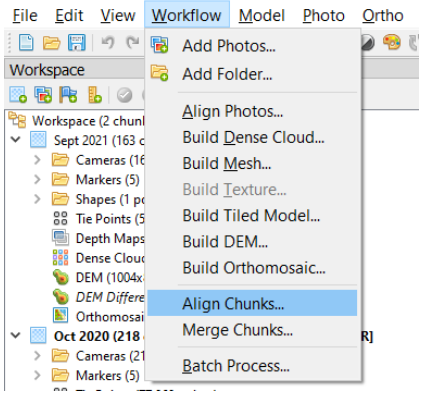
(like we do with normal GCPs) and adjust the marker location in the photos to match its true location in the photo.

e. Repeat this process until you have at least 5 well-spaced markers for the October 2020 chunk. (Note the markers in the image below are for example. Your marker locations may be different)

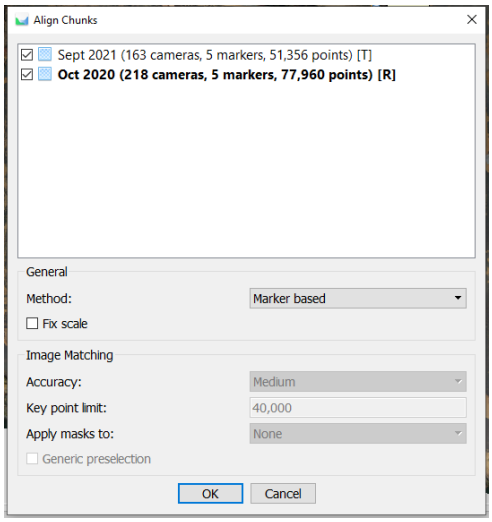


2. Now we need to find these same points in the September 2021 epoch and **create markers with same names**. This last bit is important. If the markers don't have exactly the same names, Metashape won't match them. Repeat the steps from above to add your markers to the Sept 2021 orthomosaic and then refine the marker locations using the original photos.

3. The next step is to align the chunks.
   a. From the main menu, choose Workflow -> Align Chunks.



   b. The align chunks dialog lists the chunks available to align. Make sure both are selected/checked. Change the Method to Marker based. Then click OK. The whole process should run very quickly because Metashape is just applying an affine transformation (i.e., moving or rotating the whole model in the X, Y, and Z directions).



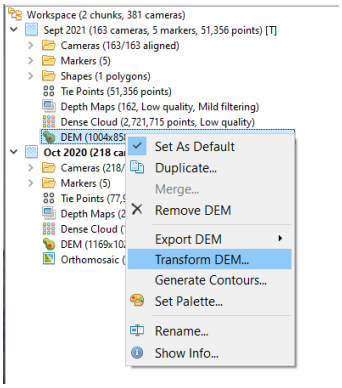
4. The alignment will work on the sparse and dense point clouds. The DEMs and orthomosaics, however, will not be transformed. So this would be a good time to delete those. Remake the DEM, but no need to remake the orthomosaic.

5. Once the alignment is done, take a few minutes to look at the dense point clouds with the Show Aligned Chunks tool. Hopefully your alignment is greatly improved.

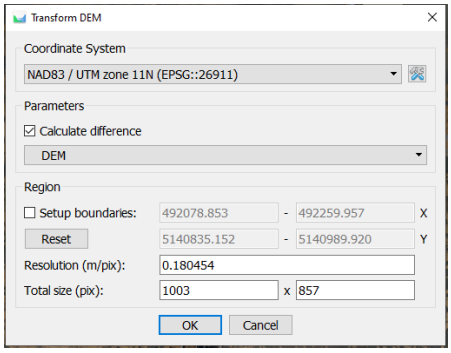
Section 3: Calculating a DEM Difference

1. At this point you should have both your chunks aligned and a DEM (in UTM Zone 11N) built from each chunk's point cloud. Now we'll compute a DEM difference layer.

2. Activate the September 2021 chunk. Right click on the DEM and Choose Transform DEM.

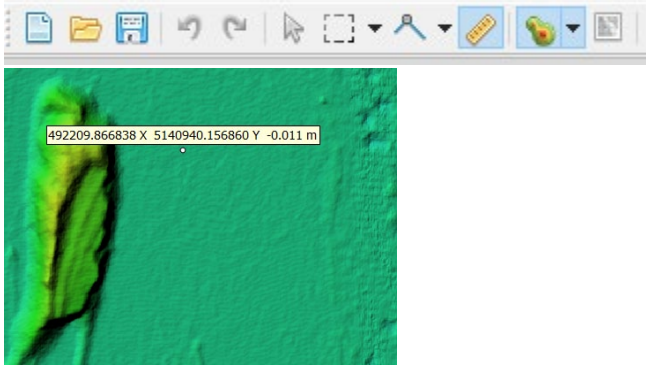


3. From the Transform DEM dialog, make sure your coordinate systems is set correctly. Then select/click the Calculate Difference option. From the drop-down menu, then select the October 2020 DEM. This will subtract the DEM values from October 2020 from the September 2021 DEM. Click OK to run the DEM difference. **Metashape will ask if you want to replace the default DEM; choose No.**



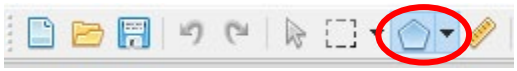
4. Metashape has "*helpfully*" named your DEM difference layer "DEM." To avoid confusion, change it's name to "DEM Difference."

