Value in the Near Infrared

Debunking the Myth of a False-NDVI

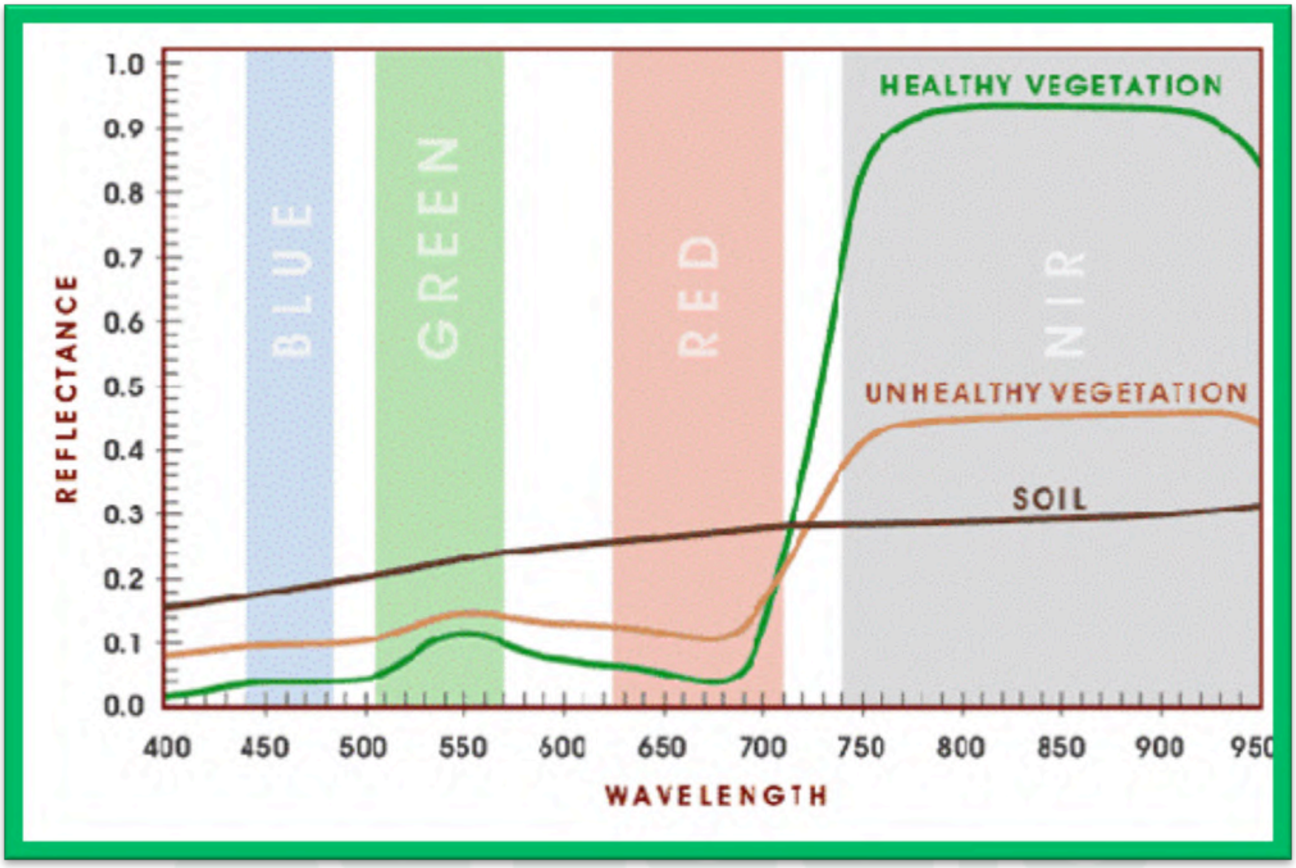


Figure 1 Variation between healthy and unhealthy vegetation is much smaller in the visible bands of light compared to the near infrared bands of light

If you have been interested in using Unmanned Aerial Systems for agriculture, you may have run into some acronyms that are being used. These usually include: RGB, NIR, NDVI, and False-NDVI. Here's a short breakdown of what each of those mean:

RGB: Red Green Blue (also known as visual or natural color). This is the spectrum of light that our eyes can see. When we take a picture with an RGB (visual) camera of a corn plant, it shows up green. See below for RGB image of a test plot.

