Volume

2

ICARDA IN COLLABORATION WITH OREGON STATE UNIVERSITY

Veg Measure User Manual Series

Software Introduction

VEG MEASURE USER MANUAL SERIES

Software Introduction

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How to cite VegMeasure 2 Software:

Johnson, M.D., Louhaichi, M., Johnson, D.E. and Pearson, A. 2015. VegMeasure 2. Version 2.2. ICARDA, Amman, 11195, Jordan.

How to cite VegMeasure Image Positioning Tool Software:

Johnson, D.E., Louhaichi, M., and Pearson, A. 2015. VegMeasure Image Positioning Tool. Version 1.2. ICARDA, Amman, 11195, Jordan.

Introduction

VegMeasure is a Digital Vegetation Charting Technique (DVCT) that measures vegetation on the ground in a non-destructive manner. Just like quadrat sampling, it looks at how much cover the vegetation has and the types of plants can be identified to determine the ecological status. However using DVCT is much quicker, more objective, and can derive further metrics than traditional quadrat sampling. The colors from the digital camera can be interpreted by a VegMeasure computer software to create meaningful classes, for example: dark brown-soil, whitish color-litter, green-leaves. The software enables: hue extraction, calibrating a threshold, K-means classification, brightness algorithms, and green leaf algorithms. Large scale maps can be created with greater ease with this digital method. With repeat monitoring changes in vegetation can be monitored. This method can be more accurate amongst various field collectors since it does not rely on perceptions and creates a permanent digital record that can be revisited.

To use this method, certain field collection procedures have to be followed and an understanding of the software is needed. This manual series has been created to facilitate this process. Volume 1 is for field data collection and Volume 2 teaches how to process the images in the VegMeasure computer software. Volume 1 can be taken to the field to help with the camera set up and field data collection and Volume 2 can be left back in the office where the images are being processed. In this volume you will learn how to use the image positioning tool, and the VegMeasure2 Program.

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Chapter 1

VegMeasure Image Positioning Tool

2. Software Introduction

The image positioning tool is important to set your camera type and generate usable KML files.

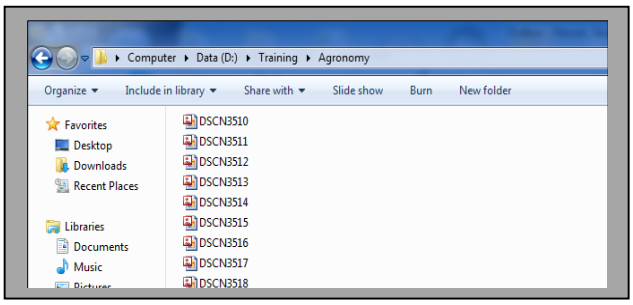
To bring your images into VegMeasure software it is recommended to use the image positioning tool. This program will help identify your camera, process all files sequentially, and associate with them a KML reference file that is readable by VegMeasure and other GIS Programs. KML files (Key Hole Markup Language) are files with spatial information that can be read by many spatial programs. This file summarizes, the longitude, latitude, elevation, GPS date and time, camera date and time, image name, and image path for each image taken.

The Following Cameras are Supported:

HTEC Inspire 4G
Nikon CoolPix AW100/AW120
Nikon CoolPix P510
Panasonic DMC-ZS10
Apple iPhone 4
Apple iPhone 5S
Samsung Galaxy S4
Samsung Galaxy Note 3

Step 1: Download Images

It will be helpful to have all the quadrat shots from one site or project in a **separate folder** on your computer. Make sure to separate out reference, landscape photos, and any photos taken at an angle in a separate folder or subfolder.

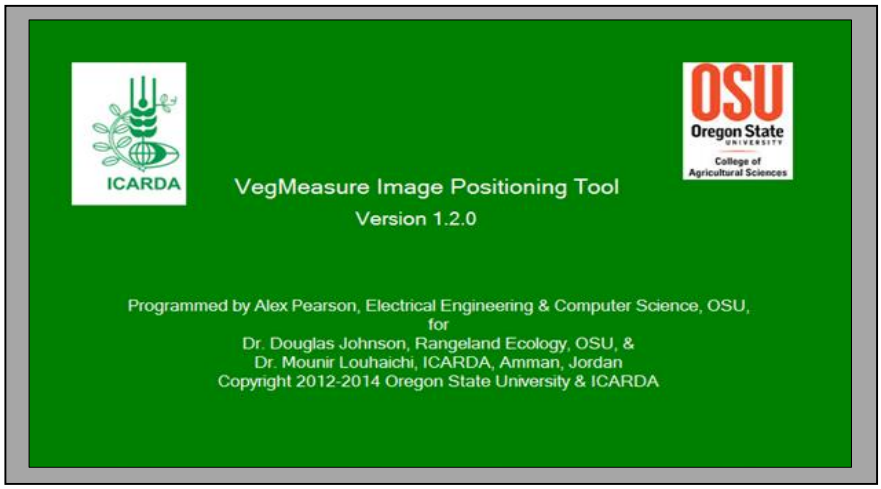


Step 2: Acquire access to and Install the Image Positioning Tool Program

In order to use the VegMeasure Image Positioning Tool software you will have to download it from the VegMeasure Website http://www.vegmeasure.org/.
Create a folder called VegMeasure Image Positioning Tool on your hard drive and unzip the files from VegMeasureImagePositioningTool1.2.1 to the VegMeasure2 folder you created. To run the program double click on the Application KlmCreator.exe. You will need to have administrator access to your computer and thus may need to contact the IT department of your institution.

Step 4: Run Image Positioning Tool Program

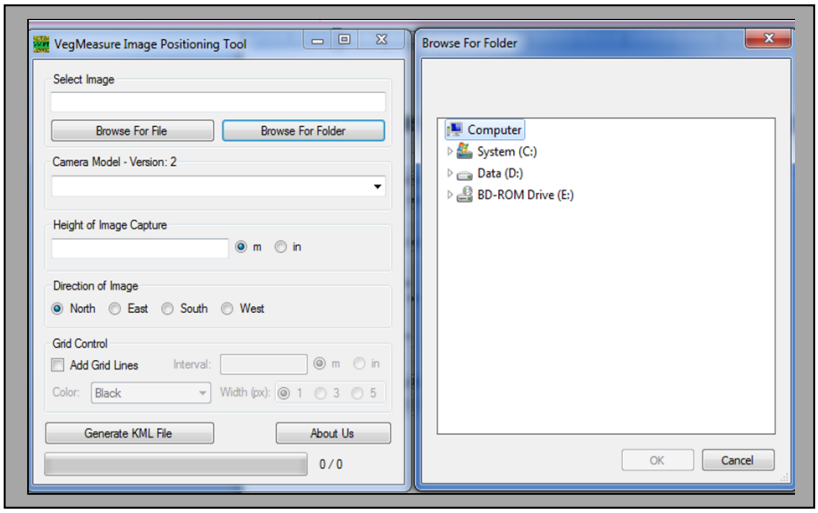
The program should be located in your program files under VegMeasure Image Positioning Tool. Click on the ___ icon. After the program opens it will ask you to select where your files are located.



Step 5: Upload Images

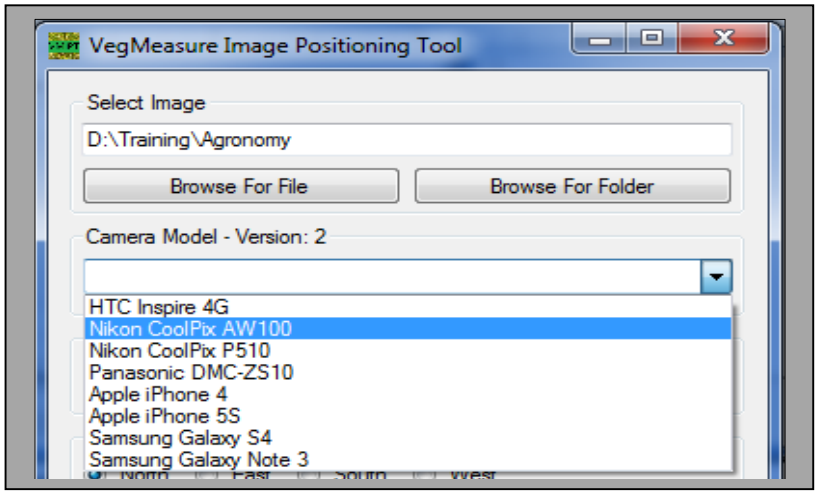
When the program opens a window will appear like the one bellow that will ask for different pieces of information that you will need to fill out to produce the KML file. The first thing is to select a file or folder where your images are located.

Click on **Browse for Folder** and then select the folder where your files are located.



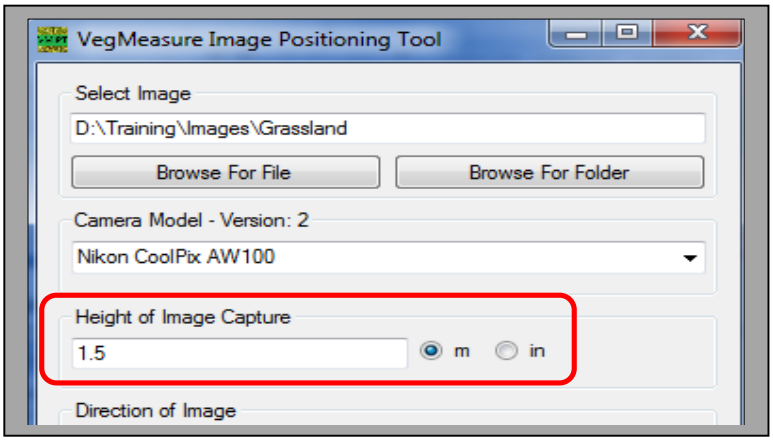
Step 6: Select the Camera Model

Choose a camera model from the drop down list.



