Monitoring Agricultural Tillage Practices with NASA Hyperspectral Satellite Imagery
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Video Transcript

“We are the Midwest Agriculture and Climate team. The statistic we were given to begin our project is that agriculture in the US contributes to 8% of the nation's greenhouse gas emissions annually. Tillage practices, the way farmers prepare their land to plant their crops, is a large part of this. There are two main types of tillage- conventional and conservation tillage, which are classified based on the amount of crop residue left on the field. Conservation tillage stores carbon in the soil and is better for the environment. Currently, the Conservation Technology Information Center (the CTIC) monitors conservation tillage through the line-transect survey, which is inefficient. Our project goal was to create an improved methodology using NASA remote sensors for detecting these different tillage practices.”

“We acquired our information from the US Geological Survey, the US Department of Agriculture and its National Agriculture Statistics Survey, and the CTIC. The need of these organizations is an efficient method that can identify the different tillage practices for accounting purposes, such as a carbon credit system. By using our methodology, these organizations can further their research in understanding agriculture as it relates to climate. We would also like to thank our science advisor, Dr. Kenton Ross.”

“Our initial project target was to create a methodology for monitoring tillage that would be more practical, time and cost effective than current monitoring methods. Our purpose for doing so is to there by enhance the agricultural division of a carbon credit system that could be implemented in the near future. We focused our attention on the use of the hyperion sensor on the eo-1 satellite mainly for its hyperspectral capabilities which we found to be very useful in generating crop residue imagery.”

“In order to classify different types of tillage we needed to distinguish between crop residue and soil. We accomplished this by using hyper-spectral indecies, mainly CAI, the Cellulose absorption index. CAI identifies crop residue due to its unique OH- absorption feature at 2100 nm, a stark contrast from the reflectance pattern of soil, shown above. We found that CAI correlates linearly with crop residue fraction.”

“Again, the CAI is a band combination which illuminates the unique spectral properties of crop residue. We obtain the necessary hyperion bands , convert the default digital numbers into radiance values. these values are specifically what the detector reads. radiance values are then converted into reflectance fractions to be input in the CAI model. From there, the CAI index values linearly related to crop residue percentages.”

“Although the two are linearly related, a conversion mechanism is still needed. the standard method for doing this is that someone goes into the field and collects ground data, meaning they calculate the crop residue percentages for multiple fields. using precise gps coordinates, those residue percentages are then compared to the CAI values. a regression analysis is then done to compute the relationship between index values and residue percentages.”

“For our method, we assume the maximum residue percentage for any given pixel is 85% and the minimum is 5%. A frequency distribution of CAI values is shown below, the right bar represents the 99th percentile and the left bar the 1st percentile. we associate the 99th percentile with 85% residue cover and the 1st percentile with 5% residue cover. percentiles are chosen to eliminate scattering efffects, sensor errors, and other anomalous behavior. This gives us the end values needed to compute residue percentages from our index values
From this linear model, we are able to develop the image shown on the left, and we compared this to the image shown on the right, which was derived from ground data, using the standard method by Dr. Craig Daughtry of the USDA.”

“We then compute our indices, CAI on the left and LCA on the right, and overlay ground validation points provided to us by Dr. Daughtry to test our accuracy. As you can see, represented by the blue points, we were approximately 80 percent accurate with the CAI which is very comparable to Dr. Daughtry’s 82 percent accuracy using the standard method. The LCA tested significantly less accurate.”

“In conclusion we found that hyperspectral data yields the most accurate results, however in order for widespread tillage analysis, the temporal resolution must be improved. Spatial improvements would also help to increase pixel accuracy at a smaller scale. With this new method we were able to accomplish a new and more efficient method for monitoring tillage practices solely through the use of NASA Earth Observing Satellites, without the necessity of ground data.”