ADDA Lab

Drones in Agriculture and Forestry

CALCULATING TREE AND CROP HEIGHTS USING DRONE IMAGES

Dr. Suresh Muthukrishnan, Furman University, Greenville, SC, USA

Overview, Objective, and Skills

Scenario: Drones are getting integrated into many industries including agriculture and forestry. As an entrepreneur, you are interested in finding ways to use drones for agricultural, forestry, and mining industries. You have access to some sample data set that you would like to use to experiment until you get the desirable results.

Learning Objective: In this exercise you will learn to 1) process drone RGB images captured over a dairy farm to produce an orthomosaic of the area, digital surface model (DSM) that depicts the top of everything on the ground, digital terrain model (represents the bare ground surface), and 2) using DTM and DSM, calculate the actual height of crops within the farm.

Skills Introduced and Practiced: 1) ArcGIS Drone2Map image processing, 2) producing orthomosaic, DTM, and DSM data outputs, and 3) calculating the height of trees or crops using QGIS.

Lab Completion Requirements: You will be submitting a final 3D PDF map and reflection from your experience working for the imaginary media company on this project.

As you are becoming more experienced in GIS and in figuring out ways to solve your problems or troubleshoot your way out, this lab has minimal instructions for you to follow. Just sharing some screen shots showing the steps involved.

Data Used: Data needed for this project is provided on Moodle. Important notes to keep in mind:

- Do not modify the images, i.e. do not rotate or edit the images. Modifying images alters the geometrical properties of the camera and may deteriorate the quality of the results.
- The main input to Drone2Map are images (JPEG or TIFF formats are accepted by most programs).

Data Storage and Processing: Download the data from Moodle to your local computer hard disc. Make sure the computer has enough space not just for the data but also for the processing and the resulting output files. Create a new folder for this lab and unzip the contents of the downloaded file to this new folder.

Before You Begin: Prepare you File and Download Data

1) Create a folder to save your work for this lab titled ArcGIS Drone2Map Lab 11.
2) On Moodle Day 11 download the “Lab 11 Data: Pasture RGB” and save the data to your folder.

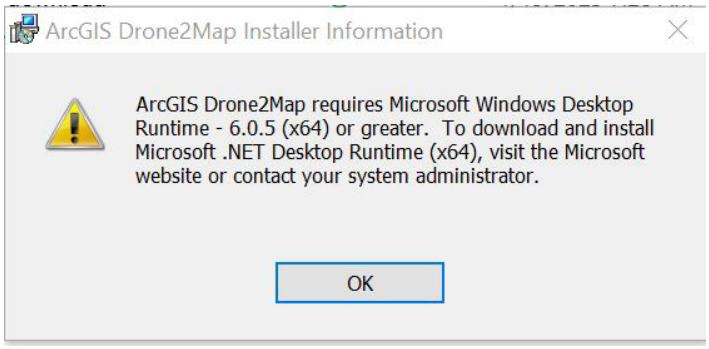
Part I: Instructions for Downloading and Installing ArcGIS Drone2Map Software

1) If you have not already completed this step, navigate to the following link and download the file: https://drive.google.com/file/d/12HOGoicyLrGZtEV8rxOQCjW4xmBDTWsL/view?usp=share_link
2) Unzip the file and open "1.ArcGIS_Drone2Map_20221_178064" application.
3) After unzipping, begin the installation process.

Important Note: This software is licensed for educational use only and non-educational use and sharing of account information with non ADDA people is strictly prohibited.

Additional Updates and Installation

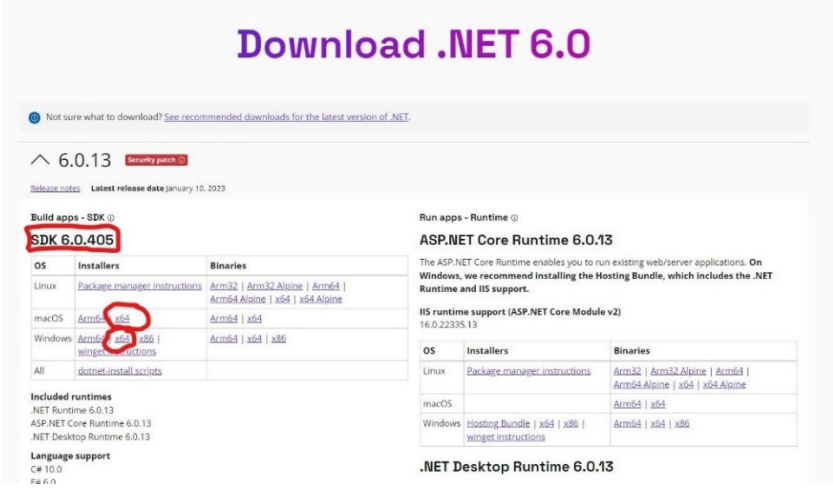
During Drone2Map installation process, it is possible that you will get prompted to install additional software that is required to run Drone2Map. You may receive the following error message:



If you do not receive this message within the first few steps of the installation process, then you can skip the following instructions and go to the next section, Part II.

If you did receive the above error message, you will need to install the Microsoft Windows Desktop Runtime – 6.0.5 (x64) on your computer before proceeding. Proceed with this section.

1) Navigate to the following link and download the property version of the 6.0.405 x64 bit version for whichever operating system you are using: https://dotnet.microsoft.com/en-us/download/dotnet/6.0



2) After completing this step, you can continue and finish installing Drone2Map.

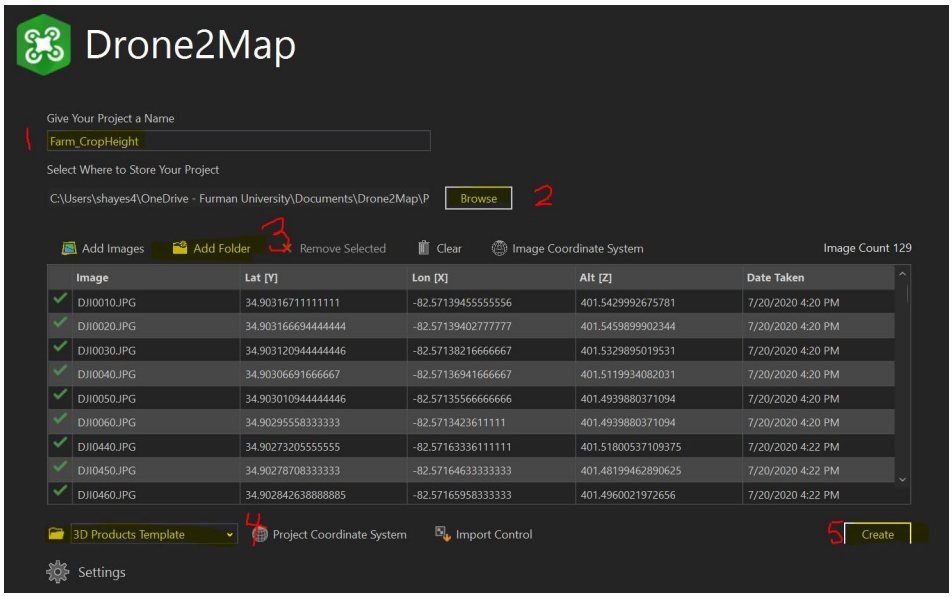
Part II: Finish Downloading and Setting Up Drone2Map

1) Proceed through the installation process for ArcGIS Drone2Map.
2) When prompted to select an agreement option, select “I accept the master agreement.”
3) Once finished, launch the application and login to your ADDA ArcGIS Online account if requested.