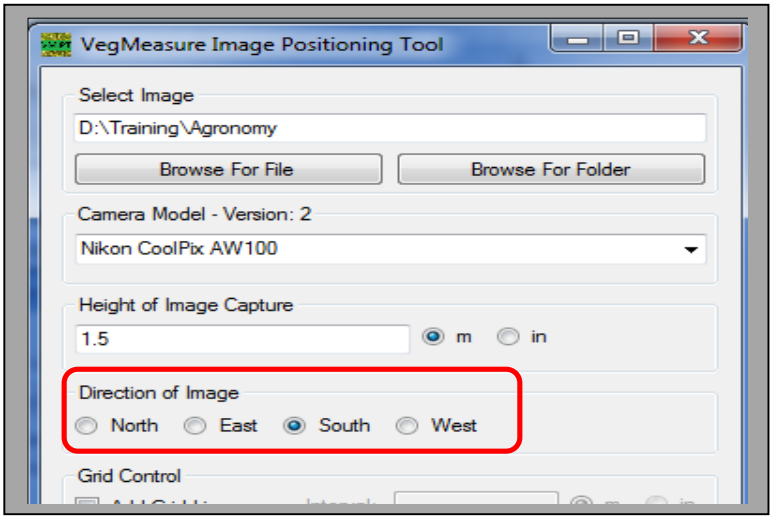
Step 7: Fill in the Camera Height

The height of the image is important to scale the vegetation properly. Select the height that the pictures were taken. *If the images were taken at different heights they need to be separated into different folders that correspond to their height and direction.*



Step 8: Select the Direction of the Image

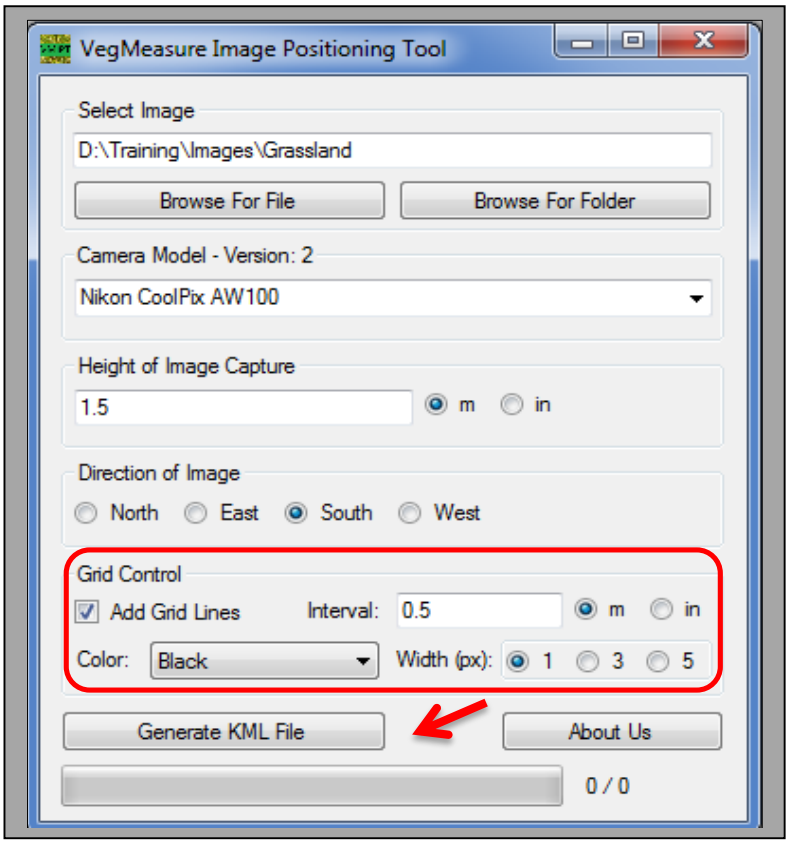
The direction of the image is important to account for the effect of shadows. Select the direction that the pictures were taken. *If the images were taken at different directions they need to be separated into different folders that correspond to their height and direction.*



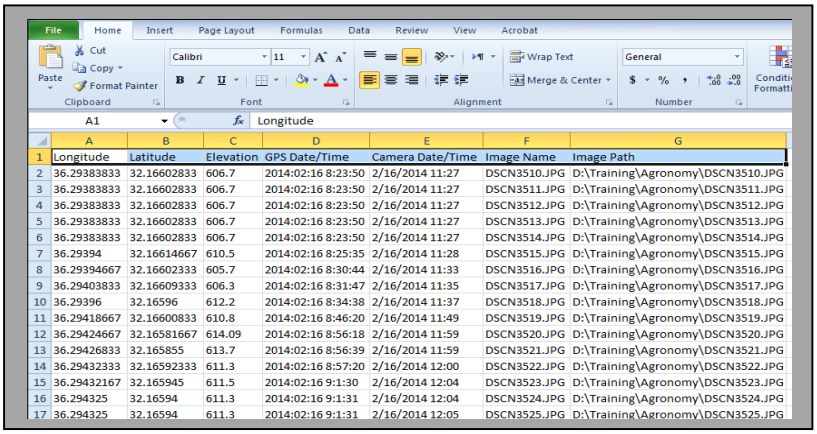
Step 9: Generate KML and Summary files

Before you generate the KML file you can choose to have a grid added to your original picture. This is optional. If you want grid lines, you can decide the distance between the lines, thickness, and color. Once you click "Generate KML File," the software will process and create new files with the same name, in the same folder, however with a

different extension (.kml). A summary file (.csv), titled "summary" will be created in the same folder as well.



The summary file has the GPS data for each picture that includes the following information: longitude, latitude, elevation, GPS date and time, camera date and time, image name, and image path.



Longitude	Latitude	Elevation	GPS Date/Time	Camera Date/Time	Image Name	Image Path
36.29383833	32.16602833	606.7	2014:02:16 8:23:50	2/16/2014 11:27	DSCN3510.JPG	D:\Training\Agronomy\DSCN3510.JPG
36.29383833	32.16602833	606.7	2014:02:16 8:23:50	2/16/2014 11:27	DSCN3511.JPG	D:\Training\Agronomy\DSCN3511.JPG
36.29383833	32.16602833	606.7	2014:02:16 8:23:50	2/16/2014 11:27	DSCN3512.JPG	D:\Training\Agronomy\DSCN3512.JPG
36.29383833	32.16602833	606.7	2014:02:16 8:23:50	2/16/2014 11:27	DSCN3513.JPG	D:\Training\Agronomy\DSCN3513.JPG
36.29383833	32.16602833	606.7	2014:02:16 8:23:50	2/16/2014 11:27	DSCN3514.JPG	D:\Training\Agronomy\DSCN3514.JPG
36.29394	32.16614667	610.5	2014:02:16 8:25:35	2/16/2014 11:28	DSCN3515.JPG	D:\Training\Agronomy\DSCN3515.JPG
36.29394667	32.16602333	605.7	2014:02:16 8:30:44	2/16/2014 11:33	DSCN3516.JPG	D:\Training\Agronomy\DSCN3516.JPG
36.29403833	32.16609333	606.3	2014:02:16 8:31:47	2/16/2014 11:35	DSCN3517.JPG	D:\Training\Agronomy\DSCN3517.JPG
36.29396	32.16596	612.2	2014:02:16 8:34:38	2/16/2014 11:37	DSCN3518.JPG	D:\Training\Agronomy\DSCN3518.JPG
36.29418667	32.16600833	610.8	2014:02:16 8:46:20	2/16/2014 11:49	DSCN3519.JPG	D:\Training\Agronomy\DSCN3519.JPG
36.29424667	32.16581667	614.09	2014:02:16 8:56:18	2/16/2014 11:59	DSCN3520.JPG	D:\Training\Agronomy\DSCN3520.JPG
36.29426833	32.165855	613.7	2014:02:16 8:56:39	2/16/2014 11:59	DSCN3521.JPG	D:\Training\Agronomy\DSCN3521.JPG
36.29432333	32.16592333	611.3	2014:02:16 8:57:20	2/16/2014 12:00	DSCN3522.JPG	D:\Training\Agronomy\DSCN3522.JPG
36.29432167	32.165945	611.5	2014:02:16 9:1:30	2/16/2014 12:04	DSCN3523.JPG	D:\Training\Agronomy\DSCN3523.JPG
36.294325	32.16594	611.3	2014:02:16 9:1:31	2/16/2014 12:04	DSCN3524.JPG	D:\Training\Agronomy\DSCN3524.JPG
36.294325	32.16594	611.3	2014:02:16 9:1:31	2/16/2014 12:05	DSCN3525.JPG	D:\Training\Agronomy\DSCN3525.JPG

Chapter 2

VEGMEASURE USER MANUAL SERIES

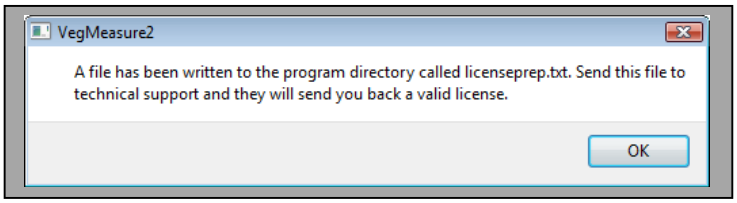
VegMeasure 2 Getting Started

This chapter will guide you through VegMeasure installation and software basics.

This chapter will give you an overview of the software. Aside from showing you how to install the program and run the software, it will also show you how to specify input photos, preview images, and the basics of processing images. At present the Veg Measure software is separate from the image positioning tool so you will need to install two different programs to process the images.

Installation and Registration

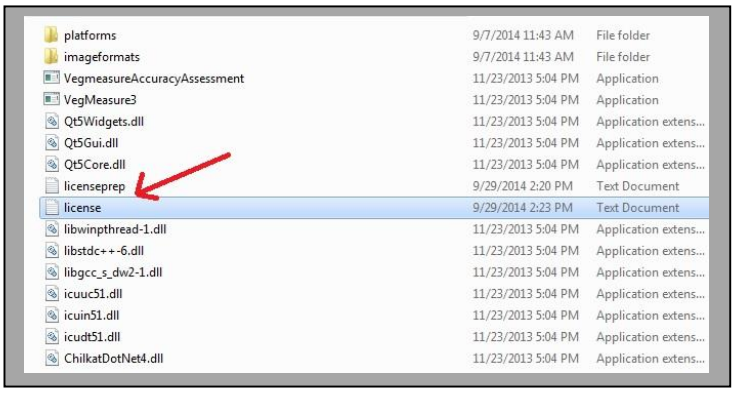
Read *Obtaining a VegMeasure 2 License* found at http://www.VegMeasure.org. In order to use the VegMeasure 2 software you will have to obtain a license. To do this, you will first create a Vegmeasure2 folder on your hard drive. Unzip the files from VegMeasure-2.zip to the VegMeasure2 folder you created. To run the program double click on the Application vegmeasure2 (vegmeasure2.exe). The first time the program runs, a licenseprep.txt file is created in the directory that contains the program. This file along you're your name, institution and other information should be emailed to: vegmeasure@gmail.com, so your license can be generated.