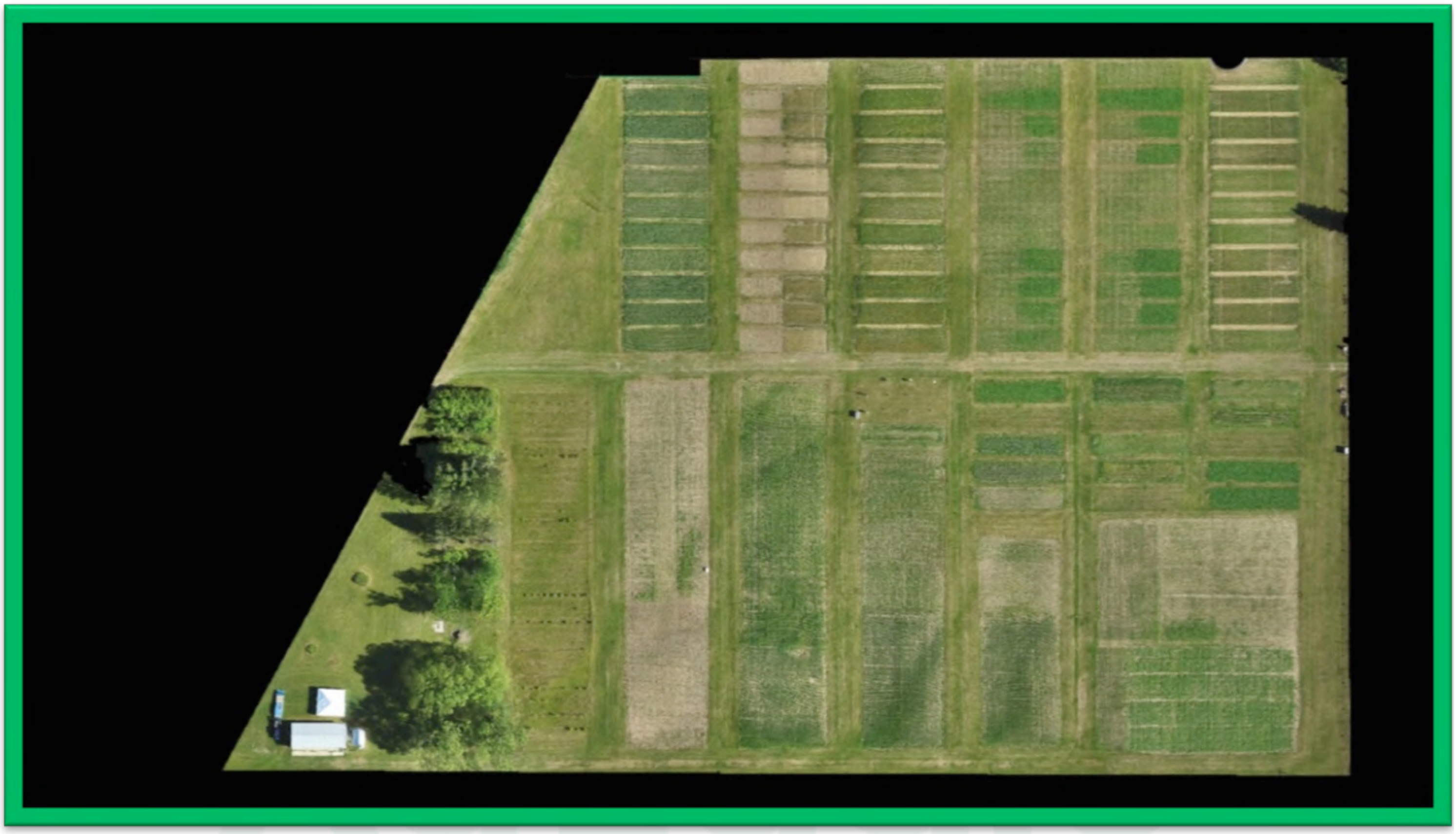


Figure 2 RGB processed image

CIR (NIR): Color Infrared (Near infrared). This normally includes two visible and one near infrared band. The NIR band is a wavelength that cannot be sensed by the human eyes. The reason why it's being used is because plants react to stresses in these bands much earlier and much more drastically than in the visible bands of light that we see. See below for NIR image of the same test plot, taken within the same morning.

