

How to Calculate Vegetation Indices Using ArcMap and Earth Explorer (Landsat 8)

Vegetation indices derived from readily available satellite imagery can be used to identify cropping practices such as tillage methods and use of cover crops. This document will go over how to calculate the Normalized Difference Vegetation Index (NDVI) which is positively correlated with green vegetation cover and Normalized Difference Tillage Index (NDTI) which is positively correlated with crop residue and green cover.

Additional information and literature on vegetation indices:

- Burke, David G and John Dawes. (2014). A Novice Experiment with Satellite-Based Classification of Agricultural Crops and BMPs. Burke Environmental Associates.
http://chesapeakeconservancy.org/images/Satellite_Report.pdf
- Namik Kemal Sonmez & Brian Slater (2016) Measuring Intensity of Tillage and Plant Residue Cover Using Remote Sensing, European Journal of Remote Sensing, 49:1, 121-135, DOI: 10.5721/EuJRS20164907
<https://doi.org/10.5721/EuJRS20164907>
- Zheng, Baujuan. (2012) Broad-scale Assessment of Crop Residue Management Using Multi-temporal Remote Sensing Imagery. Dissertation. Virginia Polytechnic Institute and State University.
<https://vtechworks.lib.vt.edu/handle/10919/19201>
- Hively, W.D., S. Duiker, G. McCarty, and K Prabhakara. (2015) Remote sensing to monitor cover crop adoption in southeastern Pennsylvania. Journal of Soil and Water Conservation 70(6):340-352, DOI:10.2489/jswc.70.6.340

Contents

Creating NDVI and NDTI Raster Layers.....	3
Validating NDVI & NDTI with Field Data.....	8
Calculating a minNDTI	10

Creating NDVI and NDTI Raster Layers

1. Download time series of satellite photos from Earth Explorer :
<http://earthexplorer.usgs.gov/>
 - You will first need to create an account if you do not already have one.
 - You can search by address/place or use map and zoom to area.
 - You can choose a date range and # of results option you want to see.
 - Next select imagery type to search. Go to Landsat>Landsat Collection 1 Level-1 (Level 1 has highest quality and level of processing)> For recent satellite imagery choose Landsat 8 OLI/TIRS, to download historical imagery choose Landsat 7 or Landsat 4-5.
 - Search through imagery to find scenes or scene for desired dates. You will want a scene that does not have cloud cover in the location you want to analyze.
 - To download click> download options and select Level-1-Geo Tiff Data Product.
 - Imagery downloads are large in size, it is not recommended that you do not save on a network drive and instead save on computer hard drive. Extract data from downloaded zip files. Once unzipped you should see several .tif's for each spectral band for the time scene selected.
2. Open up ArcMap and check that your Spatial Analyst Extension is enabled.
3. To calculate NDVI (Normalized Difference Vegetation Index) with Landsat 8 you will need to bring in band 4 and band 5 into your mxd. To calculate NDTI (Normalized Difference Tillage Index) with Landsat 8 you will need to bring in band 6 and band 7 to your map. Optional: After bands are brought into map right click each band, choose properties and shorten name of each layer.(EX. LC08_L1TP_024029_20171125_20171206_01_T1_B7.TIF to Band7)
4. Optional: Clip raster bands to area of concern (county boundary, watershed boundary, etc). This can be done before hand to shorten process time or after.
5. Find Raster Calculator tool in search or ArcToolbox>Spatial Analyst>Map Algebra>Raster Calculator.
6. Open Raster Calculator, for NDTI your input bands will be band 6 & band 7. The equation will be: $(\text{Float}(\text{"band6.TIF"}) - \text{Float}(\text{"band7.TIF"})) / (\text{Float}(\text{"band6.TIF"}) + \text{Float}(\text{"band7.TIF"}))$