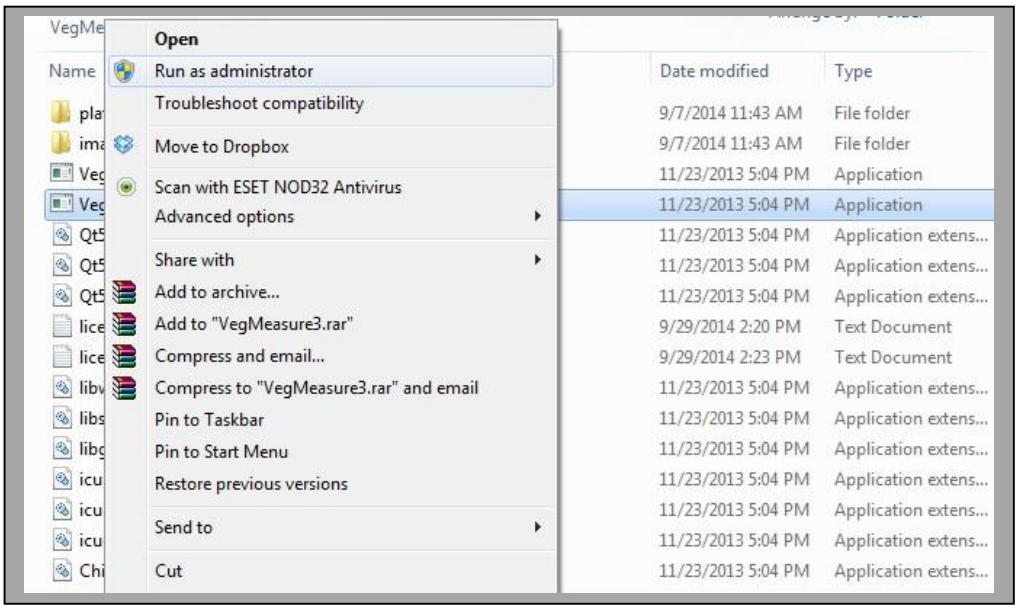
A license file will be returned to you by email. This license file must be copied to the same directory (VegMeasure2) that contains the program (vegmeasure2.exe) and the licenseprep file. After the license is placed in this folder, the program will run.

You should also create a short cut or pin the application to your taskbar or start menu. This is done by right clicking on the vegmeasure.exe file and selecting where you want the shortcut or pin.

You can then click **VegMeasure2.exe** to open the program.



If you have problems running the VegMeasure2.exe file right click and select "Run as an Administrator"

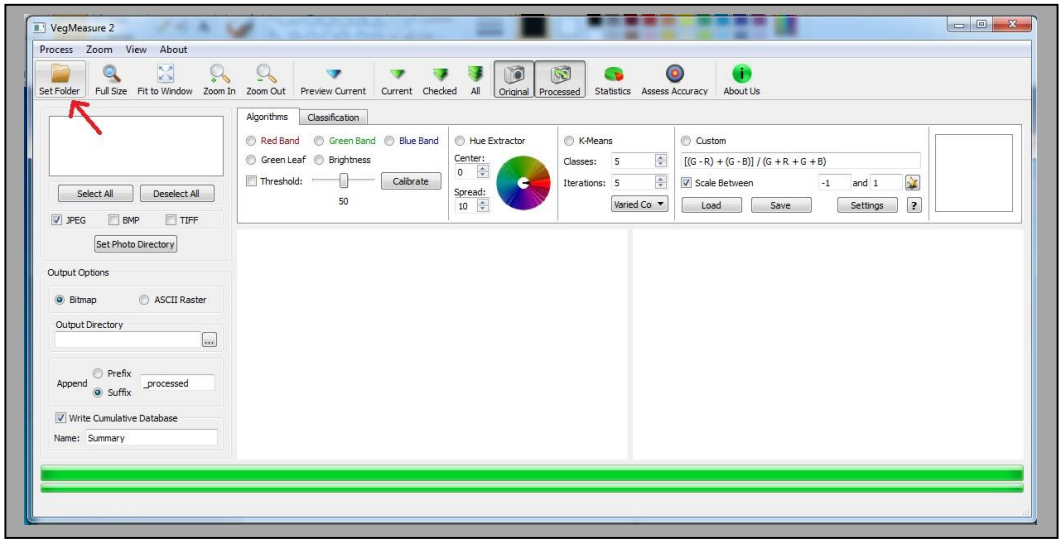


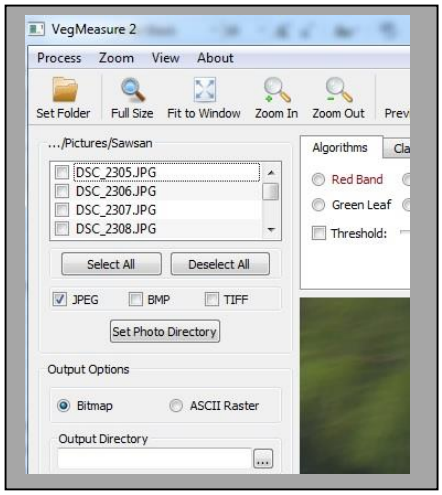
Software Overview

Here you will learn how to specify input photos, preview images, process images, basic program statistics, and output specifications. This is important to understand before performing some more advances processing functions.

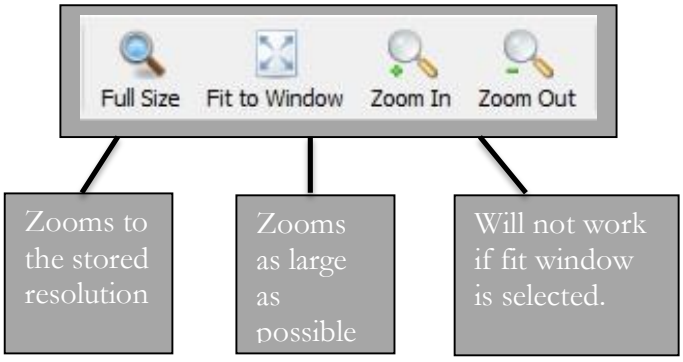
After clicking on VegMeasure2.txt the program will open and you can specify the input photos. Ideally you have already using the image positioning tool in chapter 1 before performing this step to assure that your image files have gps data associated with them.

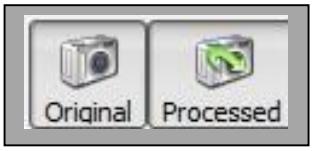
Click the "Select Folder" button to specify the directory which contains your photos that need processing. Select the folder and click "OK."





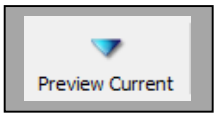
Select the checkboxes to specify the images that you would like to process. When you lick and image, a preview should appear.



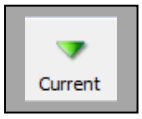


You can switch between the original and the processed image). Just click on one or the other to switch back and forth.

You will learn how to process later in the next chapters



After selecting an algorithm – select this button if **no output file** is desired.



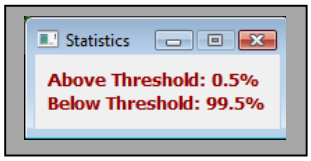
After selecting an algorithm – select this button if an **output file is desired**.

Will automatically process all checked images.

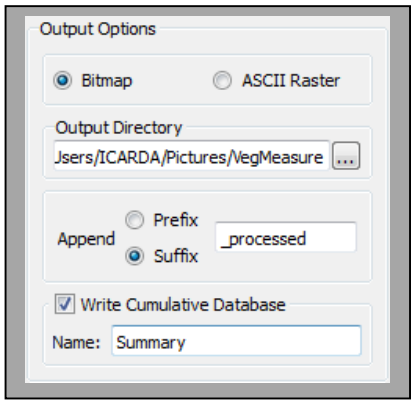
Will process all photos listed, whether they are checked or not.

Will give you the percentage of pixels classified above and below the threshold.

This is also stored in the .inf file for the image.



Red- stats apply to the small preview
Green- stats apply to the full preview (exact)
Blue- stats apply to the most recently saved processed image



In the lower left you can specify the output options. Processed images will carry that of the input image.

Bitmap- is identical to what the preview shows.
ASCII- raster map.

Append- adds a prefix or suffix on to original name for the processed images.
inf.- stats are written in this output file. They have the same name as the input file.
Write Cumulative Database- selecting this will create a database with cumulative statistics for all photos.

Image Processing

This chapter will teach you the theories and concepts behind image classifications.

In this chapter you will learn about various algorithms and image processing techniques. The concepts explained in this chapter are important to understand before conducting an image classification. This chapter will cover color bands in imagery, how to calculate green leaf cover, brightness, using a threshold, calibrating a threshold, and hue extraction.

Red, Green, and Blue Band

Each pixel in the original image has color information stored in the RGB format. There is a red, green, and blue index, and each runs from 0 to 255. Thus, (0, 0, 0) represents black, (255,0,0) represents pure red, etc. Selecting the "Red Band" algorithm will replace the original RGB color (r, g, b) at each pixel with its filtered red value (r, 0, 0). The raster output will contain with red value r at each pixel. Green and blue bands follow similarly.

