Developing a Remotely Sensed Cover Crop Identification Tool

Introduction

The Cover Crop Identification Tool (CC ID Tool) is an ArcGIS toolbox which evaluates the possible presence of cover crops on agricultural fields. The goals of this project are to create a repeatable and shareable process to determine the presence of cover crops over a winter season using publicly available imagery and to produce a statewide dataset of the results. We are interested in detecting cover crops to determine their efficacy on the landscape as a best management practice for controlling soil and nutrient loss through wind and water erosion during the winter months. In the conventional cropping system, a majority of the crops are grown from spring to fall and the soil is left to rest throughout the winter months. This often means leaving the soil with some plant stubble or bare ground throughout the winter.

Over the past decade, planting an additional crop during the winter months, called a cover crop, has been advocated as a way to promote soil health and reduce soil loss. The goal is that the cover crop be planted toward the end of the growing season or soon after the harvest to establish biomass and roots before winter temperatures and snow limit growth. The roots hold the soil providing greater protection from wind and water erosion compared to bare, exposed soil.

The CC ID Tool addresses an underlying need for conservation managers to understand the effectiveness of cover crops on the landscape as well as track and manage those efforts over time. The tool can also help to plan/prioritize future conservation efforts and identify areas of potential opportunity for further outreach and incentives.

Cover Crop Identification Tool

During the months after harvest, we observe that in many areas of Iowa, fields are bare in areas not specifically planted to cover crop or covered in permanent vegetation, such as forest or grass. Ideally, the CC ID Tool captures a snapshot of fields in the fall, early spring, and later spring to document areas of growth and change on the landscape using Sentinel 2 satellite imagery.

Normalized Difference Vegetation Index

$$NDVI = (B8 - B4)/(B8 - B4)$$

The tool uses the Normalized Difference Vegetation Index (NDVI), a formula that uses the Band 8, the near-infrared satellite imagery band (which vegetation strongly reflects) and Band 4, the red light band (which vegetation absorbs) to quantify the vegetation on the landscape by calculating a value ranging from -1 to 1, with higher values indicating greater vitality and plant health. Low or negative values indicate water, bare earth, or urban areas. Using NDVI reveals areas of intentional growth by observing a pattern of greenness in individual images as well as from fall through spring.

Discussion of the Tool

STEP 1

The first step of the tool creates Normalized Difference Vegetation Index rasters for the three images provided by the user. The tool uses each of the images (fall image, early spring image, and late spring image) as well as a field boundaries layer that has zonal statistics applied for each field from a zonal statistics table.

Compare the next three images below and notice the changes in NDVI from fall to early spring to later spring. The color range in the images is a gradient of maroon to cream to bright green (no growing vegetation to strongly growing vegetation). The starred areas are the approximate location of documented cover crop fields.

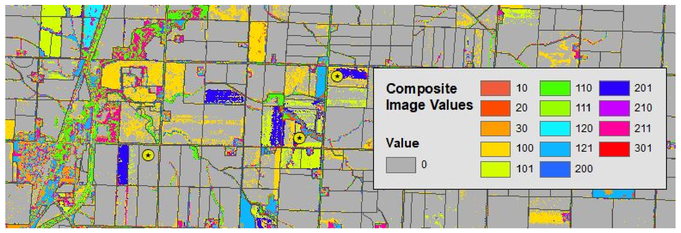
Fall NDVI - 11/21/2017
In this late fall image, most fields are light maroon or cream, indicating non-vegetated fields. Intense green indicates permanent vegetation. Light green in crop fields indicates potential cover crops.

Early Spring NDVI - 04/25/2018
In this early spring image, most fields indicate no growing vegetation. Some areas of light green are emerging in rectangular patterns which indicates intentional planting.

Late Spring NDVI - 05/25/2018
In this late spring image, many of the potential cover crop fields are no longer indicated. The cover crops have been culled prior to planting the cash crop.
Comparing this image to the previous two, there is less cream and light green and more maroon and intense green. The intense green are permanent vegetation areas which allows them to be differentiated from cover crop fields.

STEP 2

The second step takes the pixel values from the three NDVI images and combines them into one image. There are 15 different combinations of images which indicate varying levels of greenness through the season. More details about this step can be found in our handbook.



STEP 3

The final step of the tool reclassifies the composite image from 15 potential values to three values. The new categories are: No Cover Crop, Cover Crop, and Potential Cover Crop. The tool creates two products: a reclassified raster image and a polygon layer that shows the majority category by field to give an indication of cover crop potential.

Product 1: Reclassified Raster Image

Product 2: Field with Majority Category

Tool Development

Staff examined Landsat 8 and Sentinel 2 satellite images from August 2017 to July 2018 to begin to narrow the window of image dates to use for developing the process. Staff decided to use the Sentinel 2 imagery for this project because it provides a clearer image with 4 bands at 10m resolution compared to Landsat 8 which is 30m resolution. Sentinel 2 also has two sensors which means more images are collected and at a more frequent rate.

When choosing an image, staff tried to find images that were free of snow, smoke, and clouds, or at least minimal cloud cover. It was observed that during the fall, the cash crop (corn or soybeans) begins to mature and dry out and eventually is harvested. During this time most fields are going from a higher NDVI value to a lower NDVI value as the fall progresses. Much of the cash crop is harvested by October or November. Vegetation growth usually begins in April so fields with cover crops, along with pastures and other permanent vegetation, will produce a higher NDVI value than bare ground. Optimal dates for imagery by season were set after examining a range of imagery and chosen when they showed the needed growth characteristics.

Connect with Us

For more information and details about this project, downloading the ArcGIS Desktop toolbox and access to the statewide dataset, visit our Cover Crop project webpage.

A handbook is being developed that explains the toolbox development in more detail. It will be available on the project website in April 2021.

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To view more information about this project, visit: https://www.iowaview.org/cover-crop-mapping-project/

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