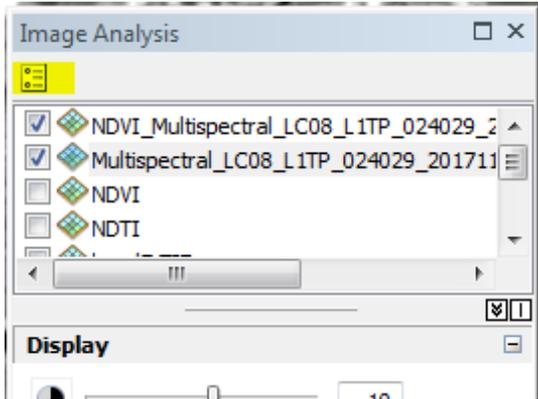


7. For NDVI, your input bands will be band 4 and band 5. The equation will be:
 $(\text{Float}(\text{"band5.TIF"}) - \text{Float}(\text{"band4.TIF"})) / (\text{Float}(\text{"band5.TIF"}) + \text{Float}(\text{"band4.TIF"}))$

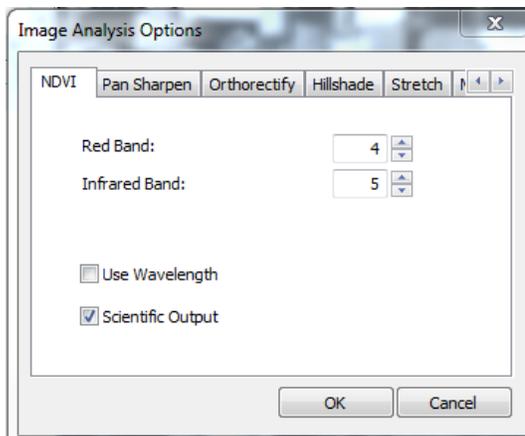


Alternatively you can also calculate NDVI in ArcMap's Image Analysis window:

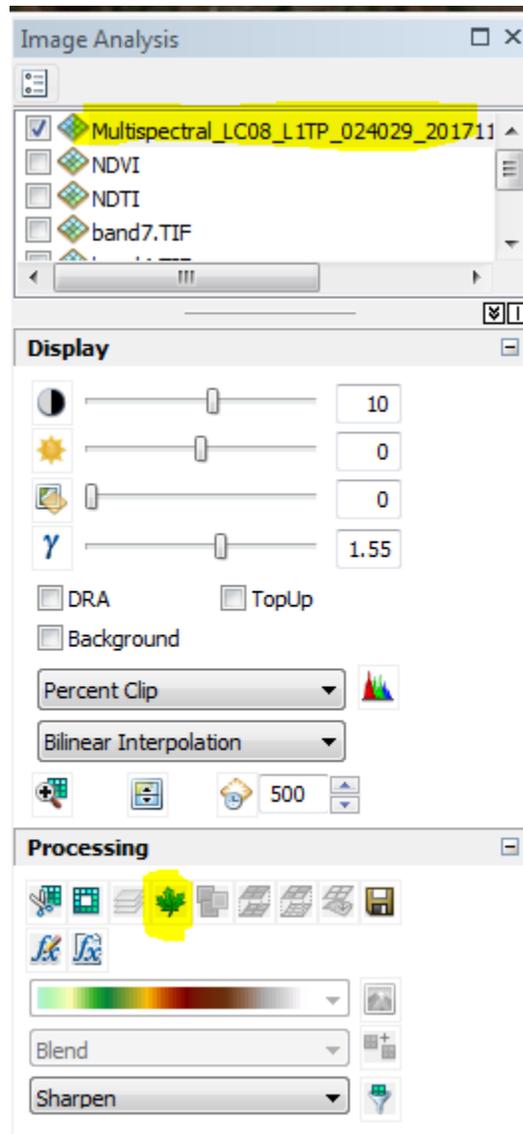
1. To access Image Analysis window in ArcMap go to Windows>Image Analysis.
2. Add the Multispectral layer from desired landsat 8 time scene. It will look like this:
LC08_L1TP_024029_20171125_20171206_01_T1_MTL
3. Click the options tab in the Image Analysis window.