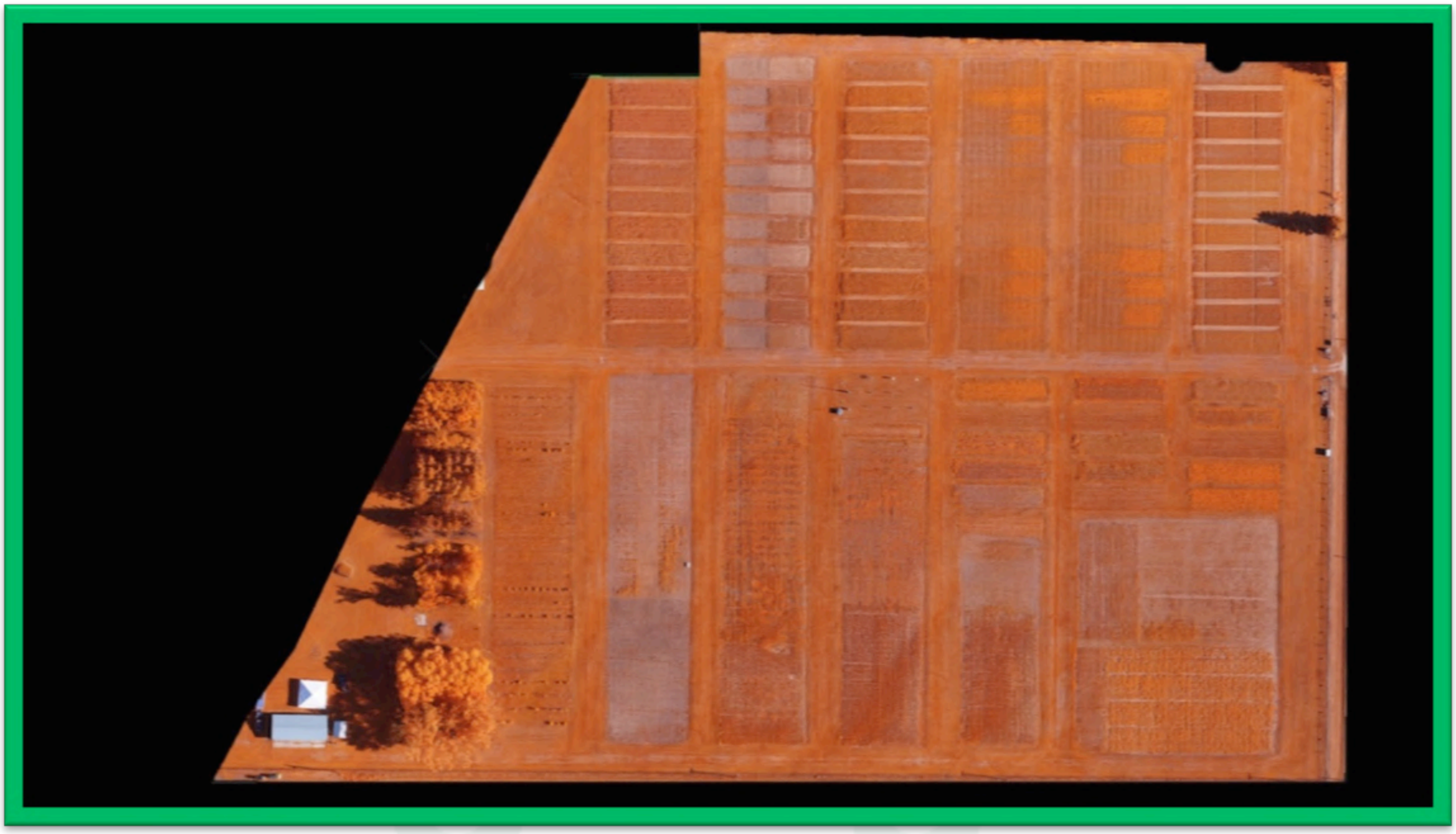


Figure 3 CIR processed image

NDVI: Normalized Difference Vegetation Index. This is a calculation that uses a visible band (normally the red) band of light that our eyes can perceive, as well as the NIR band of light that our eyes cannot perceive. The NDVI is sensitive to plant chlorophyll content and therefore factors that influence plant biomass and health are often detectable using NDVI. See below for NDVI map, created from the CIR (NIR) image of the test plot where red areas have lower NDVI (biomass) and green areas have higher NDVI values or biomass.