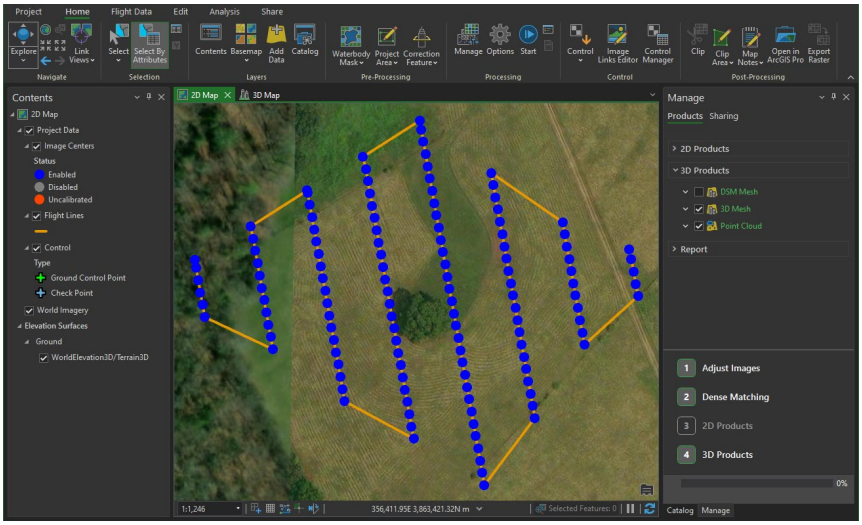
Part III: Set Up Project

When you launch ArcGIS Drone2Map, you will automatically be prompted to create a new project. Input the following into your new project:

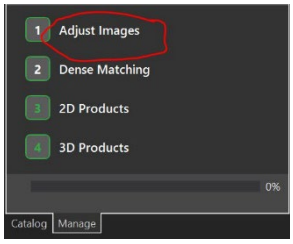
1) Give Your Project a Name: Farm_CropHeight
2) Browse: Save your project in your folder you created at the beginning of this lab.
3) Add Folder: Navigate to the “Lab 11 Data: Pasture RGB” folder and add it to your project. Note: when you open the folder, it will say “The container is empty,” which is okay. Select OK and wait for the images to be added to the project like they are below. You should have a total county of 129.
4) Select the dropdown menu in step 4 and select “2D Products Template.”
5) Select “Create” to finish creating the project.



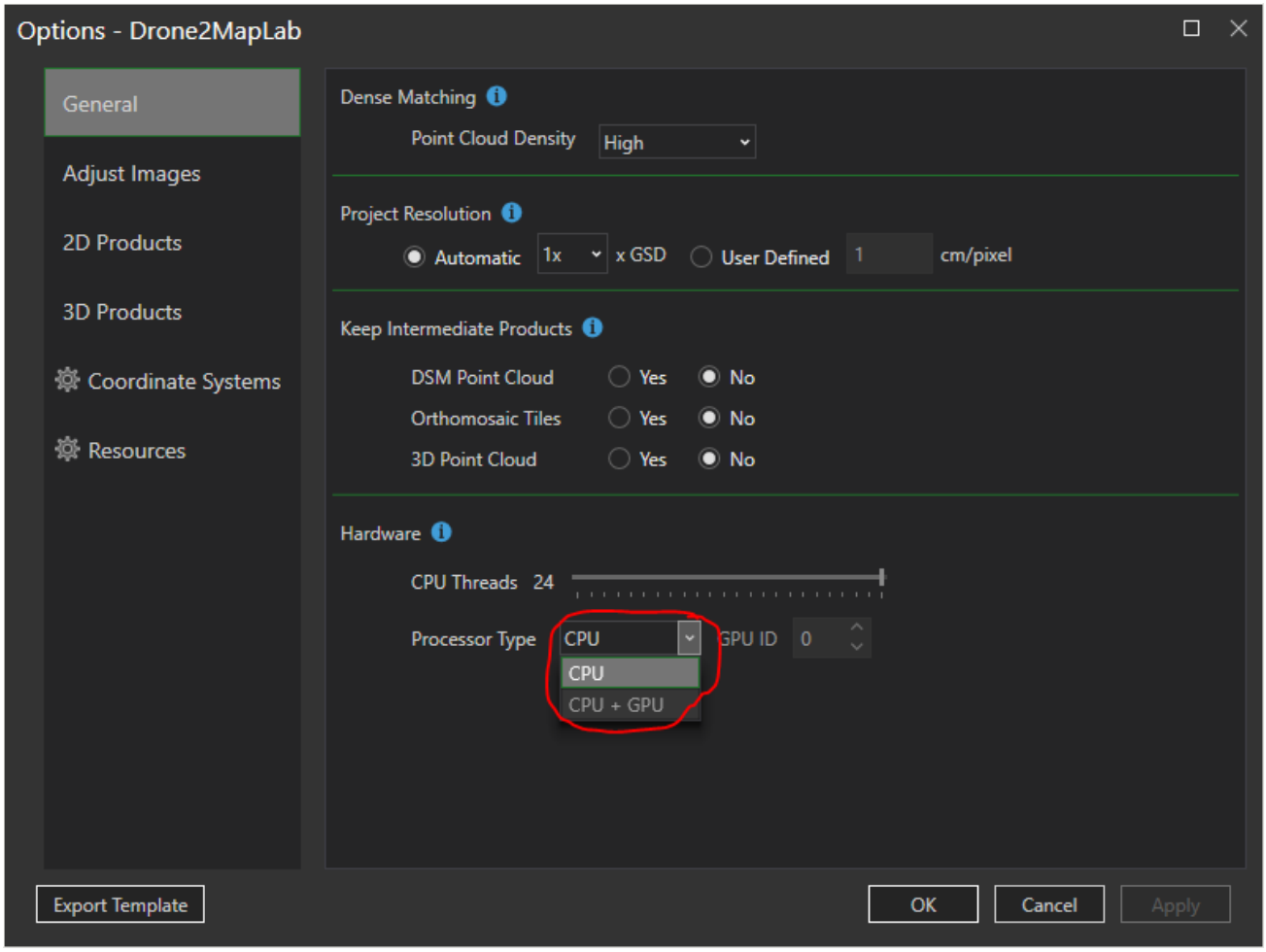
Drone2Map will read the input images and lay them out using the embedded geotagged coordinates as shown in the figure below. If your images don’t contain the coordinates, it will likely display an error message.