5. Use the measure tool to check the DEM difference values in a handful of "no change" areas

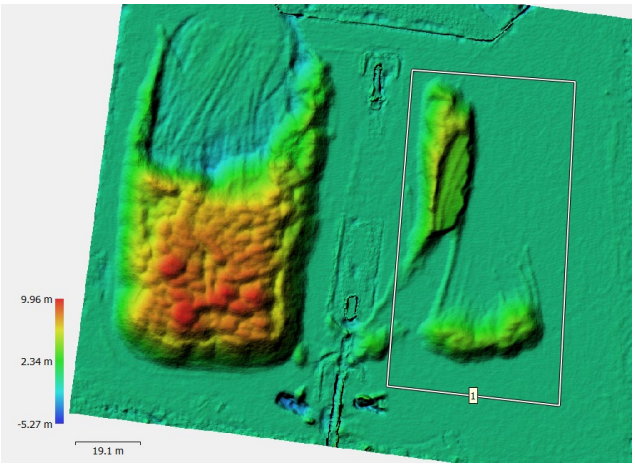


Section 4: Estimating Volume

1. Make sure you're viewing the DEM difference layer. Select the polygon tool from the main toolbar (you may need to click the black down triangle to expand the options to find the polygon tool).

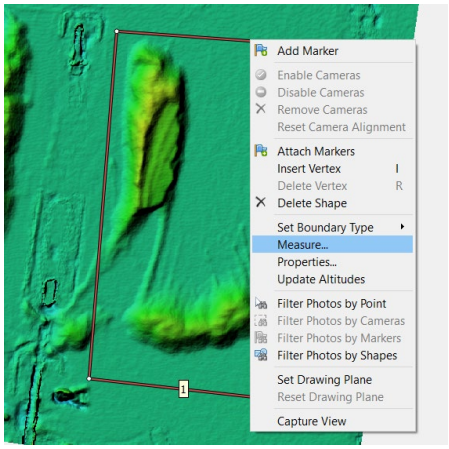


2. Using the polygon tool, digitize a polygon around the wood chip pile(s) on east pad. You may want to make it a bit more precise than the rectangle I digitized below, but no need to go overboard. ***The most important thing is that each vertex (mouse-click) when you're drawing the polygon needs to be on the pad itself, not on part of the chip pile.*** It's OK if a line extends over a portion of the pile as long as a polygon vertex doesn't occur there.



3. Change back to the navigation tool on the main toolbar.

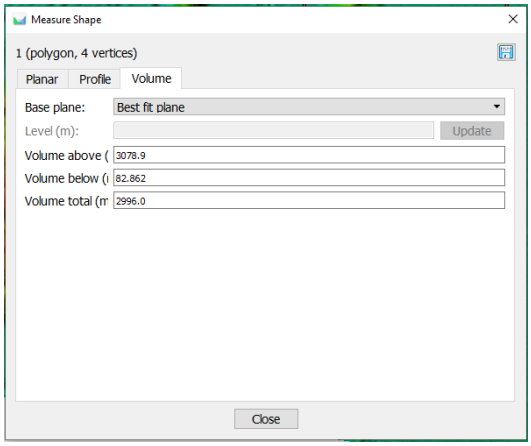
4. Right-click on the polygon you just digitized and choose **Measure…**



5. From the Measure Shape dialog box, choose the **Volume** tab. Leave the Base Plane set to Best fit plane (this will use the vertices of the polygon you digitized to interpolate a ground surface under the chip pile).

   Three volume measures are reported: above the base plane, below the base plane, and total (above – below). Below base plane measurements reflect areas where the observed elevation is lower than the best-fit plane estimate. This number should be pretty small relative to the above base plane volume. For

this lab, report the above base plane volume.



Lab Questions to Answer

Please answer the following questions and where appropriate provide justification for your answers.

1. How well did the alignment (coregistration) process work for you?

2. On average, what was the DEM difference in areas that did not change? Were there areas where the DEM difference showed change where it didn't occur?

3. What was your estimate for the volume of the wood chip pile? How large was your below base plane volume compared to the above base plane volume? Do you think that was an acceptable value for below base-plane volume?

4. Include a screenshot of your DEM difference that also shows the markers you added for aligning the chunks.

Lab Grading Rubric

Question	Points
1	_____ / 10
2	_____ / 10
3	_____ / 10
Total	**_____ / 30**