Green Leaf

The green leaf algorithm selects pixels that correspond to green living vegetation from conventional color photography. It uses a formula that ratios the digital numbers for each of the three color channels (Louhaichi et al. 2001). The digital numbers are made into a ratio using the following formula:

$$\frac{(G-R)+(G-B)}{G+R+G+B}$$

where:

G = digital number of the green channel (0 to 255)

R = digital number of the red channel (0 to 255)

B = digital number of the blue channel (0 to255)

Brightness

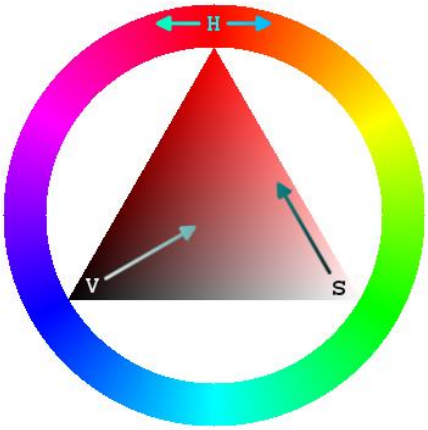
The brightness of a pixel with RGB values (r, g, b) is determined by the formula

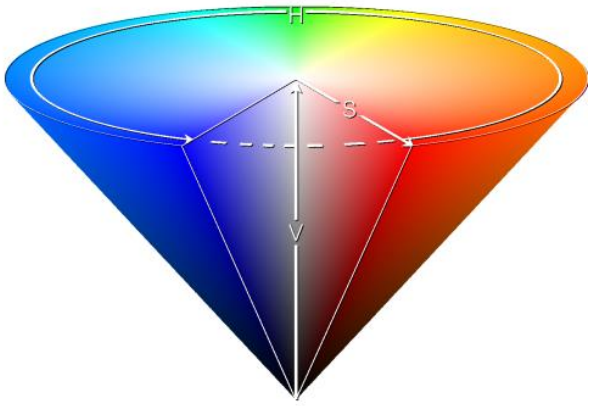
$$brightness = 0.299\,r + 0.587\,g + 0.144\,b$$

The values range from 0 to 255.

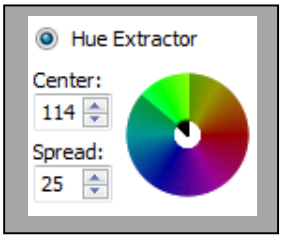
Hue Extraction

In addition to the RGB color classification, colors may be described in the HSV (Hue-Saturation-Value) system. The following images illustrate the various components:





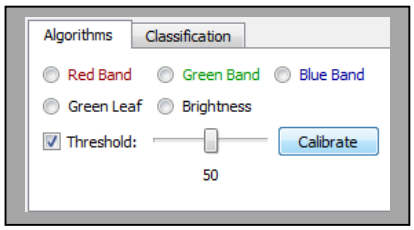
The Hue extraction allows you to filter for colors whose hue lies in a particular color range. Hue values lie on a circle and range from 0-359. Thus, a hue of 0 is the same as a hue of 360. To use the algorithm, simply specify the hue range to classify based on a center value and a spread. The preview wheel shows the specified region as a lighter color.



Using a Threshold

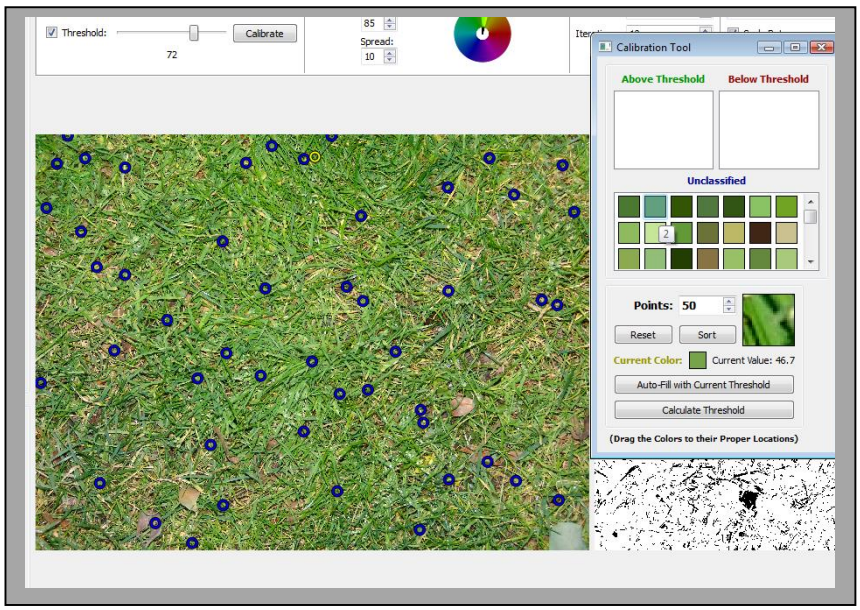
A threshold can be helpful in determining how much of an image belongs to one of two classes. For example, how much of the image is bare ground and how much is plant matter. Setting a threshold will segment the data into two classes: above or below the threshold. The threshold value can range from 0 to 100. However if you remember the red, blue, and green bands in images range from 0 to 255, so values have to be scaled to the 0 to 100 range. After values are scaled, a threshold of 50 applied to the red band will classify each pixel as 0 or 1 depending on whether or not its red value is below or above 50.

Thresholds can be set on many attributes; the red band, the green band, the blue band, green lean, and brightness.



Calibrating a Threshold

To calibrate a threshold after selecting the desired attribute and value click "calibrate." Once this is selected a new window will appear.



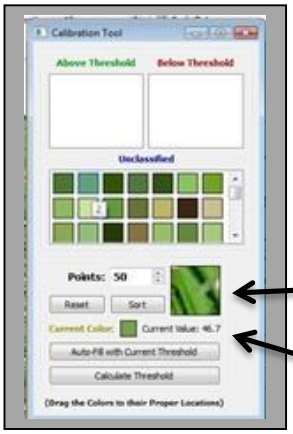
In the above example the number of points is 50, however this can be changed, it does not have to be the same as the threshold. This can be seen the box titled "**Points.**" The circles on the image indicate the location of the points. If **Reset** is selected it will generate a new set of points. The colors of the points have different meanings:

Blue- Unclassified

Green- Above the threshold

Red- Below the threshold

Yellow- It is currently selected.



The calibration tool zooms into a close up and displays the value of the yellow point that is currently selected.

Close up of the yellow selected point.

Threshold value of the current point

There are various options to organize colors and points. Colors may be reordered for easier viewing by either dragging the colors to the desired location or clicking "**Sort**" to arrange them in order of their current threshold value.

Points will be assigned to the **"Above Threshold**" and "**Bellow Threshold**" box after clicking "**Auto-Fill with Current Threshold.**"

When sorting is complete click "**Calculate Threshold.**" The program will determine the best threshold to fit your criteria.

Chapter

5

Image Classification

This chapter will cover the different classification techniques that are appropriate for different scenarios.

Image classification is important is an important process to help identify trends that inform monitoring and the effect of climate and management techniques. That being said there are different types of classifications depending on what the data will be used for or what trend is being observed. This chapter will cover various classification techniques. Some of these techniques are supervised, where the researcher guides the classification process or unsupervised where the computer groups like values without data input from the researcher or user. Each has its advantages and disadvantages. Thus it is important to understand the different classification techniques so that the appropriate method is selected for the scenario at hand.

Unsupervised Classification

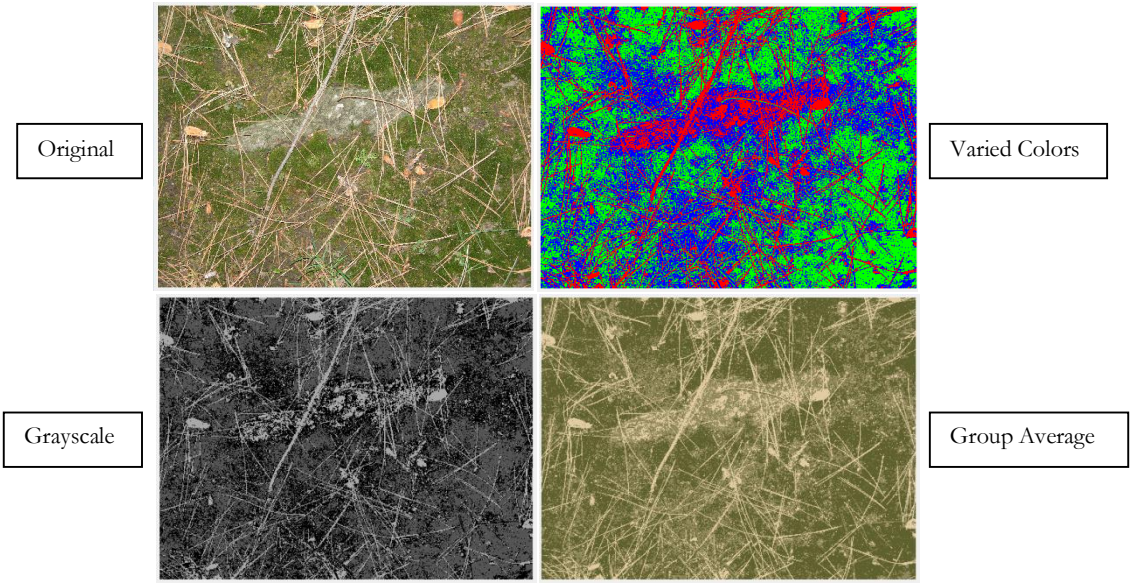
This is a common classification technique to use when little is known about and area and for preliminary analysis. The computer can observe frequencies and trends that may be missed by supervised classification. However this type of classification does allow for as much manipulation as classified techniques making cross comparison sometimes difficult between multiple images.

K-Means Classification

The K-Means Algorithm will automatically find groups of similar colors. The process is iterative, and convergence may take many steps. The program will run until a specified number of steps completes or convergence is reached, whichever comes first. The program will also indicate whether or not convergence was reached. You must specify the number of color classes to identify, and the maximum number of iterations.

There are several options for the output image coloring scheme. **Varied colors** will assign colors to each group which are as different as possible to emphasize grouping. **Monochrome** generates a grayscale image where the classes are evenly spaced between white and black. **Group Average** will give each group the average

color in it, and is a good characterization of the quality of classification. If a raster map is chosen for the output, then cell values will simply be the group number.