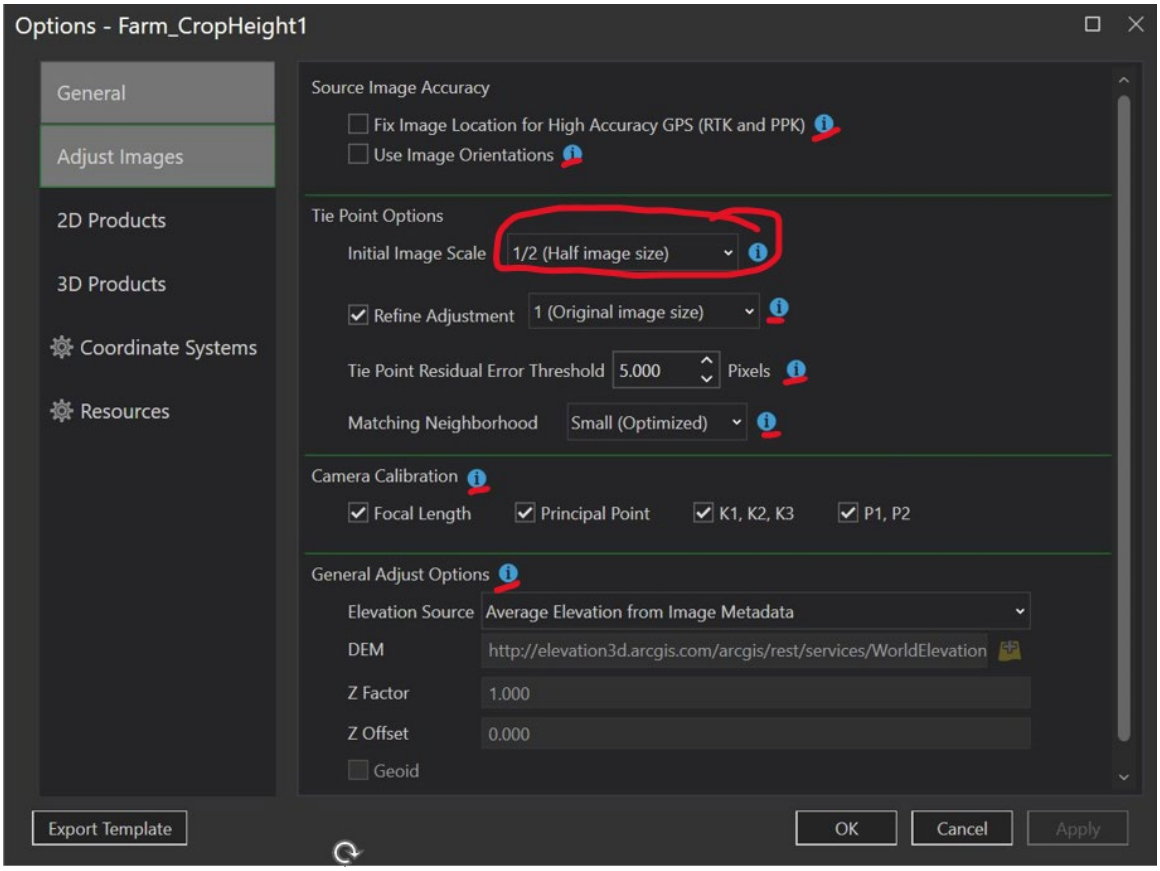
Part IV: Image Processing



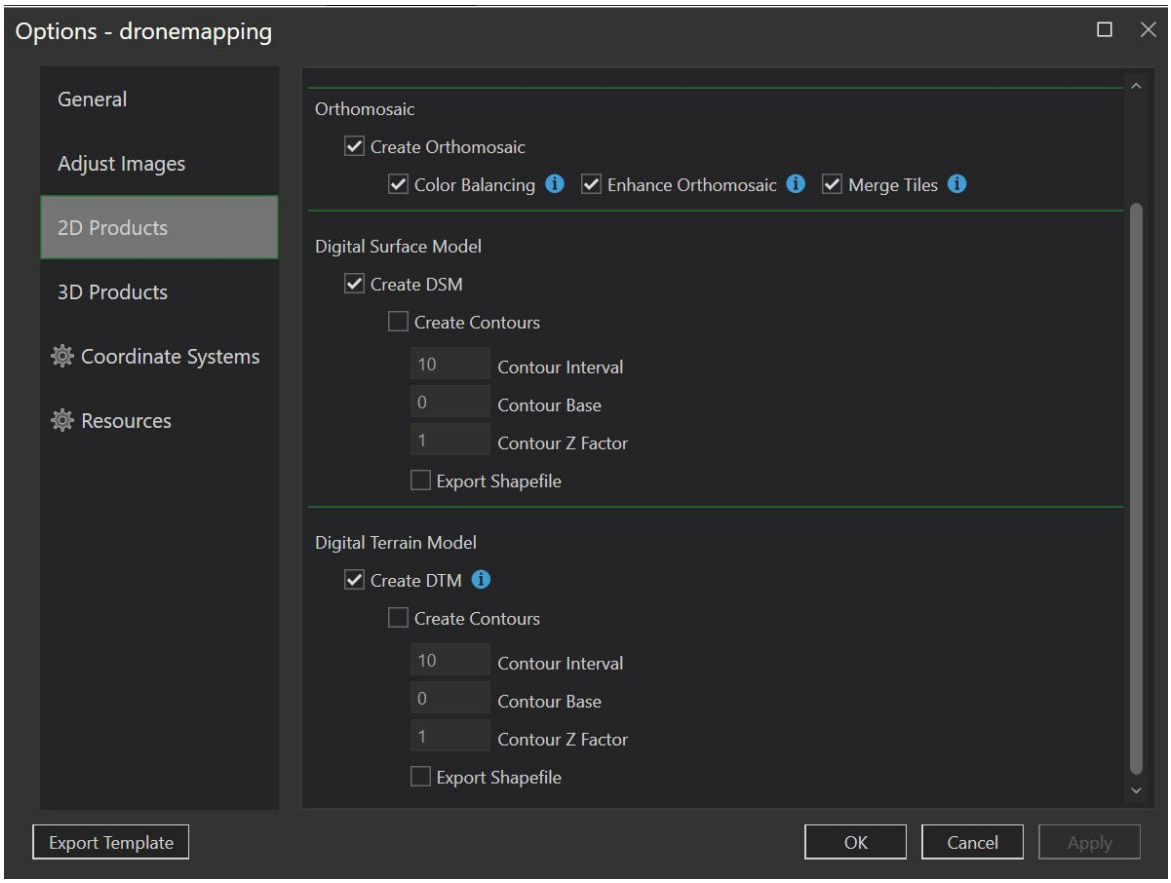
1) In the lower right-hand corner, select the "Adjust Images" option and a new window will open.
2) Under "General" tab, you have the option of setting up hardware use. The hardware parameters displayed will vary for each computer. If your computer has a dedicated GPU, you should switch processor type to CPU+GPU and select the GPU ID to use. GPU processing allows higher computational capabilities and will significantly reduce the amount of time your computer needs to finish processing your images and create output.