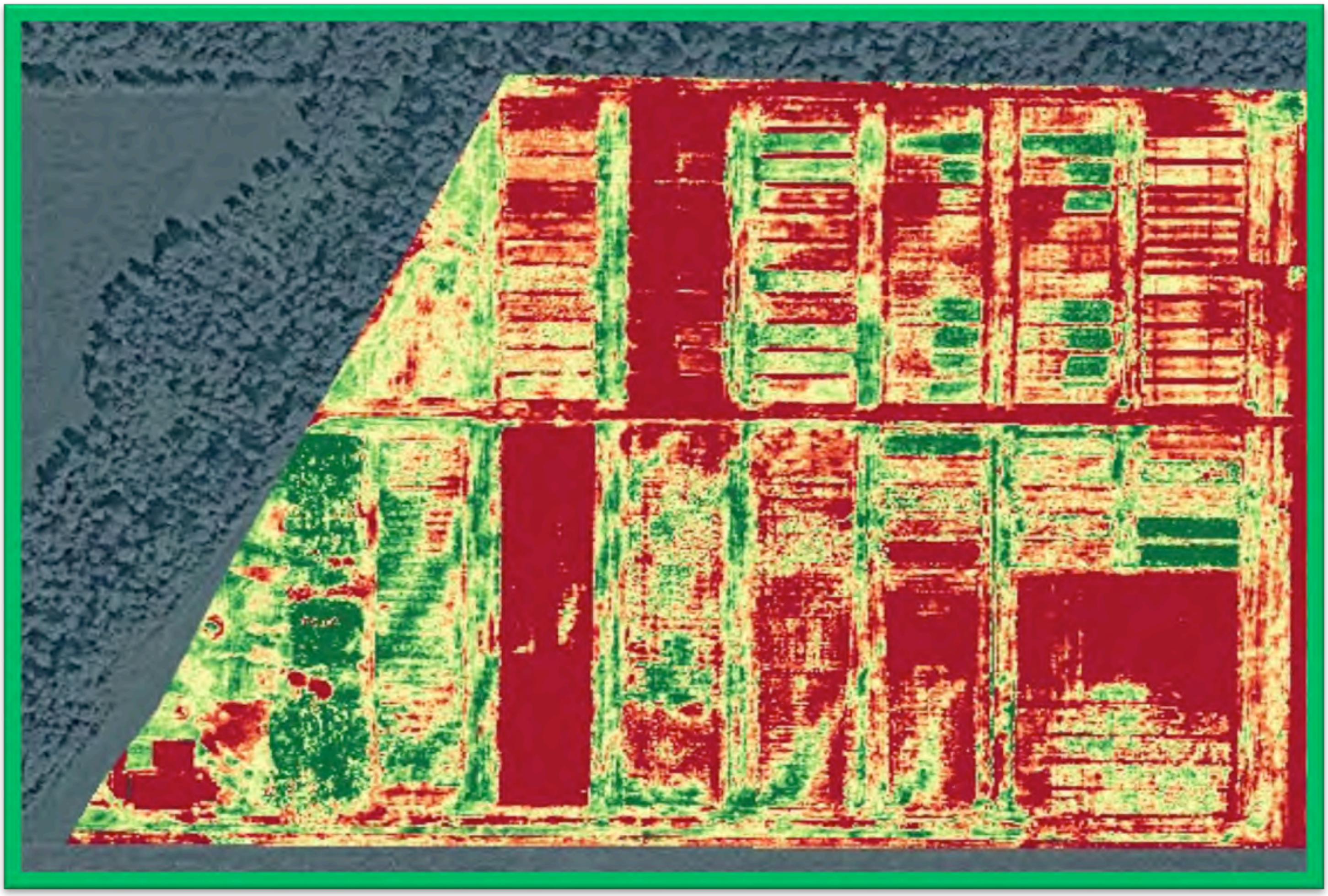


Figure 4 NDVI processed image

False-NDVI: this is a new concept of using a visual camera to calculate an NDVI map. The reason why it's called a False-NDVI is because the camera used doesn't collect the NIR band of light in the first place. Since NDVI requires NIR light, they created a new calculation that shows plant stress without the use of NIR. See below for a False-NDVI map, created from the RGB image of the test plot. This index is normally computed using the blue and green or the green and red bands, that have a smaller dynamic range than the differences between the visible and NIR bands used to compute true NDVI values. This means that the false-NDVI will normally be less sensitive to variations in plant biomass and/or stress.