Supervised Classification

Supervised classification allows for more customization in the images. This techniques makes allows for more customization for ranges, values, and categories allowing for cross comparison of values over time. This technique is helpful when the observer is looking to observe a specific value or trend. This can be done using set formulas that are stored in the software or by creating your own formula.

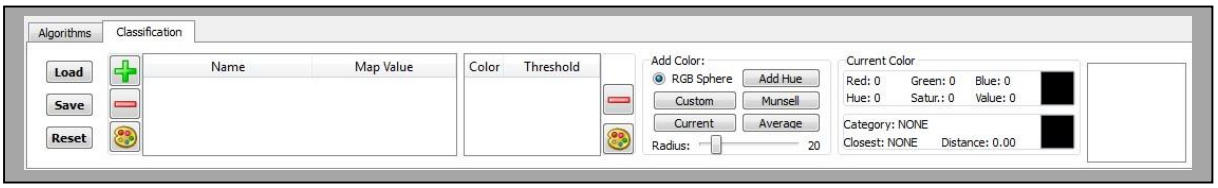
Basics

The next step is to add colors to each category with respective thresholds. The threshold represents the maximum distance in RGB color space for a point to be classified in the category. For example, suppose you add a color with RGB values (100,150,50) to the category with threshold 20. Then any point with RGB values (r, g, b) will be classified as part of the category if the following is satisfied:

$$\sqrt{(r-100)^2+(g-150)^2+(b-50)^2} \leq 20$$

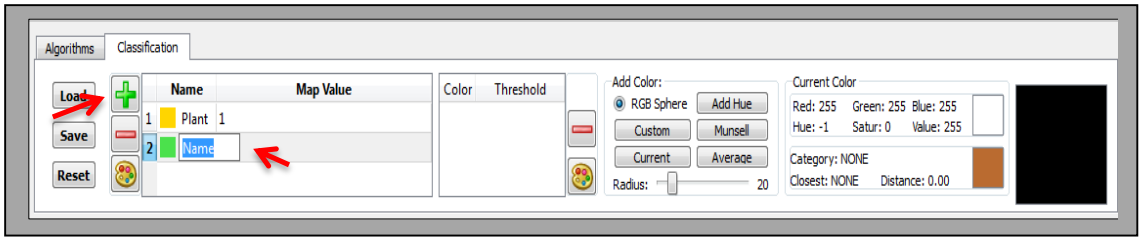
There are several ways to add colors to a category. The most basic is by clicking the **Custom** button. A dialog will appear prompting for a color which will then be added to the current category. You may add many colors to each category and a point will be classified as part of that category if it falls within the threshold of any of them.

Step 1: Click the "Classification" tab

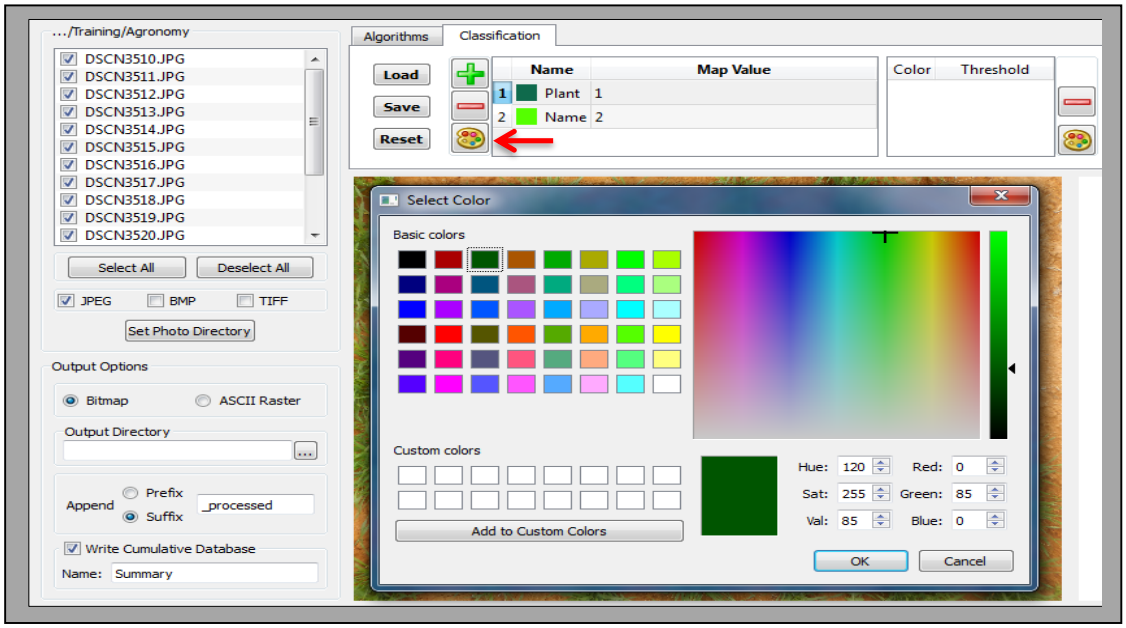


Step 2: Adding Categories

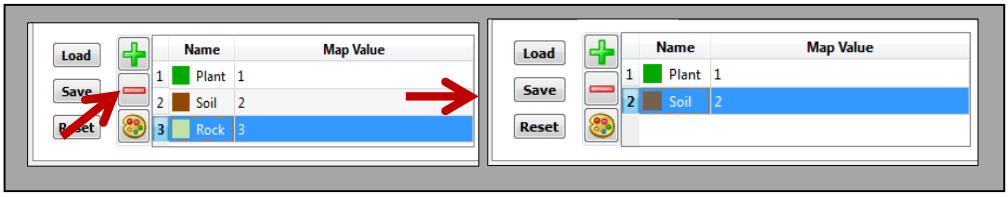
The next step is to add the categories into which your image will be classified. To add a category, click the green plus (+). A new category will be added to the list and you can modify the name and category value by double clicking the item.



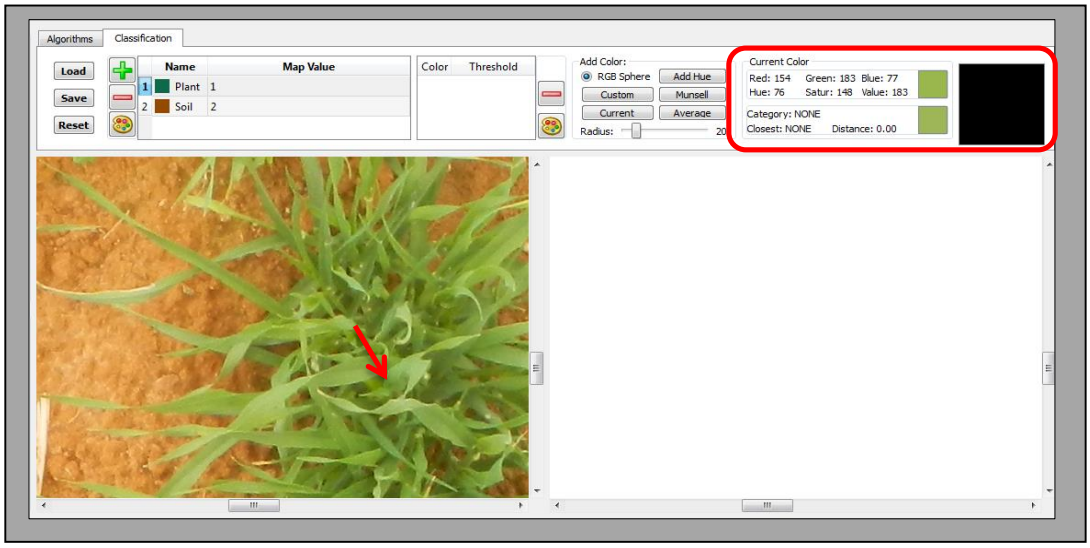
You can also change the category color by selecting the pertinent category and then clicking the palette button (). Choose the color you want, click ***OK***.



To remove a category, select the category, then click the red minus button(). The selected category will be removed from the list.

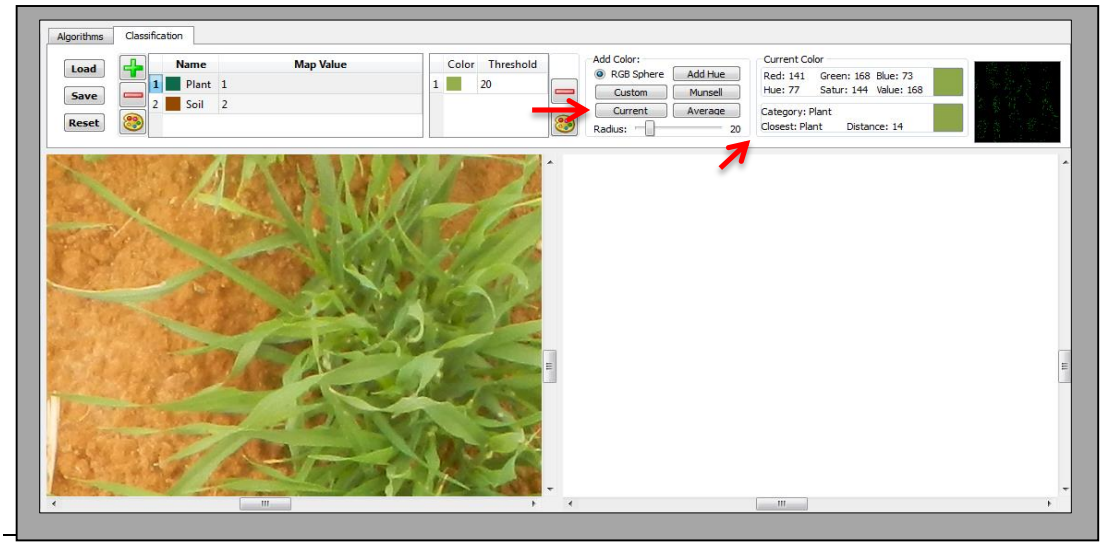


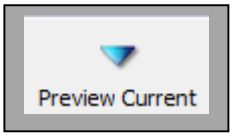
Step 3: Adding Colors to Categories (Getting Colors from the Image)
After selecting a category, while moving a mouse across the screen the values and the color of interest will be displayed on the right hand side.