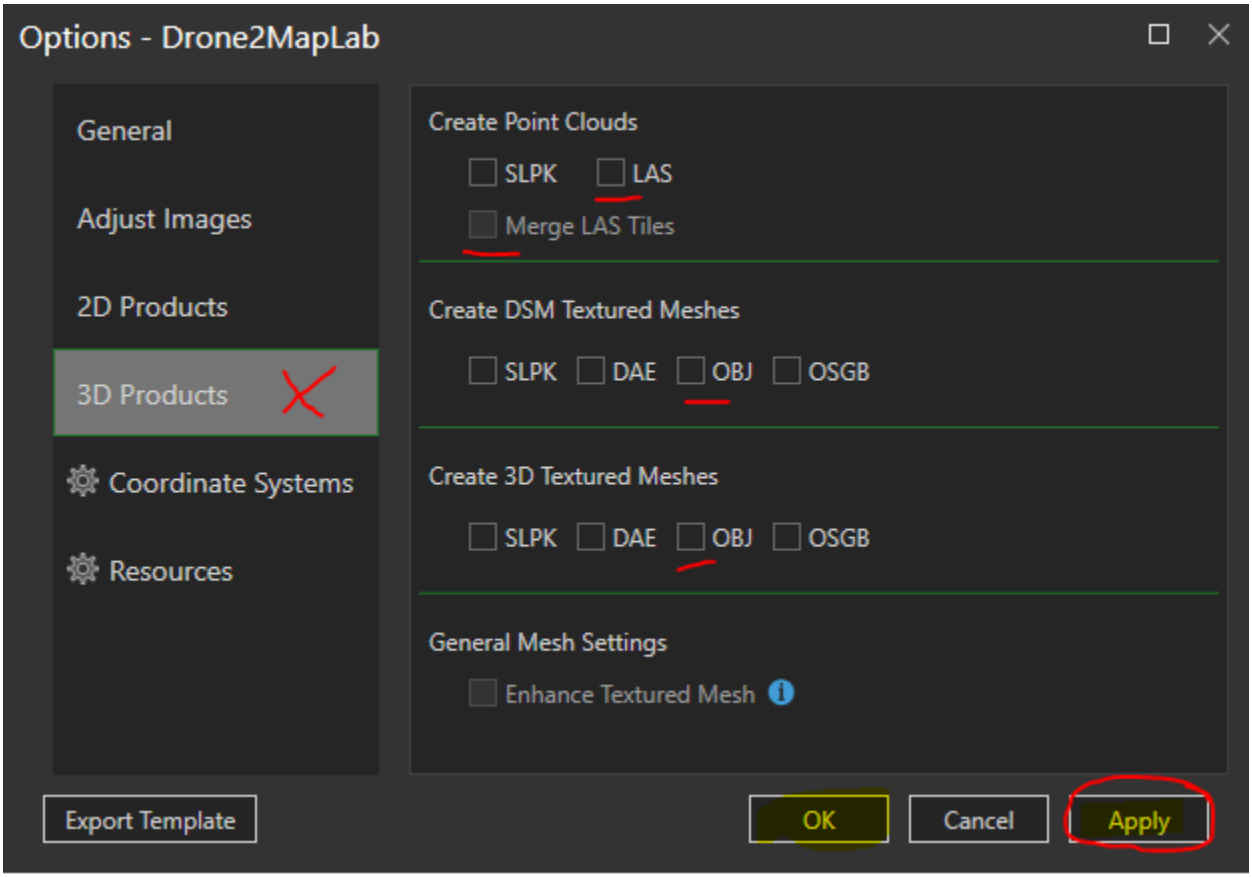
3) Under the **Adjust Images** tab, you can either take default values or change them. Click on the blue **info** icon next to the options to learn more about what each option does. Changes to these parameters will have an impact on how much time and computational power is needed for the process to complete. In most cases, the default values should be sufficient. However, if you are not happy with the resulting output quality, you can go back and adjust these parameters and re-run your analysis.



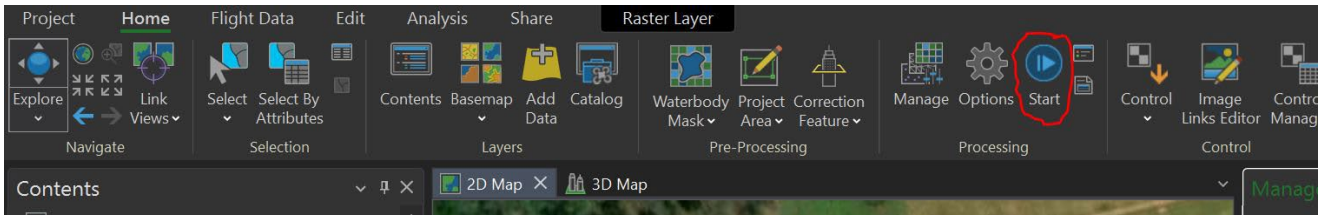
4) Under the **2D Products** tab, check the boxes for **Create Orthomosaic, Create DSM, and Create DTM**. For this exercise, you don't need to create contours of DSM and DTM, but be aware that it is an option during this process. Checking those options will result in longer time for processing and generating those outputs.



5) Under the **3D Products** tab, you should disable all the options including those checked by default. The Drone2Map **Standard** license that you have will not allow generation of any 3D products. It requires a Drone2Map Advanced license.



6) Once done with these setups, select **apply** in the lower right-hand corner and then OK to close the **Adjust Images** window.
7) At this point, you should save the project by clicking **Project → Save.**
8) Back in the main Drone2Map window, make sure you are on the "**Home**" tab and then select Start to run the image processor. Depending on your computer configuration, this may take a while to complete. To help this process run faster and prevent your computer from crashing or freezing, please consider closing other programs that may be running at the same time.

