

Mapping Variations in Crop Growth Using Satellite Data

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Why it matters

- Agriculture industry (2015)*
 - Contributed \$992 billion to U.S. GDP
 - Directly accounted for 2.6 million jobs
- Any way to optimize aspects of this industry will have widespread benefits



*USDA National Agriculture Statistics Service

Source: washington.uwex.edu

Wyoming Agriculture

- Mostly alfalfa and hay
- Mostly small fields
- Difficulties
 - Wind damage
 - Poor soil
 - High variability within field (topographic)
- Producer needs info about variability
 - Difficult to obtain from the ground
 - Remote sensing methods might be useful

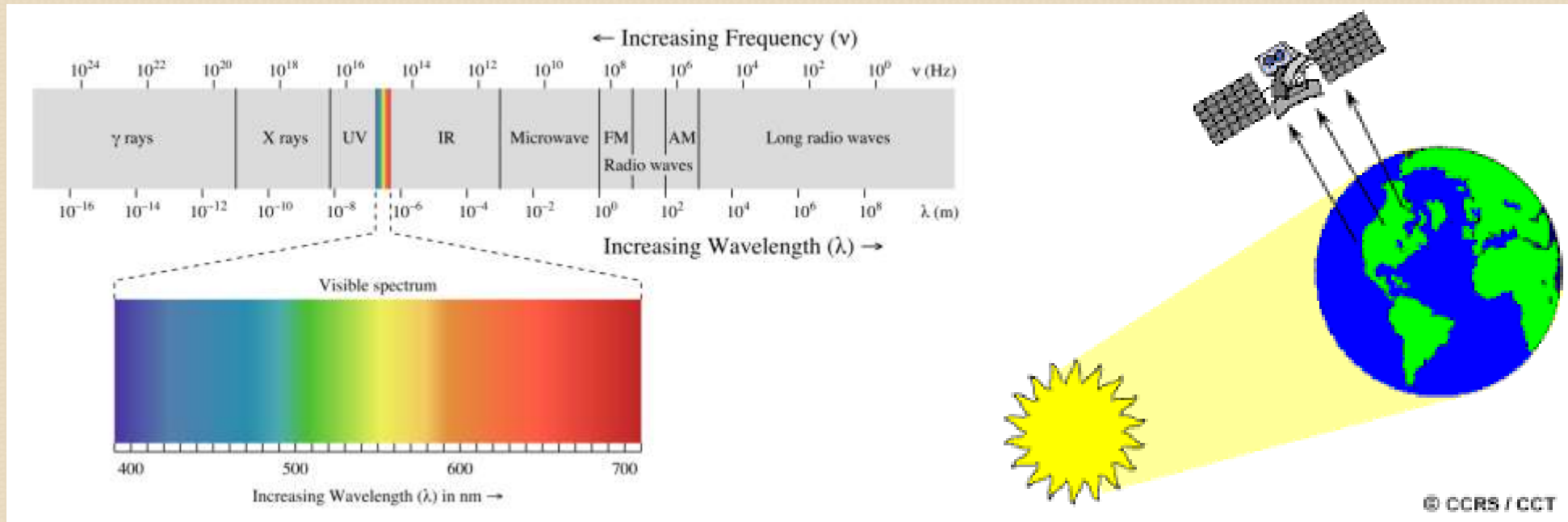
Goals and objectives

- Derive growth patterns in small crop fields using remotely sensed satellite data
 - Create visual aids in understanding crop growth patterns
 - Identify problem areas
 - Make recommendations to producers
 - Producer can address problem areas



What is remote sensing?