To add any color category of interest select the "**Current**" button and the color will be added.

All pixels having similar RGB values will be classified as part of this category and get the same color.

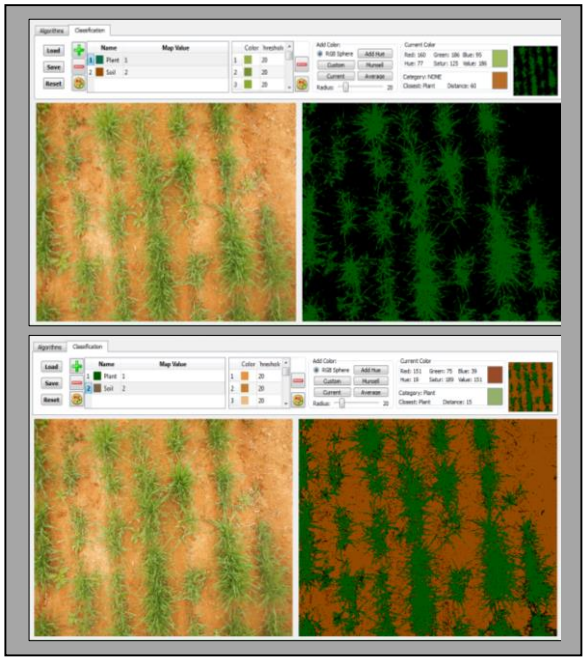




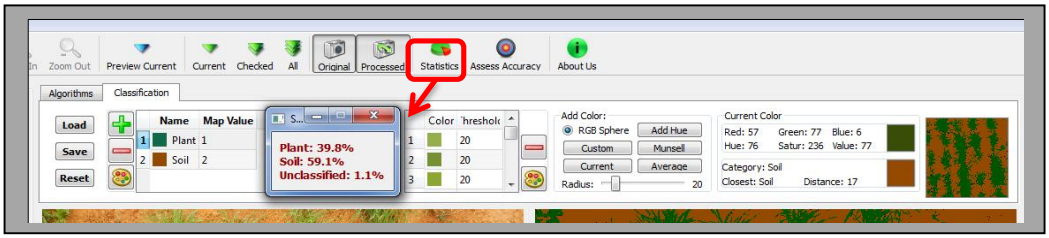
To preview the classification click on the "**Preview Current**" button. You can click this button at any time to update the display regarding the latest classification output.

Black -refers to unclassified areas.

If you would like to include another color click on the color and then click "**Current**."



In the first image there was more unclassified area, in **black**. After soil was added as a class the majority of the areas are covered and informative statistics can be generated. **The value of unclassified cells should not exceed 5%.**

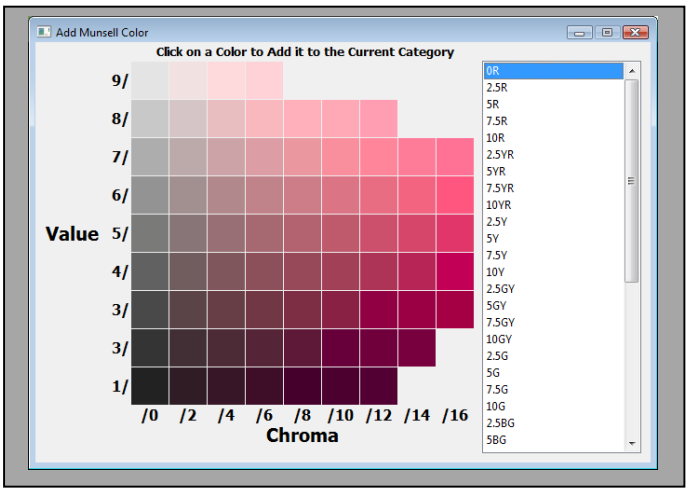


Click on the "**Statistics**" button to see what percentage falls in each class and remains unclassified. If you add more categories you can bring the unclassified rate down even lower.

Adding Munsell Color

Click this button to add a Munsell Color value.

The following box will appear.

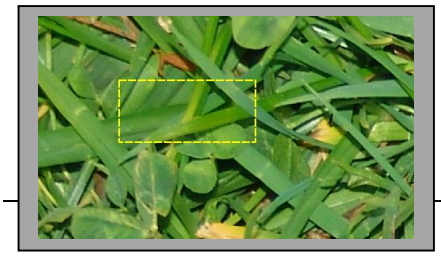


Clicking one of the colored boxes will add that color to the current category with whatever the current threshold is set to.

Determining the Average Color of a Region

It may be helpful to determine the average color of a region to help guide your classification.

Left click and drag a box around the desired region- the color preview will display the average as you drag.

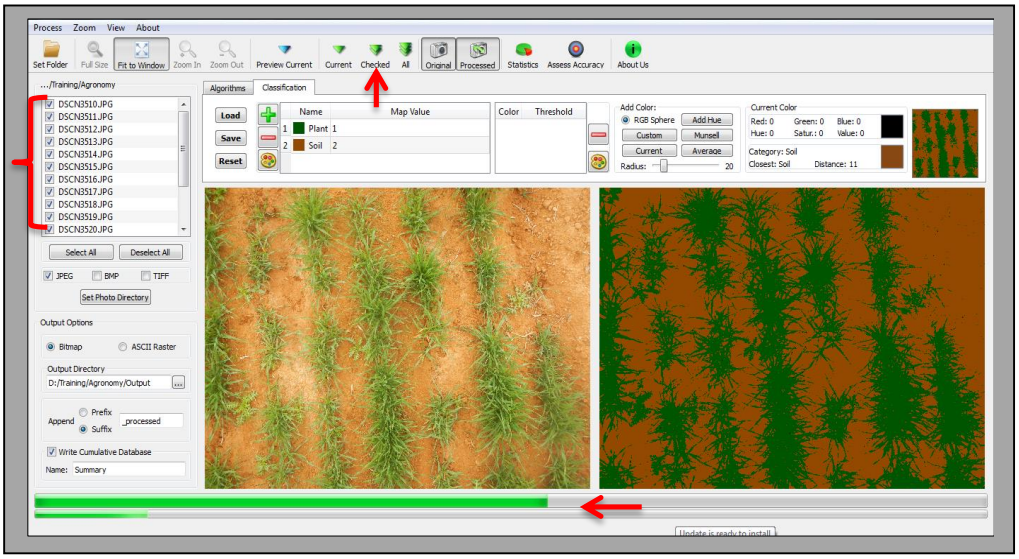


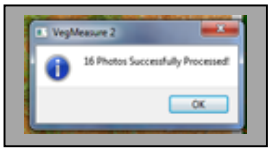
The average color can be added clicking the "**Current**" button.

Step 4: Run the program for multiple selected images
By now you may want to apply your classifications to many images.

To do this **check the images** you want to process on the left hand side and click on the "**Checked**" button.

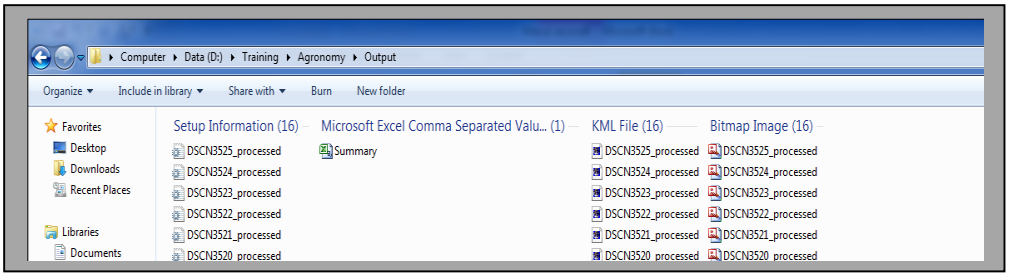
The progress of the images processing at the bottom of the screen.





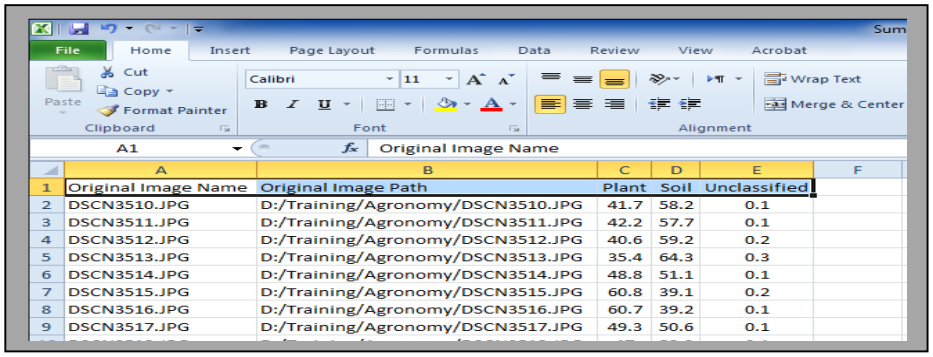
Once the process is complete a dialogue box will appear that will tell you how many images are processed. Click "**OK**" to continue.

While images are processing output files (.bmp,.kml,.inf) will be generated in the file you have specified prior. At the end of the processing, a new summary file (.csv) will also be created in the output folder.