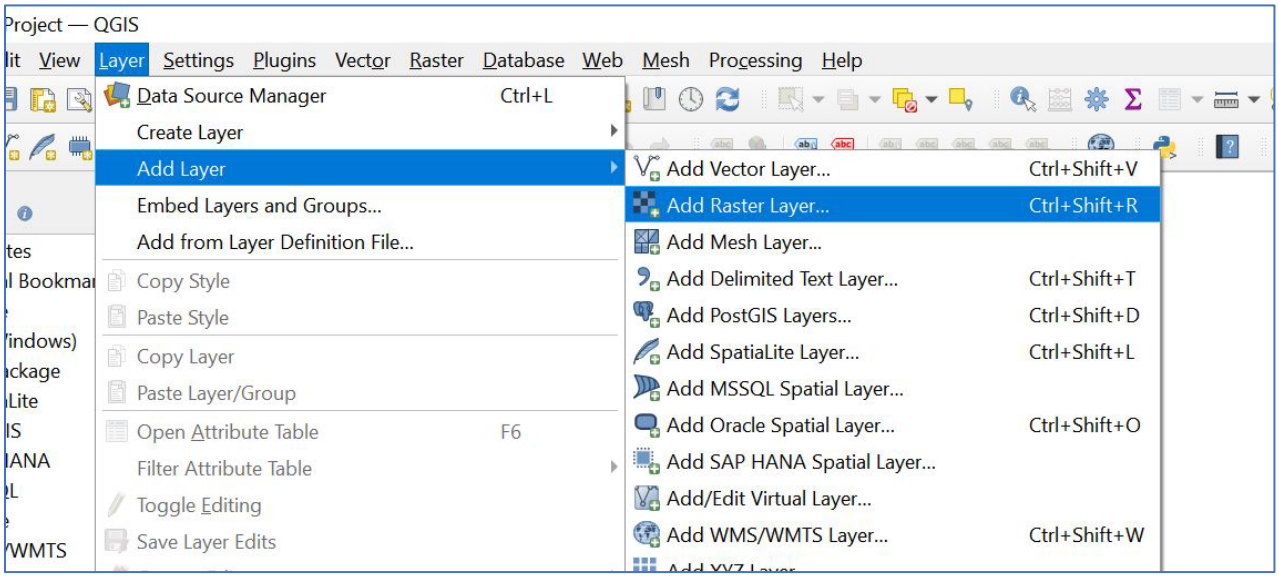


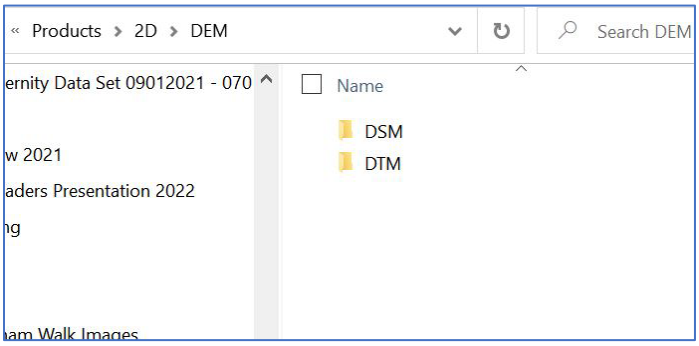
9) Once this has finished, you will see the output layers within the ArcGIS Drone2Map interface. Look at the different outputs (in 2D and 3D views) and see if you can understand what the layers are showing based on your lecture materials.

Note on Processing Time: On a desktop computer with Intel Xenon 24 core processor with 64GB RAM, this process took about 22 minutes to run. Having dedicated GPU could potentially cut about 30% of this time.

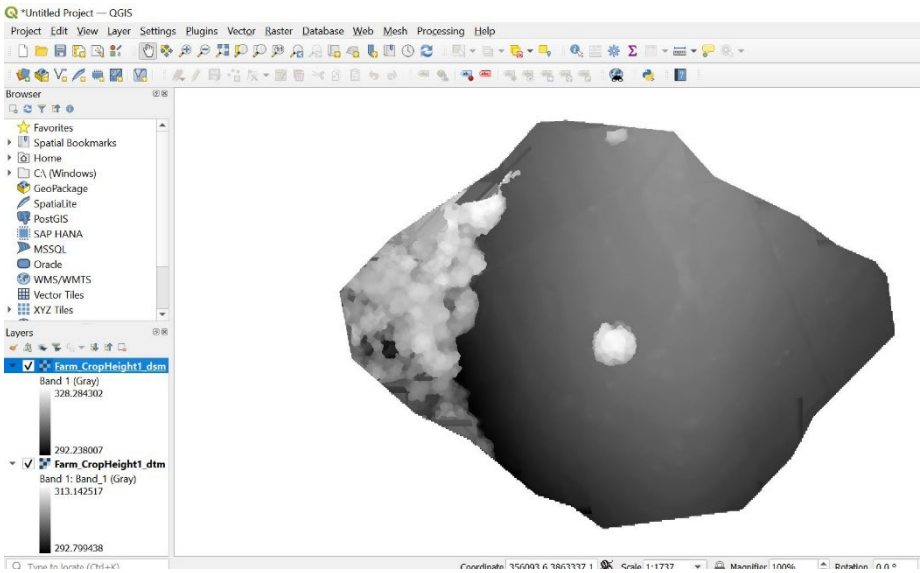
Part V: Post-Processing and Analysis using QGIS.

1) Open a new QGIS project and save the project to your Drone2Map project folder.
2) Navigate to your lab folder within your project: ArcGIS Drone2Map Lab 11 – Farm_CropHeight – Products – 2D – DEM – DSM/DTM. Navigate into the DSM and DTM folders, and select the appropriate TIF file from each folder, then input them into the project.



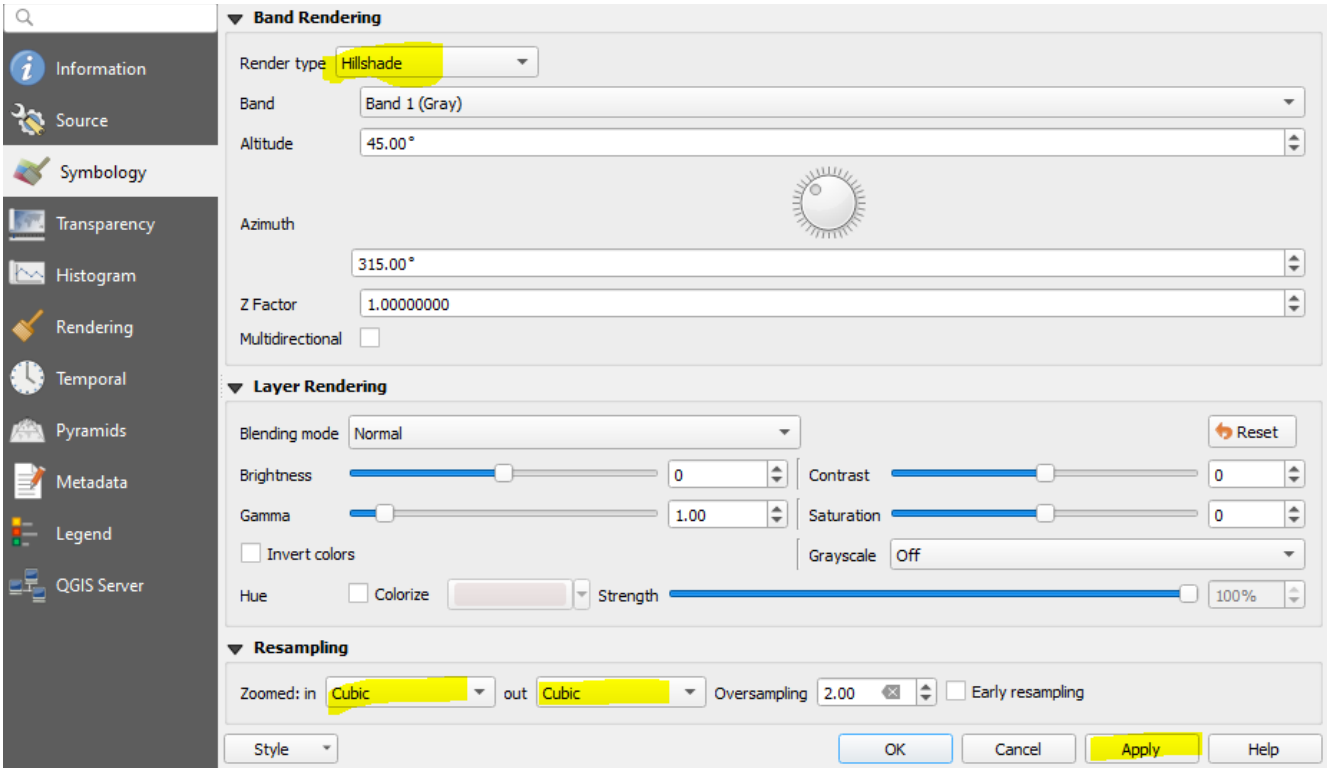


3) With these files turned on, you can play with better ways to represent elevation including changing the default gray shades to a different color scheme that more clearly shows elevation variation.