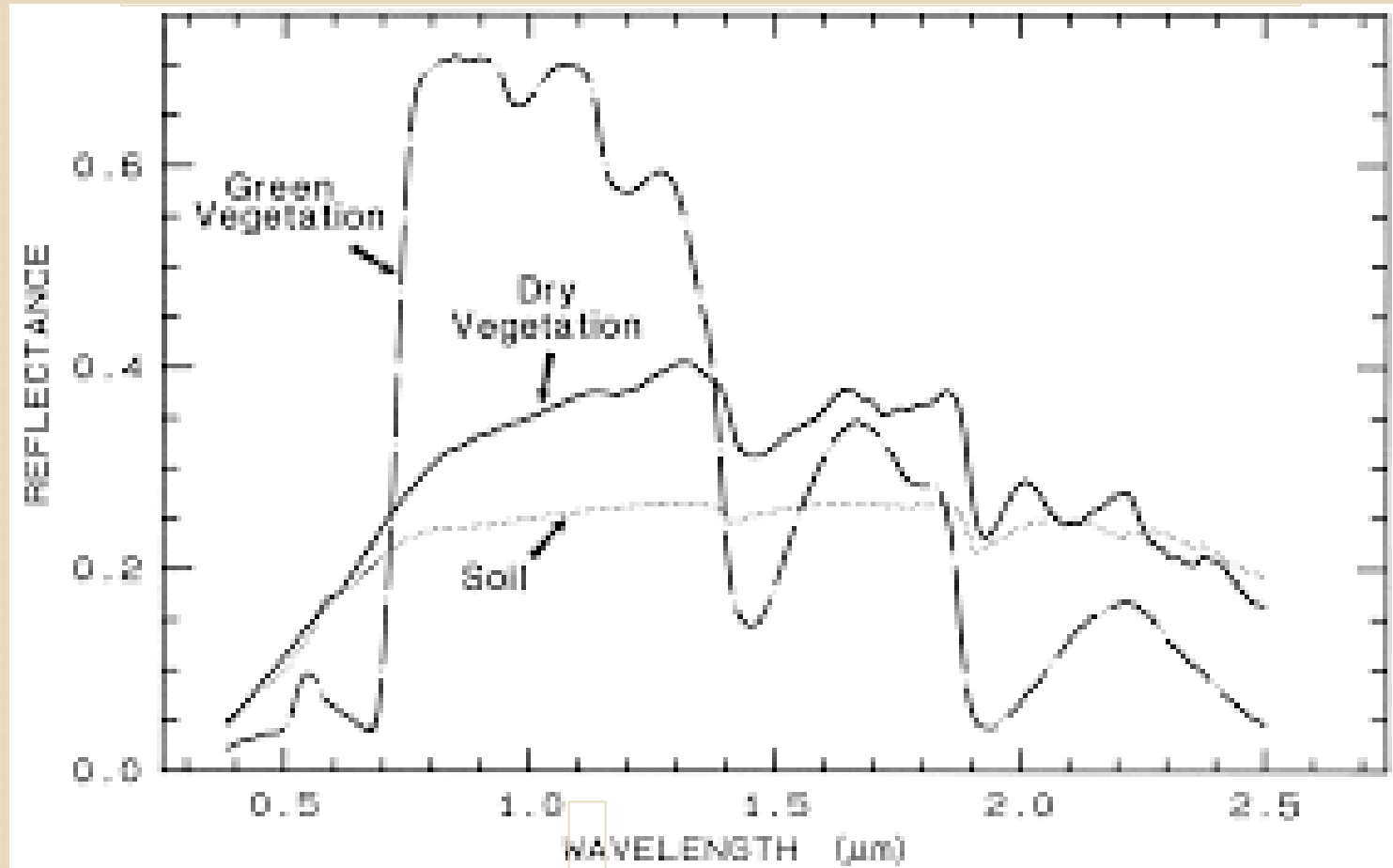
- Obtaining information through analysis of data collected at a distance



- Passive vs Active
 - Passive: energy from the sun
 - Active: sends out own energy (LIDAR or RADAR)
- Sun emits light \rightarrow Object absorbs/reflects light \rightarrow Satellite detects the light

Spectral Properties of Vegetation

Vegetation and Soil Spectral Reflectance Curve



Materials

- Study area – SE Wyoming
- Landsat data acquired from the USGS
 - 3 consecutive years per field