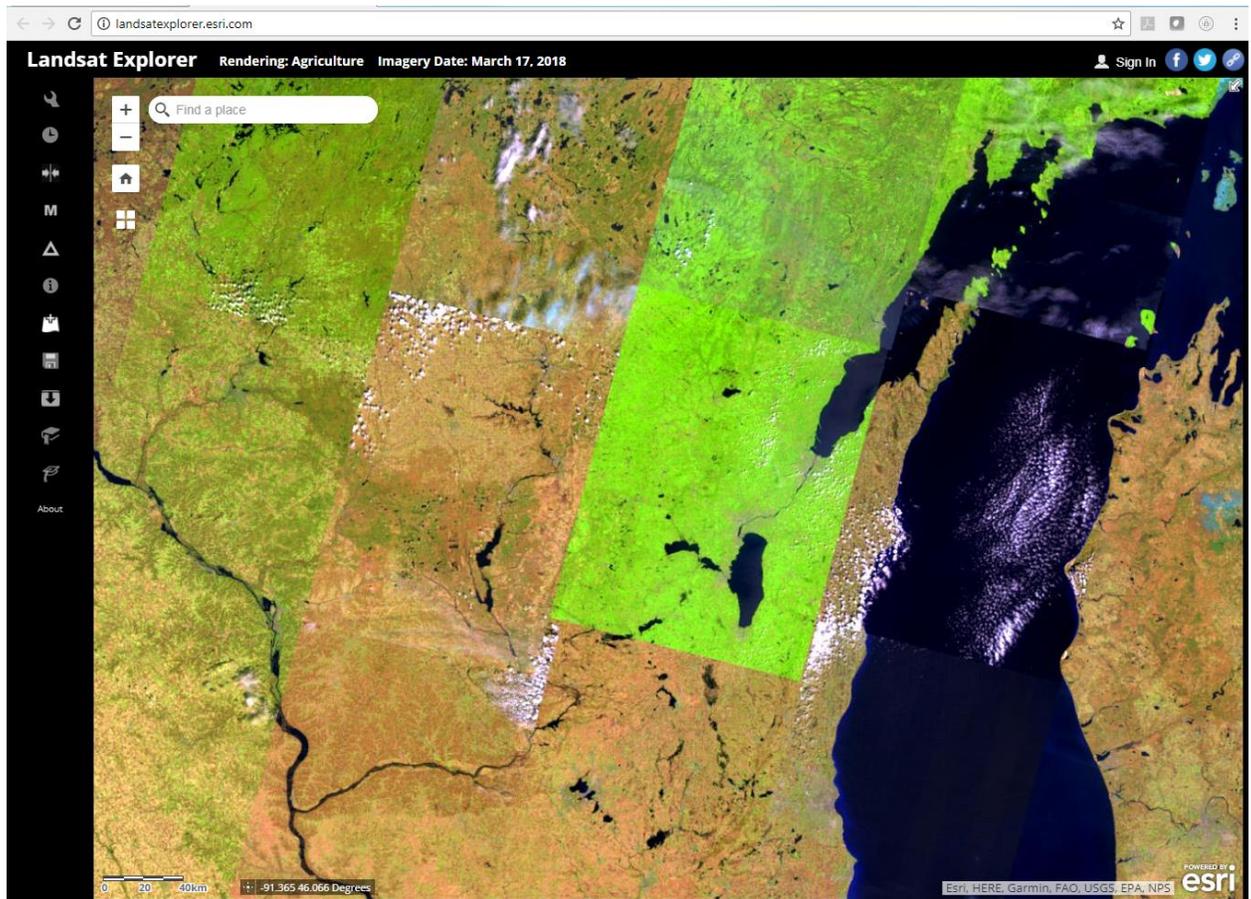
4. Make sure the options for the NDVI tab look like figure below for landsat 8.



5. Select Multispectral layer in Image Analysis window, then click the leaf under processing. This will calculate the NDVI and create a temporary raster layer. Right click on NDVI output layer and select Data>Export Data to save layer.