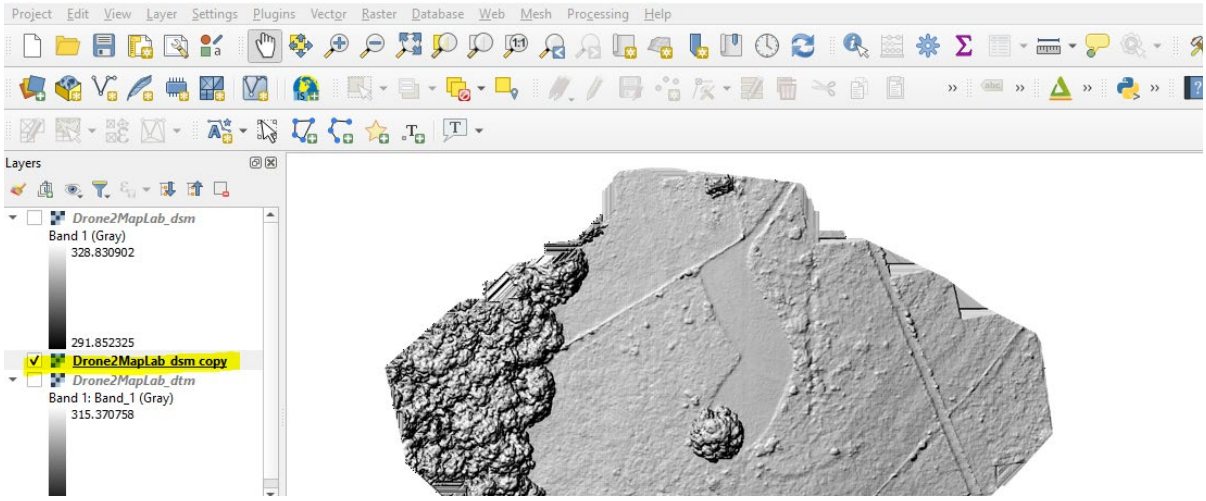


Remember that a digital surface model (DSM) represents the top of everything on the landscape, including treetops, building tops, and any other features. The Digital Terrain Model (DTM) represents the actual ground surface. Where the ground is barren (no trees or other type of features present), ideally the DSM and the DTM elevation values should be same. All the elevation values are represented with respect to the mean sea level. Using this understanding, we can calculate the true height of any features on the earth's surface using the simple arithmetic of (DSM – DTM) = True Hight of features. This can be carried out using a raster calculator.

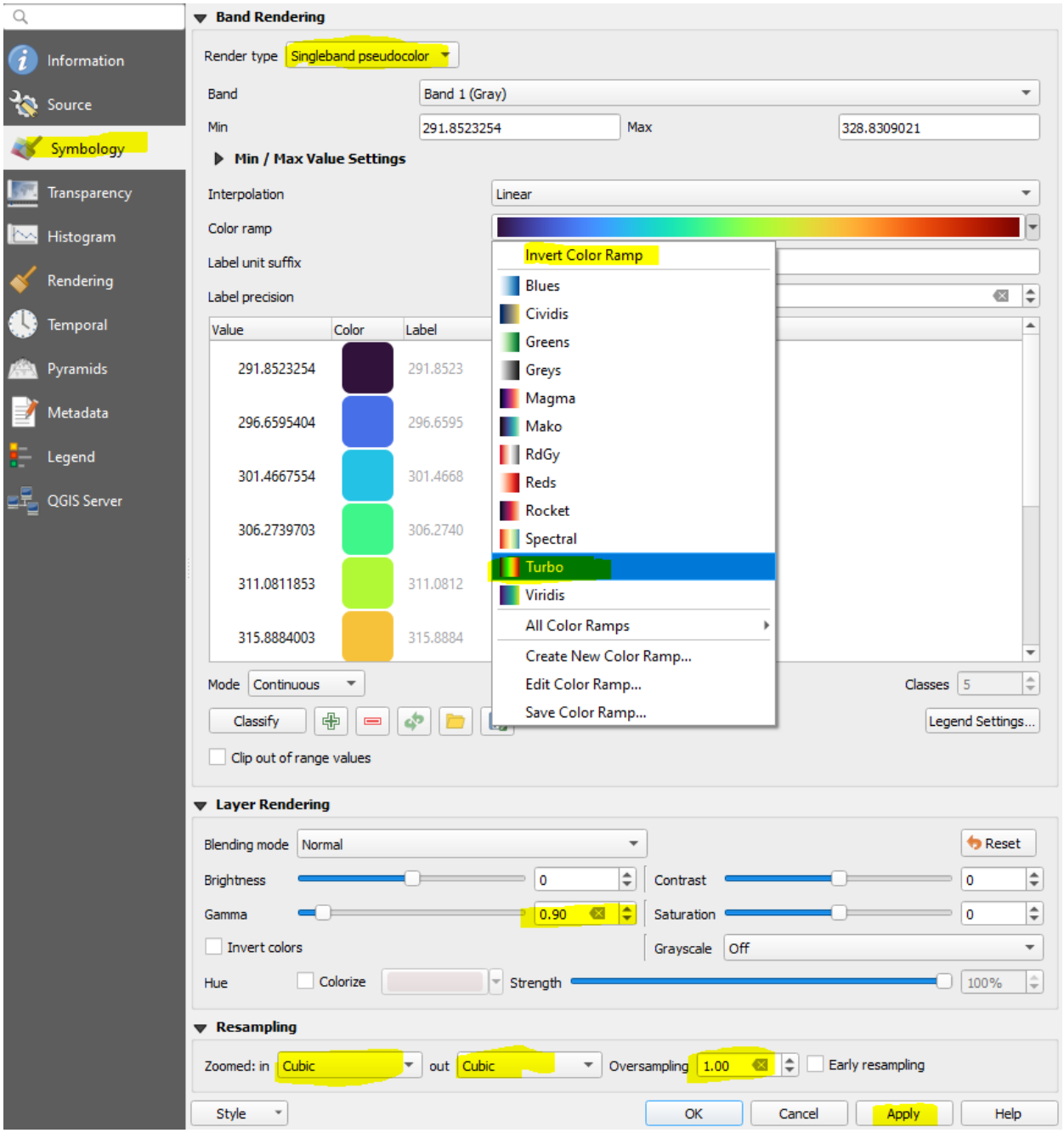
4) Now, to make the elevation data look better and bring out the variation in elevation, we should play with symbology options. First, organize the layers such that DSM is listed above DTM on your QGIS table of layers.
5) Right click on the **Farm_CropHeight1_dsm** layer and select **Duplicate Layer** option. This will add another copy of this layer to your project.
6) Now make sure to turn off all layers except **Farm_CropHeight1_dsm copy**. Right click on the new copy of the layer **Farm_CropHeight1_dsm copy** and select **properties**. Make the following changes to symbology of this layer.