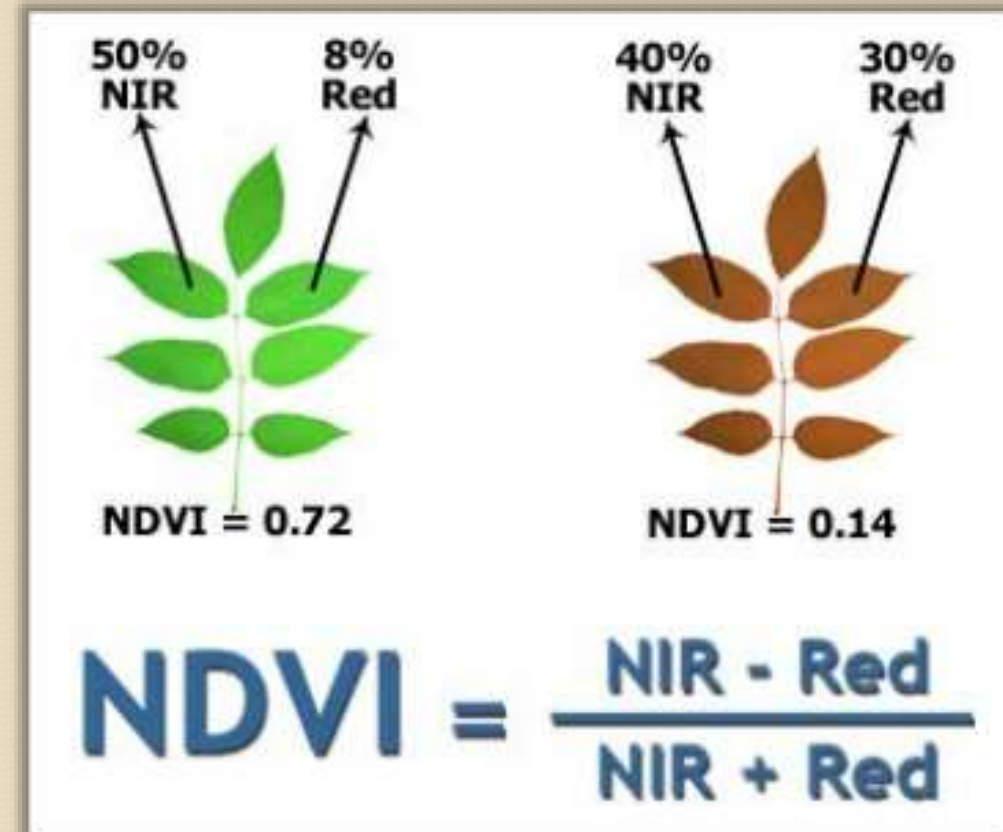
Source: Google Earth

Methods

- First approach
 - NDVI images and divide the field into above and below median NDVI
 - Uses data from two bands (wavelengths)
 - single index – easy to interpret
 - Disadvantage: data from other bands are lost
- Second approach
 - All spectral bands were used in classification

Image Analysis – NDVI

- Visible → Normalized Difference Vegetation Index (NDVI)
 - $(\text{NIR} - \text{Red}) / (\text{NIR} + \text{Red})$
- Identifies strong/healthy plants and struggling/weak plants
 - High vigor = NDVI value closer to +1
 - Low vigor = NDVI value closer to -1