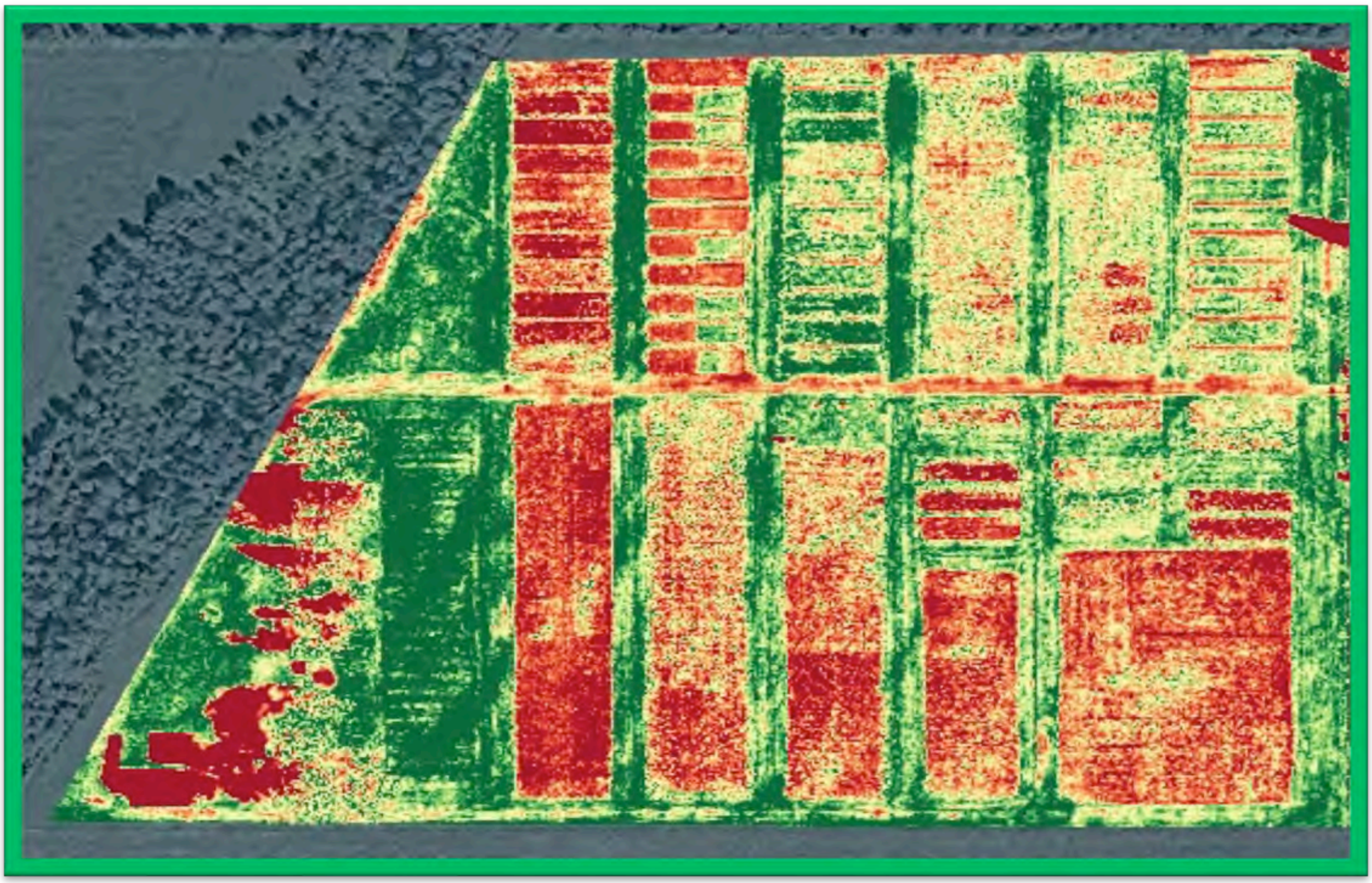
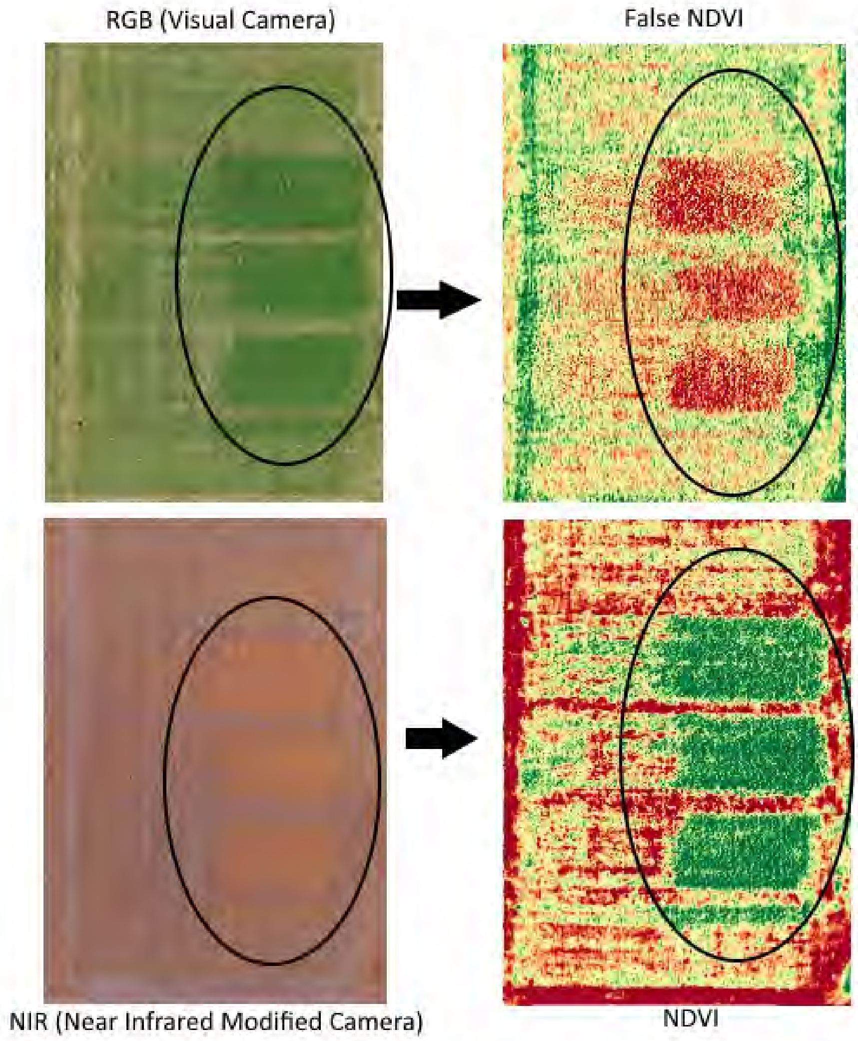


Figure 5 False-NDVI processed image

Does False-NDVI accurately show plant health?