7) Click OK to close out the properties window. You should see your DSM copy as a gray scale hillshade layer.

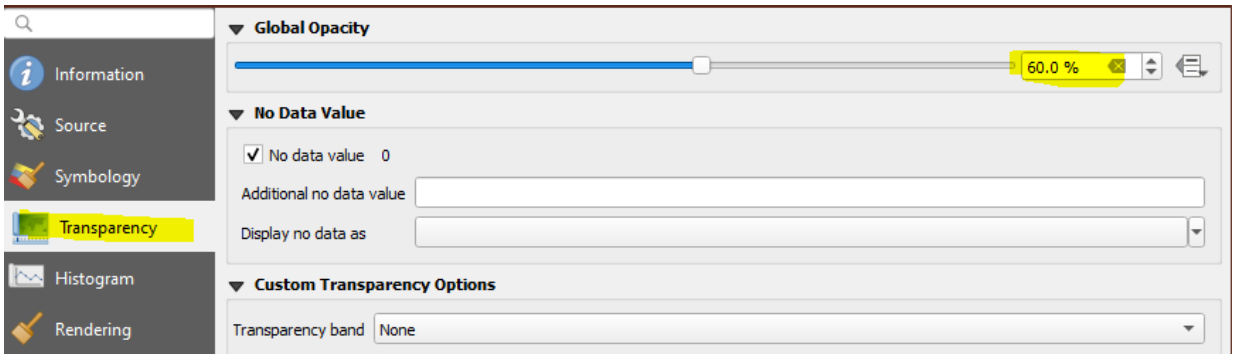


8) Now, let's make some changes to **Farm_CropHeight1_dsm** layer properties to make it look pretty. Right click on this layer and open the **Symbology** tab. Make changes to rendering type, color ramp, resampling methods and any other property that works to improve the colors.

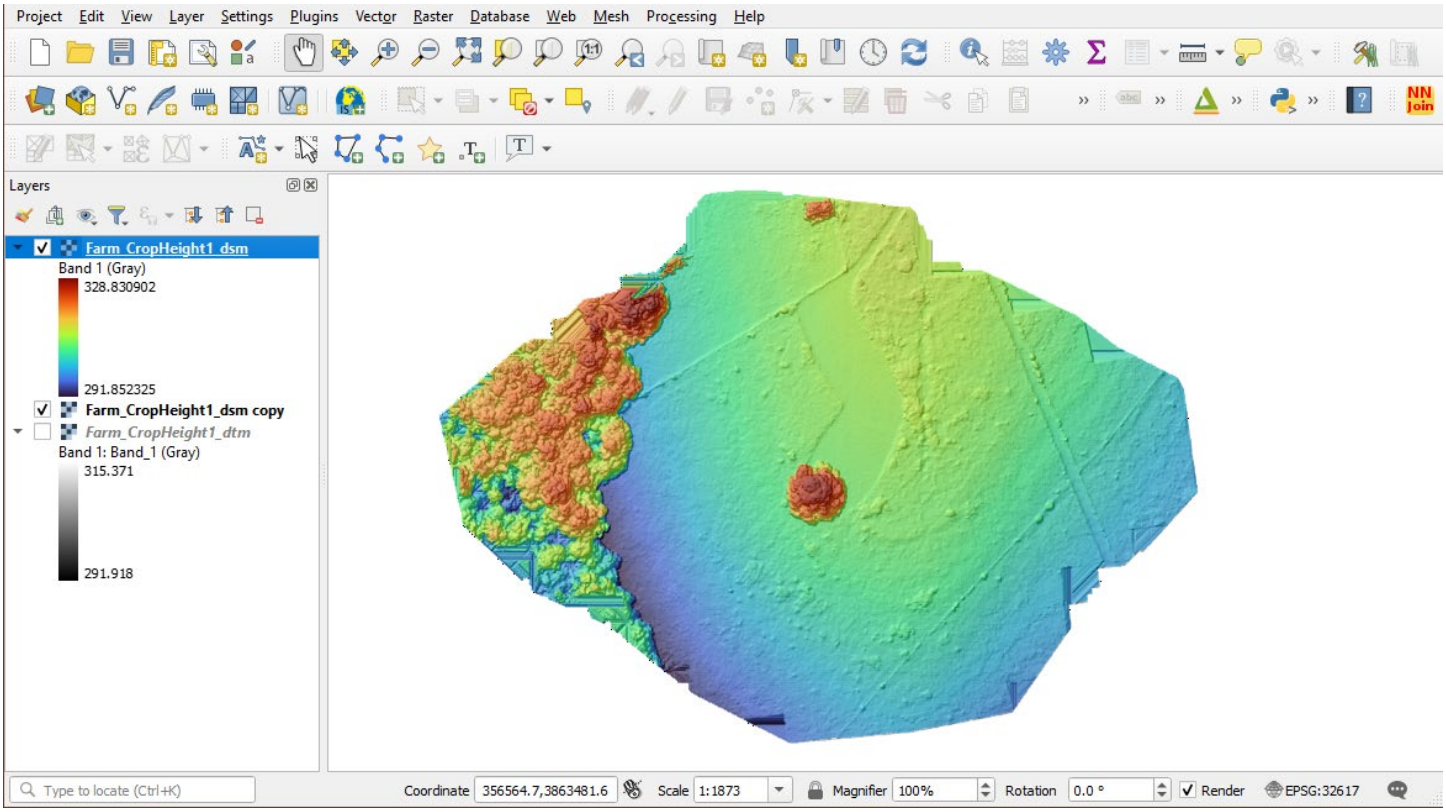


9) Click **Apply**.

10) Now, click on **Transparency** tab and change it to 60%.