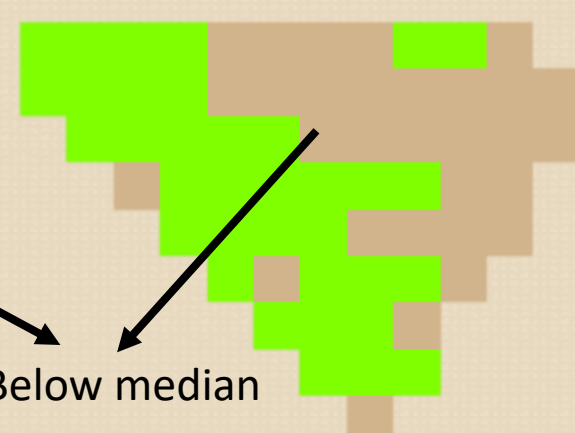
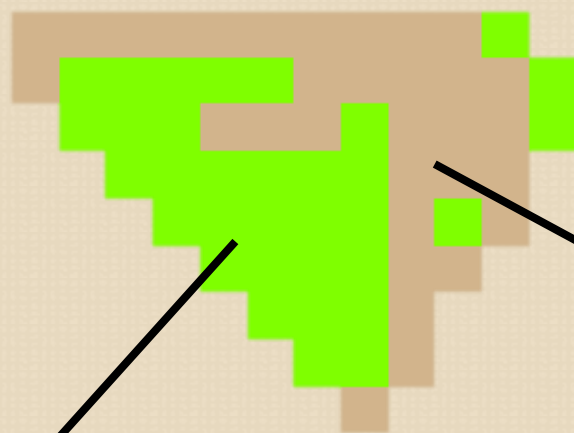
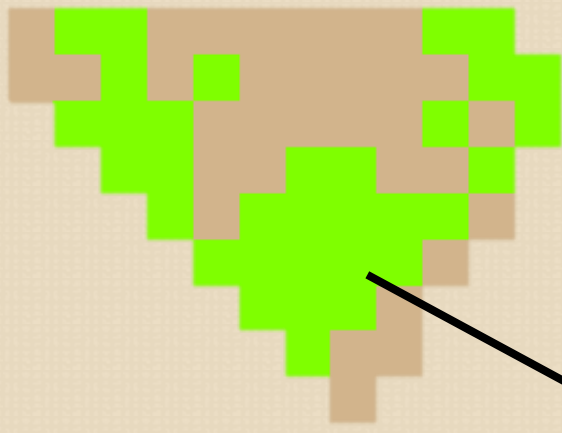
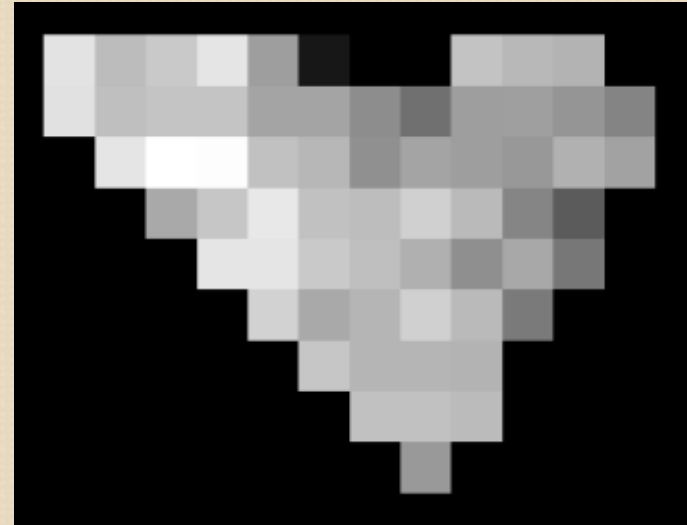
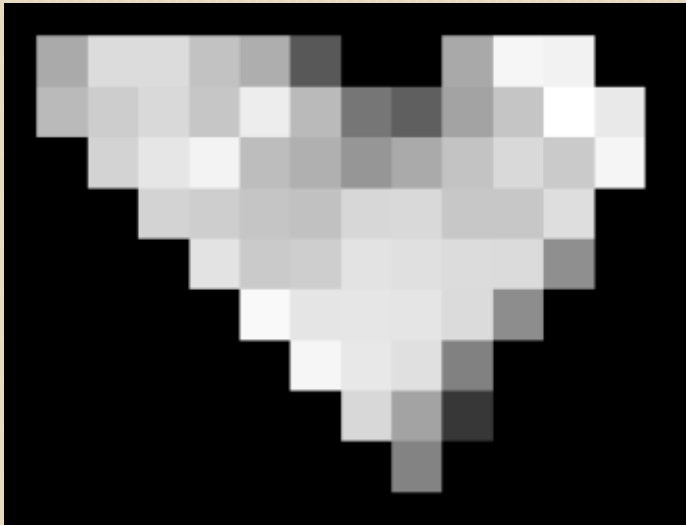
Source: ece.montana.edu