ESRI Landsat Explorer Online Tool:
<http://landsatexplorer.esri.com/>

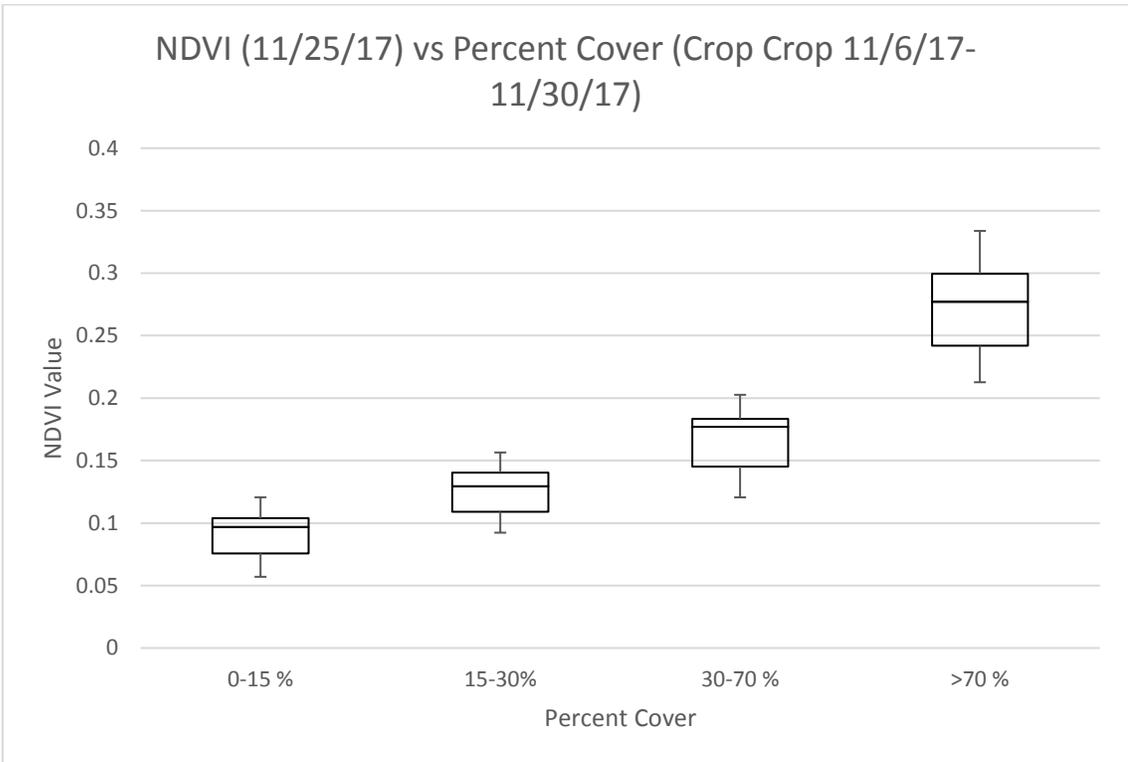
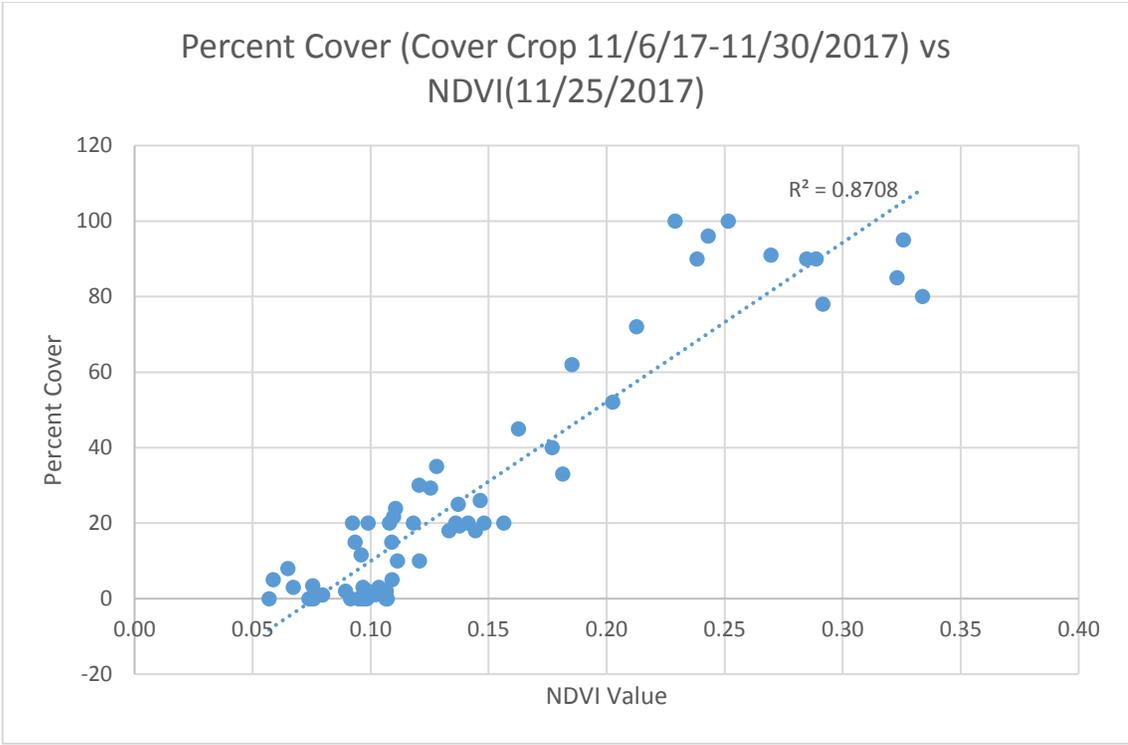