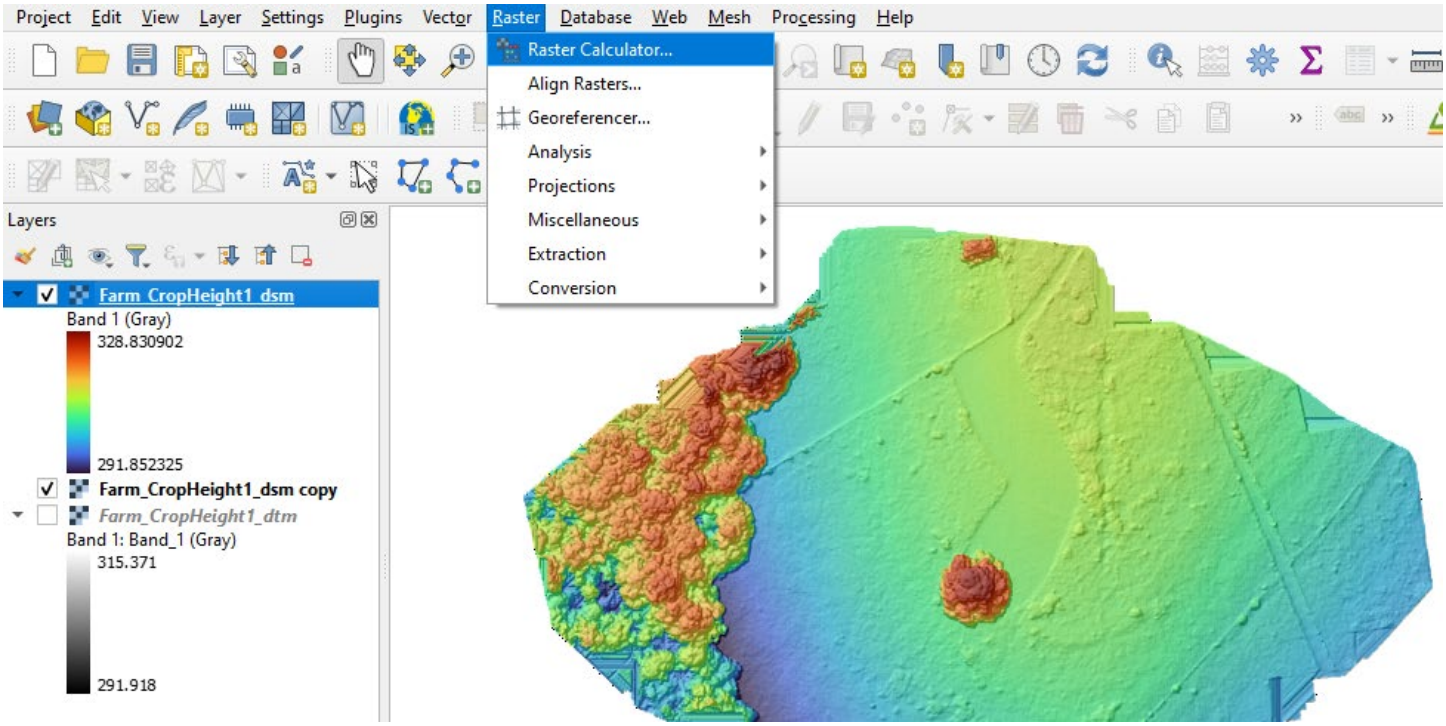


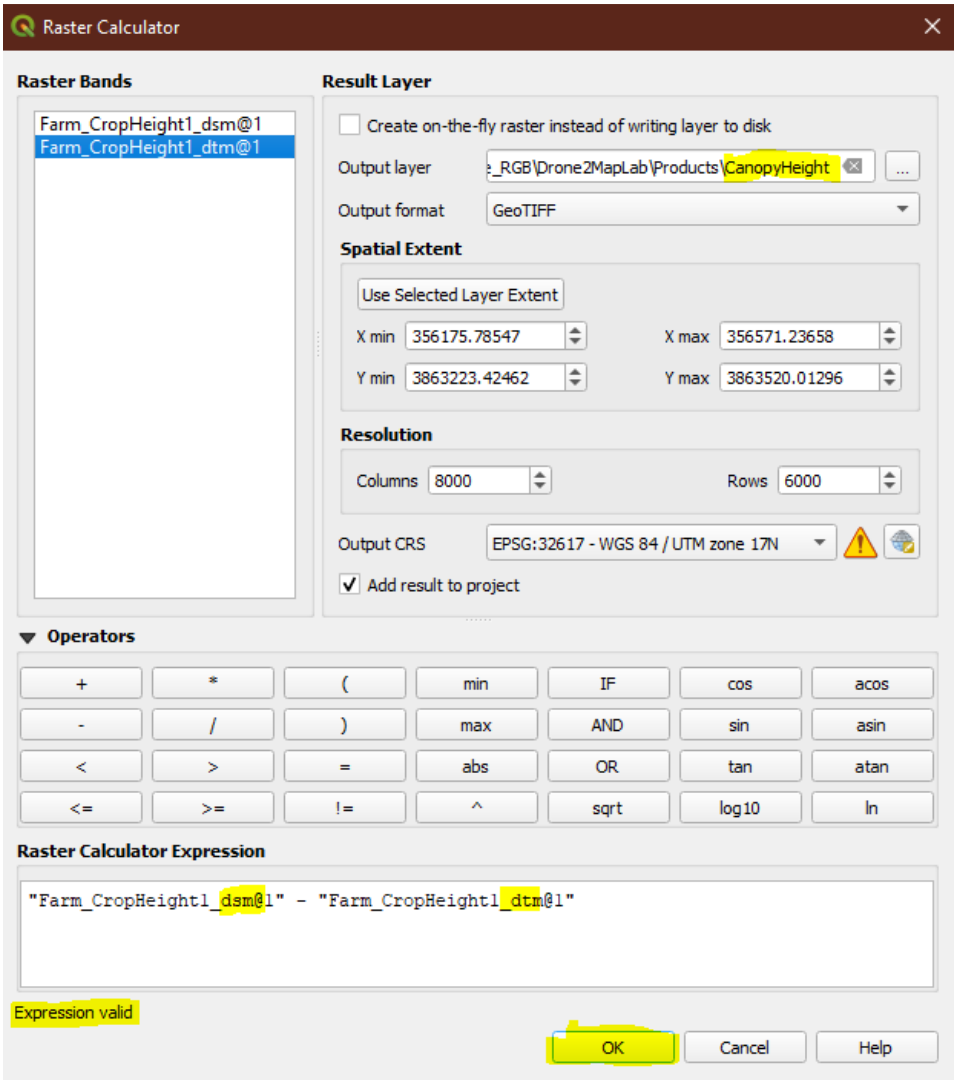
Transparency makes the hillshade layer, which lies underneath this layer visible slightly, thus making different elevation pixels show in different colors. The hillshade layer highlights the subtle variations in elevation and helps easily identify man-made features like fence lines, roads, and any building structures.



Part VI: Calculating Tree/Crop Height using Raster Calculator

1) Navigate to the 'Raster' tab on the top of QGIS and select the "Raster Calculator."





2) Now, calculate the difference in elevation between DSM and DTM. Again, DTM shows the elevation of the ground surface whereas DSM shows the elevation of everything on the earth's surface. As always, do not forget to give the resulting layer a name and save it to your lab folder. Now, think about the resulting output file.

   What does this layer show? How can we best visualize this?

3) Create a good map using all standard map elements and show the results in an effective and efficient way.

Congratulations! You have now learned how to process drone imagery and analyze the resulting layers in QGIS and generate a canopy height model (CHM)!

Submission: For this lab, please turn in 1) A PDF of your final map layout in QGIS clearly showing your final map of the difference layer you generated, symbolized appropriately. You can also include any other layers you think are appropriate. 2) A Word Document with your two-paragraph reflection. In your reflection, you can include your thoughts on questions such as: What exactly does the layer of the difference between DSM and DTM symbolize? What can we do with the resulting data layers from this project? Think of other use-cases for this process in other sectors (maybe in your job, home community, country, area of study).

Optional resource: interesting article about the accuracy of the DTM function from imagery:

https://community.esri.com/t5/arcgis-drone2map-questions/negative-and-inaccurate-height-dsm-dtm-calculated/m-p/1086216#M10