Files will have the original image name with the appended prefix and with the original image path

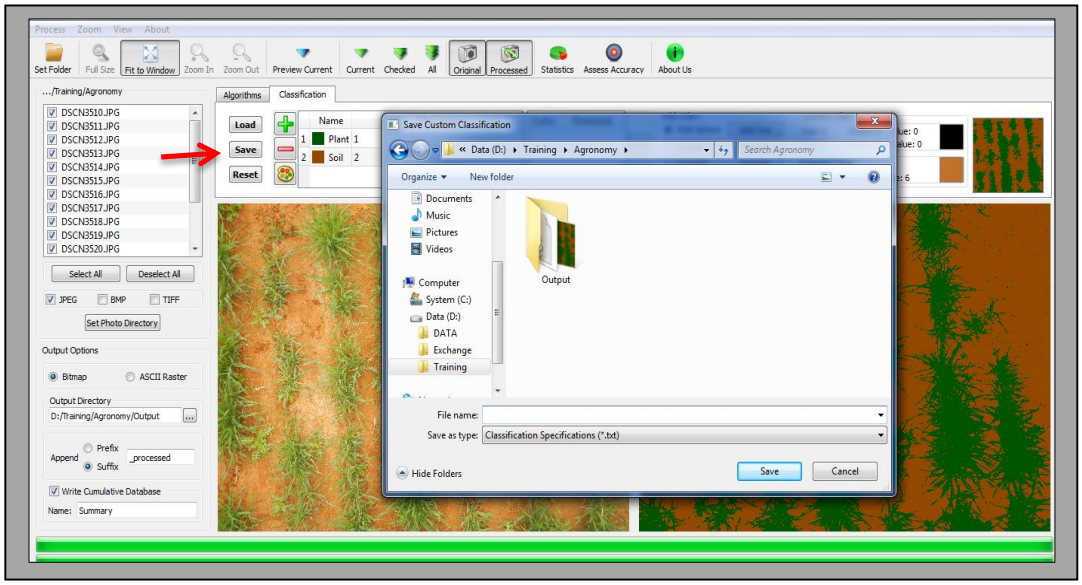
In the summary file values of the classification for each category are listed including unclassified pixels.



	A	B	C	D	E
1	Original Image Name	Original Image Path	Plant	Soil	Unclassified
2	DSCN3510.JPG	D:/Training/Agronomy/DSCN3510.JPG	41.7	58.2	0.1
3	DSCN3511.JPG	D:/Training/Agronomy/DSCN3511.JPG	42.2	57.7	0.1
4	DSCN3512.JPG	D:/Training/Agronomy/DSCN3512.JPG	40.6	59.2	0.2
5	DSCN3513.JPG	D:/Training/Agronomy/DSCN3513.JPG	35.4	64.3	0.3
6	DSCN3514.JPG	D:/Training/Agronomy/DSCN3514.JPG	48.8	51.1	0.1
7	DSCN3515.JPG	D:/Training/Agronomy/DSCN3515.JPG	60.8	39.1	0.2
8	DSCN3516.JPG	D:/Training/Agronomy/DSCN3516.JPG	60.7	39.2	0.1
9	DSCN3517.JPG	D:/Training/Agronomy/DSCN3517.JPG	49.3	50.6	0.1

Step 5: Save settings (Creation of a Parameters file)

Click on the "**Save**" button, name the file, choose the directory then click save. This creates a "Parameters file" that tells the computer which colors on which each of the classifications are based. **You must Save the Settings and create a Parameters file if you want to evaluate the accuracy of your classification with the Accuracy Assessment Tool.**

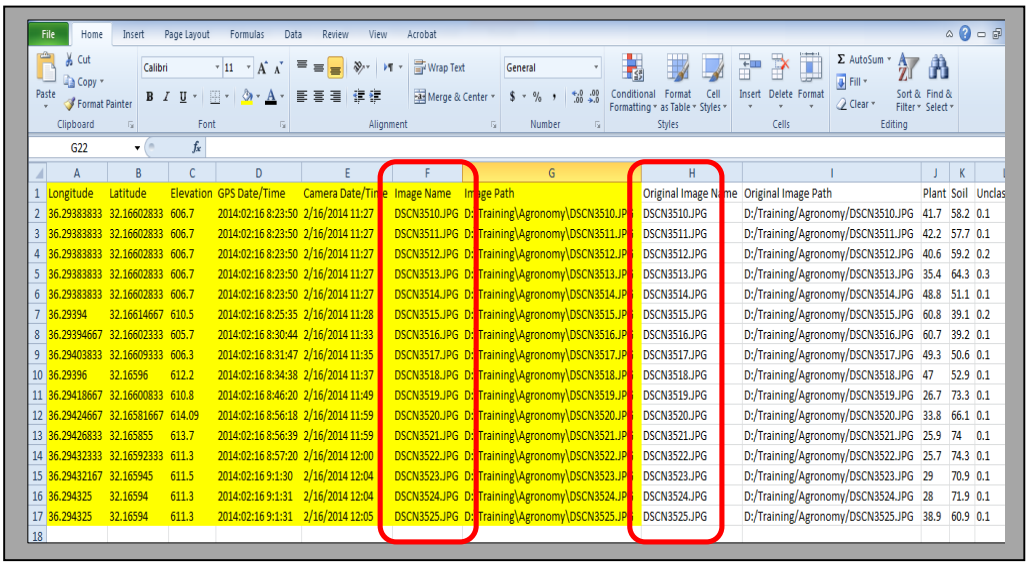


This button allows you to load saved classifications when needed.

Step 6: Add the GPS data

The GPS data still needs to be included in the summary file. This step is important so that data values can be interpolated to make larger scale maps. As well this data can be used in other analytical software for used for publishing.

The images have the same order of the GPS data that was created by using the VegMeasure Positioning Tool program. Thus you should be able to copy the data created in the VegMeasure Positioning Tool program and paste it in the summary file created here.

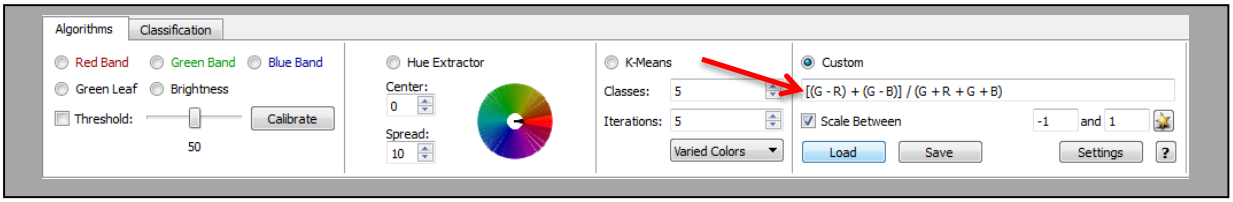


	A	B	C	D	E	F	G	H	I	J	K	L
1	Longitude	Latitude	Elevation	GPS Date/Time	Camera Date/Time	Image Name	Image Path	Original Image Name	Original Image Path	Plant	Soil	Unclas
2	36.29383833	32.16602833	606.7	2014:02:16 8:23:50	2/16/2014 11:27	DSCN3510.JPG	D:\Training\Agronomy\DSCN3510.JPG	DSCN3510.JPG	D:/Training/Agronomy/DSCN3510.JPG	41.7	58.2	0.1
3	36.29383833	32.16602833	606.7	2014:02:16 8:23:50	2/16/2014 11:27	DSCN3511.JPG	D:\Training\Agronomy\DSCN3511.JPG	DSCN3511.JPG	D:/Training/Agronomy/DSCN3511.JPG	42.2	57.7	0.1
4	36.29383833	32.16602833	606.7	2014:02:16 8:23:50	2/16/2014 11:27	DSCN3512.JPG	D:\Training\Agronomy\DSCN3512.JPG	DSCN3512.JPG	D:/Training/Agronomy/DSCN3512.JPG	40.6	59.2	0.2
5	36.29383833	32.16602833	606.7	2014:02:16 8:23:50	2/16/2014 11:27	DSCN3513.JPG	D:\Training\Agronomy\DSCN3513.JPG	DSCN3513.JPG	D:/Training/Agronomy/DSCN3513.JPG	35.4	64.3	0.3
6	36.29383833	32.16602833	606.7	2014:02:16 8:23:50	2/16/2014 11:27	DSCN3514.JPG	D:\Training\Agronomy\DSCN3514.JPG	DSCN3514.JPG	D:/Training/Agronomy/DSCN3514.JPG	48.8	51.1	0.1
7	36.29394	32.16614667	610.5	2014:02:16 8:25:35	2/16/2014 11:28	DSCN3515.JPG	D:\Training\Agronomy\DSCN3515.JPG	DSCN3515.JPG	D:/Training/Agronomy/DSCN3515.JPG	60.8	39.1	0.2
8	36.29394667	32.16602333	605.7	2014:02:16 8:30:44	2/16/2014 11:33	DSCN3516.JPG	D:\Training\Agronomy\DSCN3516.JPG	DSCN3516.JPG	D:/Training/Agronomy/DSCN3516.JPG	60.7	39.2	0.1
9	36.29403833	32.16609333	606.3	2014:02:16 8:31:47	2/16/2014 11:35	DSCN3517.JPG	D:\Training\Agronomy\DSCN3517.JPG	DSCN3517.JPG	D:/Training/Agronomy/DSCN3517.JPG	49.3	50.6	0.1
10	36.29396	32.16596	612.2	2014:02:16 8:34:38	2/16/2014 11:37	DSCN3518.JPG	D:\Training\Agronomy\DSCN3518.JPG	DSCN3518.JPG	D:/Training/Agronomy/DSCN3518.JPG	47	52.9	0.1
11	36.29418667	32.16600833	610.8	2014:02:16 8:46:20	2/16/2014 11:49	DSCN3519.JPG	D:\Training\Agronomy\DSCN3519.JPG	DSCN3519.JPG	D:/Training/Agronomy/DSCN3519.JPG	26.7	73.3	0.1
12	36.29424667	32.16581667	614.09	2014:02:16 8:56:18	2/16/2014 11:59	DSCN3520.JPG	D:\Training\Agronomy\DSCN3520.JPG	DSCN3520.JPG	D:/Training/Agronomy/DSCN3520.JPG	33.8	66.1	0.1
13	36.29426833	32.165855	613.7	2014:02:16 8:56:39	2/16/2014 11:59	DSCN3521.JPG	D:\Training\Agronomy\DSCN3521.JPG	DSCN3521.JPG	D:/Training/Agronomy/DSCN3521.JPG	25.9	74	0.1
14	36.29432333	32.16592333	611.3	2014:02:16 8:57:20	2/16/2014 12:00	DSCN3522.JPG	D:\Training\Agronomy\DSCN3522.JPG	DSCN3522.JPG	D:/Training/Agronomy/DSCN3522.JPG	25.7	74.3	0.1
15	36.29432167	32.165945	611.5	2014:02:16 9:1:30	2/16/2014 12:04	DSCN3523.JPG	D:\Training\Agronomy\DSCN3523.JPG	DSCN3523.JPG	D:/Training/Agronomy/DSCN3523.JPG	29	70.9	0.1
16	36.294325	32.16594	611.3	2014:02:16 9:1:31	2/16/2014 12:04	DSCN3524.JPG	D:\Training\Agronomy\DSCN3524.JPG	DSCN3524.JPG	D:/Training/Agronomy/DSCN3524.JPG	28	71.9	0.1
17	36.294325	32.16594	611.3	2014:02:16 9:1:31	2/16/2014 12:05	DSCN3525.JPG	D:\Training\Agronomy\DSCN3525.JPG	DSCN3525.JPG	D:/Training/Agronomy/DSCN3525.JPG	38.9	60.9	0.1

It is important to make sure the image names for each set of data matches.