So do you understand why a False-NDVI image isn't very useful to the farmer? To summarize this issue, let's look closer at the images above, all taken by Markus Weber. He flew a standard camera with a quadcopter over this test plot, and flew an AgEagle fixed wing UAS with an NIR sensor within minutes of each other. Take a look at what we found:



Each image has the healthiest portion of the field circled. Both the RGB and the NIR images show the healthy protions correctly. The RGB may be more helpful than the NIR image because it makes more sense to us. Our eyes see the visual spectrum but not in the NIR. Even though you cannot see it, the NIR image is showing more detail to stress than the RGB image. That is because crops stress in the NIR before they stress in the visual spectrum.

We convert the NIR image to "NDVI" so that our eyes can make more sense of it. You can only create a true NDVI image from an NIR sensor. That is why the image next to the RGB is labeled (false NDVI). This is because it isn't a true NDVI.

You can see the results of both the NDVI from the NIR sensor and the False NDVI from the RGB camera. The False NDVI doesn't just show stress later than the NDVI, it's actually completely wrong.

NDVI may have it's weaknesses, but it is still far superior than a False NDVI from an RGB camera. No matter what technology comes along, crops stress in the NIR before the visual bands of light, so using a true NDVI from a NIR sensor is better than a false NDVI with a RGB (visual camera).

Unhealthy vegetation actually has a higher reflective value than healthy vegetation. So your false-NDVI can often show up completely backwards and wrong. That's why ground-truthing images for correctness is the most important part of remote sensing!

So why does this happen? In the visible bands of light (RGB, what our eyes can see), most of the light is absorbed by the plant instead of being reflected. In the NIR bands of light, much more is reflected, so our NIR cameras can pick up on that reflectance.

Overall, we need to have both NIR and RGB. The value of needing NIR is because we need something to compare the RGB bands to. Being able to calculate the difference between NIR and visible light reflectance is key to providing good information of the overall health of the plant.

In conclusion, just because you can create an index like False-NDVI, doesn't mean you should. And I'm not the only person saying this. Take a look at some of the most respected individuals in the Remote Sensing for vegetation industry, as well as the most respected individuals in the Unmanned Aerial Systems for agriculture industry.

"The whole concept of false NDVI based on a standard (not converted) RGB camera sounds absolutely crazy to me"

– Gabriel Torres, Micasense

"The dynamic range, and the power to differentiate subtle differences between vegetation, are leagues apart. Large differences will be visible using false NDVI, but you might as well just use RGB images directly. The point of using NDVI is to add useful information that the naked eye is not able to detect easily"

– Dr. Deon Van Der Merwe, Kansas State University

"A low dynamic range and a map for the False NDVI that does not correspond well with your true NDVI map. I personally would not want to give up a true NDVI for the false NDVI."

– Dr. Kevin Price, Executive Vice President, Research and Product Development at AgPixel, Collaborator, Agronomy at Iowa State University

"I would confirm your reason for questioning the usefulness of the false NDVI for vegetation work, and would suggest that those who cannot afford a converted camera should maybe not be trying to compare their false NDVI to the true NDVI – they are very different products and should be presented that way."

– Dr. Kevin Price, Executive Vice President, Research and Product Development at AgPixel, Collaborator, Agronomy at Iowa State University

"Applying NDVI methods willy-nilly to any old image and expecting instant science is just plain lazy; and justification of your methods in the context of repeatable research would be an uphill climb. Frankly, if usurping visible spectrum for near infrared made sense, then they'd stop putting those fancy, expensive sensors on Landsat. The image is the image; and the old adage of "garbage in garbage out" certainly applies here. Know your land. Question your own methods. Check your work!"

– Beau Dealy, APIS Remote Sensing Systems

If you wish to read more about it, take a look at some research from NASA:

http://earthobservatory.nasa.gov/Features/MeasuringVegetation/measuring_vegetation_2.php