- Easily visualize landsat satellite imagery. Renders NDVI and other indices on the fly.
- Bring in other layers from ArcGIS online.
- Change detection.
- Export data.

Validating NDVI & NDTI with Field Data

To determine what values best correspond to vegetative cover indices for NDVI and NDTI it is recommended that you field verify several locations in your area. It may not always be feasible to do this due to weather and satellite imagery timing. For NDVI you will want to field verify the amount of green cover in the field and for NDTI you will want verify total cover green and crop residue. You can then correspond observed values to your raster outputs.

1. You will need to have a field boundary layer for fields that were checked in the field for cover percentages.
2. If you have access to ArcCollector you can use this tool in the field to document percent cover data that is geo-located while in the field. Otherwise create an attribute field in field boundary table layer for percent cover and enter in corresponding values. You will also need to create an attribute field for unique id's for each field.
3. Next you will need to go to ArcToolbox>Spatial Analyst Tools>Zonal>Zonal Statistics as Table. Input raster or feature zone data: Field layer, Zone field: Unique Id attribute field, Input Value Raster: NDTI or NDVI raster, Output Table: Name and save to desired location. Statistics type: Mean
4. Join output table from zonal statistics to field boundary layer.
5. Open field attribute table after joining and select table options>export. Choose file location and choose file type .txt.
6. Open excel spreadsheet, import data from text and go exported text file.
7. You can then create a scatter plot from Mean NDVI/NDTI vs observed percent cover or create box plots from data to correlate NDVI/NDTI values to observed cover percent. See figures below.



Calculating a minNDTI

A single landsat image cannot provide a reliable assessment of tillage practices due to the timing of tillage and planting, therefore utilizing several images and calculating a min NDTI can provide a more accurate estimate of tillage practices.

1. Choose several landsat images from April-June and September-November time frame and run NDTI index calculations.
2. There are two different methods to composite images:
 - Method 1 (Image Analysis Window):
 1. Open up Image Analysis window in ArcMap.
 2. Select the images that you want use.
 3. Click composite bands. This creates a temporary layer of all selected images.
 4. Export composite layer.
 - Method 2 (ArcToolbox)
 1. Go to ArcToolbox> Data Management Tools> Composite Bands.
3. Next go to ArcToolbox> Spatial Analyst Tools>Local>Cell Statistics
Input: Composite raster created from previous step
Overlay statistic: Minimum
4. Resulting raster will contain the minimum value for each pixel from composite layer bands.