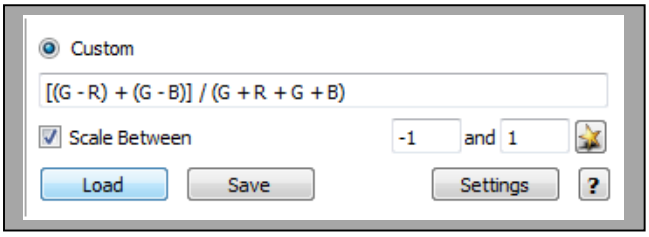
Create a Custom Formula

To allow for maximum flexibility the user can specify a custom formula. Simply type any formula in the equation box. It can be anything involving the usual symbols ()[]{}+-*/^%. In addition, you can use the variables R, G, B, H, S, V which represent the red band, green band, blue band, hue, saturation, and value of the current color. Each cell in the original image will be processed with the specified formula.

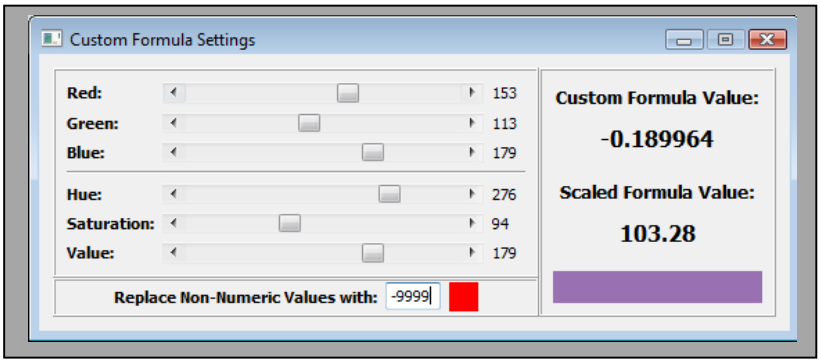


The scale bounds determine the range of output values so that the output image may be properly colored (after proper scaling, output values range from 0-255). To

automatically calculate these bounds, press the button with a star next to the scale bounds () and the program will calculate the minima and maxima of your formula. To see these values click the **Settings** button.



To see specific examples of your formula and ensure that it is correctly interpreted, **click the Settings button**. A window will appear which allows you to specify RGB or HSV values (both will adjust when either is specified). You can then see the value calculated using your formula, and the scaled value. This window also allows you to determine how the program handles non-numeric values, such as division by zero.



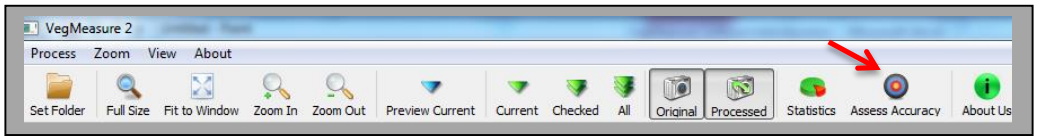
As an example, the custom formula corresponding to the red band is just 'R' and must be scaled from 0 to 255. The custom formula corresponding to the Green Leaf algorithm is: [(G - R) + (G - B)] / (G + R + G + B), and must be scaled from -1 to 1. This can be seen in the first image of this section.

Custom formulas may be saved and loaded for future use.

Accuracy Assessment

This chapter will show you how to use the assess accuracy of a classification in VegMeasure.

A classification is incomplete without an accuracy assessment. With the Assess Accuracy tool in VegMeasure you can compute an error matrix and a Kappa Index of Agreement for processed pictures.



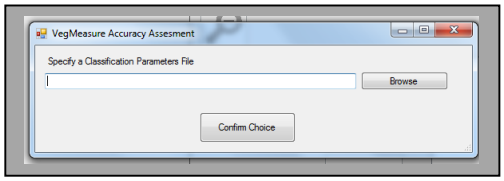
Click the "**Assess Accuracy**" button at the top of the program to open the accuracy assessment tool. Wait for another window to open.

Select the folder containing the processed pictures.

Type in the number of images

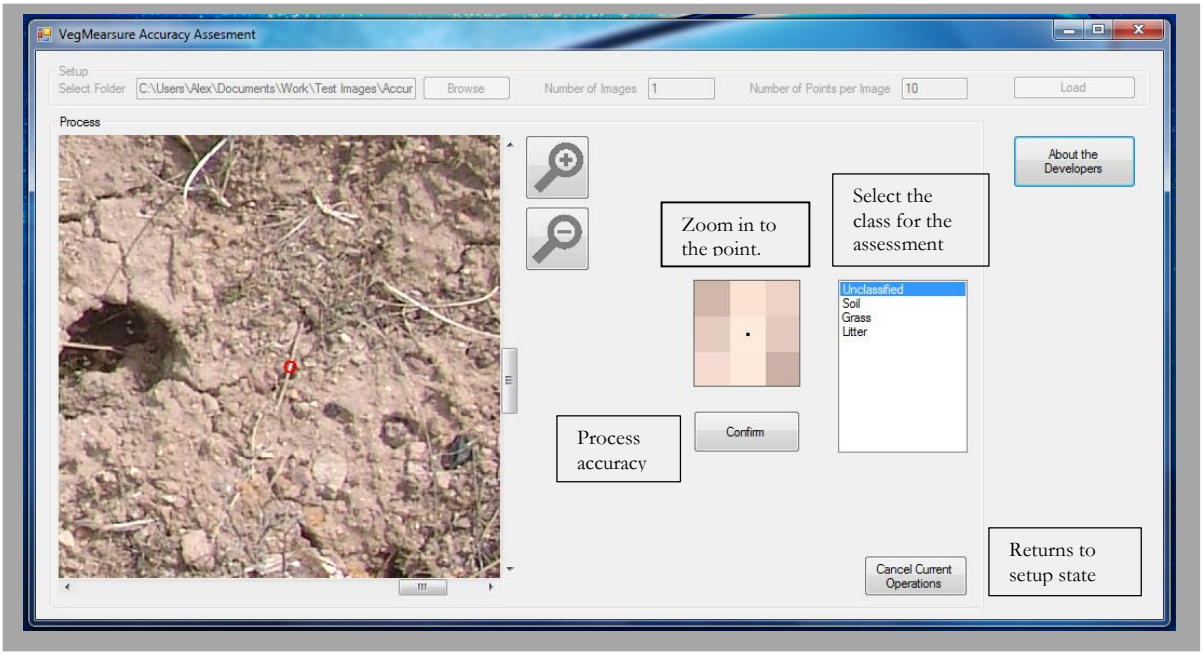
Type in the number of random points that will be reviewed for each image.

Then press the "**Load**" button.



Find the "**parameters"** file that was created in same folder where the images are located with the exl extension. This is the file you saved with the classification.

When the setup is complete and the first picture is loaded the window will look like the screen shot bellow.



The images will be chosen randomly based on the number of images specified prior. The number of points specified will appear. The active point is a **red** circle and the other points are displayed in **yellow**.

All the points may not show immediately as the image may be large. Use the scroll bars and the zoom feature to navigate the image and preview all points.

Click the **"Confirm**" button to process the accuracy file. A .csv file will be generated with the accuracy results. This will be located in the same directory as the images being analyzed. An example of an error matrix with accuracy assessments is given below:

Ground Truth

Machine Classified	Bare Ground	Annual Forb	Perennial Forb	Annual Grass	Perennial Grass	Shrub	Row Total
Bare Ground	44	9	0	0	0	0	53
Annual Forb	7	41	5	0	1	0	54
Perennial Forb	0	6	50	8	13	0	77
Annual Grass	0	0	4	42	9	3	58
Perennial Grass	1	5	9	9	38	1	63
Shrub	0	0	0	3	0	29	32
Column Total	**52**	**61**	**68**	**62**	**61**	**33**	337

Producer's Accuracy
BG = 44/52 = 85%
AF = 41/61 = 67%
PF = 50/68 = 74%
AG = 42/62 = 68%
PG = 38/61 = 62%
S = 29/33 = 88%

User's Accuracy
BG = 44/53 = 83%
AF = 41/54 = 76%
PF = 50/77 = 65%
AG = 42/58 = 72%
PG = 38/65 = 58%
S = 29/32 = 91%

Overall Accuracy
(44+41+50+42+38+29)/ 337
or 244/337 = 72%

In the above example the **path name** listed displays **the image** that is being used. Bellow this are multiple statistics regarding the image; Overall Accuracy, Producer's Index, Users Index, and Error Matrix.

Overall Accuracy- The overall accuracy is calculated by summing the number of pixels classified correctly and dividing by the total number of pixels

Producer's Index of Accuracy- The producer accuracy is a measure of the probability that the classification algorithm has assigned an image pixel into category X, bare ground in our example, given that the ground truth is category X.

Users Index of Accuracy - User accuracy is a measure indicating the probability that a pixel placed in category X is correct given that the machine classification has placed the pixel into Class X.

Error Matrix (Visual/Correction) - This section shows the error matrix with the machine classified classes along the vertical axis and the user selected classes along the horizontal access.

NaN% - indicates that there were not samples reviewed in this category. In this case, more samples should be used.