Method 1 – NDVI – Field 1

August 14, 2003

July 31, 2004

August 19, 2005

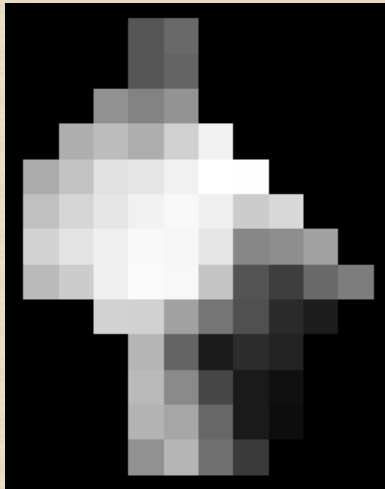


Above median

Below median

Method 1 – NDVI – Field 2

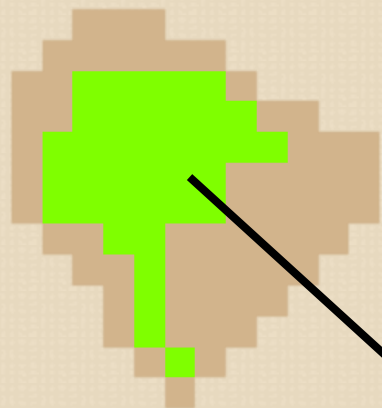
July 13, 2003



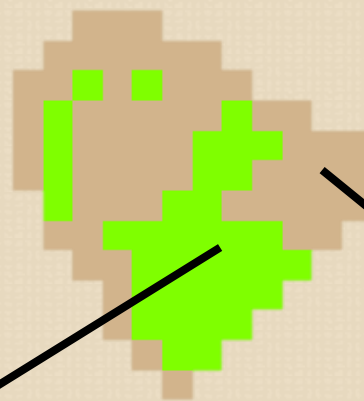
July 31, 2004



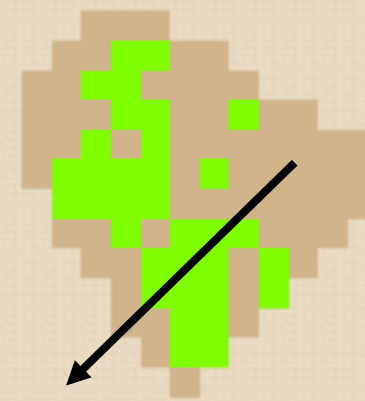
August 19, 2005



Above median



Below median



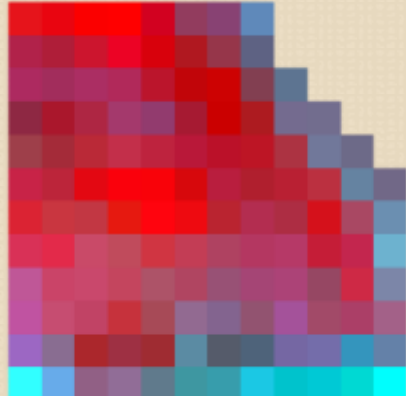
Method 2 – Multispectral bands – Field 3

- To test if having more than two classes provides additional benefit to the producer

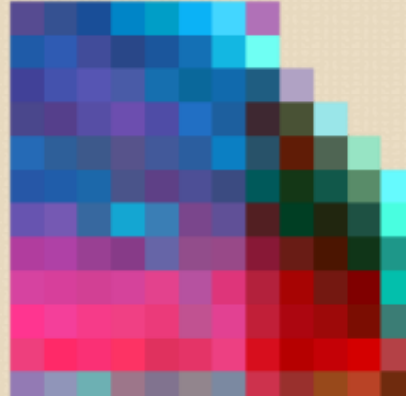
July 18, 2014



July 14, 2015



July 23, 2016



Unsupervised classification of false color infrared

- Software determines groups of similar pixels
- 6 classes were used in this example
- Shows a gradient instead of a binary image

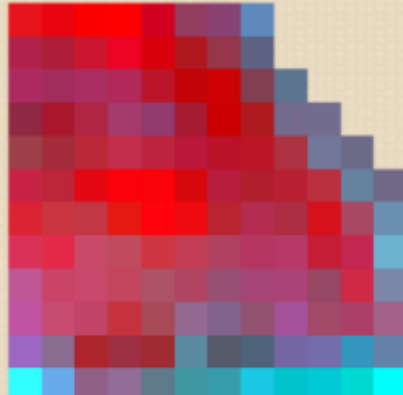
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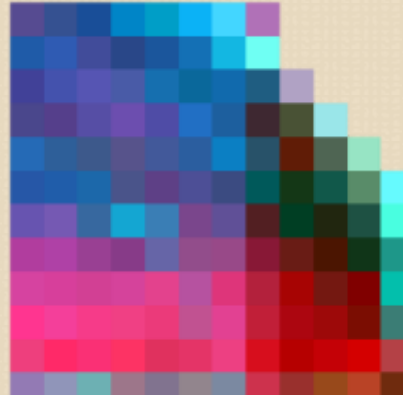
July 18, 2014



July 14, 2015



July 23, 2016



Unsupervised classification of false color infrared

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- Lighter green to tan as NIR reflectance decreases

Future work

- Classified images from both methods will be presented to the producers
- Feedback received will be used for refining the classification and determining which method is most effective and to determine the overall benefit of this study

Conclusions

- Challenges
 - Clouds
 - Temporal & spatial resolution
- May be beneficial to treat farm as multiple sections
 - Remote sensing identifies potential problem areas
- Further consultation with producers is necessary to determine optimal method

Acknowledgements

- WyomingView
- USGS for no-cost Landsat data

