Precision Agriculture

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The "Precision Approach"

"Precision farming" refers to the use of an information and technology-based system for within-field management of crops. It basically means adding the right amount of treatment at the right time and the right location within a field. Susan Moran, USDA-ARS

Requires:

"Variable rate technologies" – devices that can be mounted on tractors and programmed to control the dispersion of water and chemicals based upon the information gained from the remote sensors.

"Site-specific technologies" – location specific tracking (GPS), mapping, (GIS), and sensing (including remote).

Photo by Keith Weller, courtesy of USDA-ARS

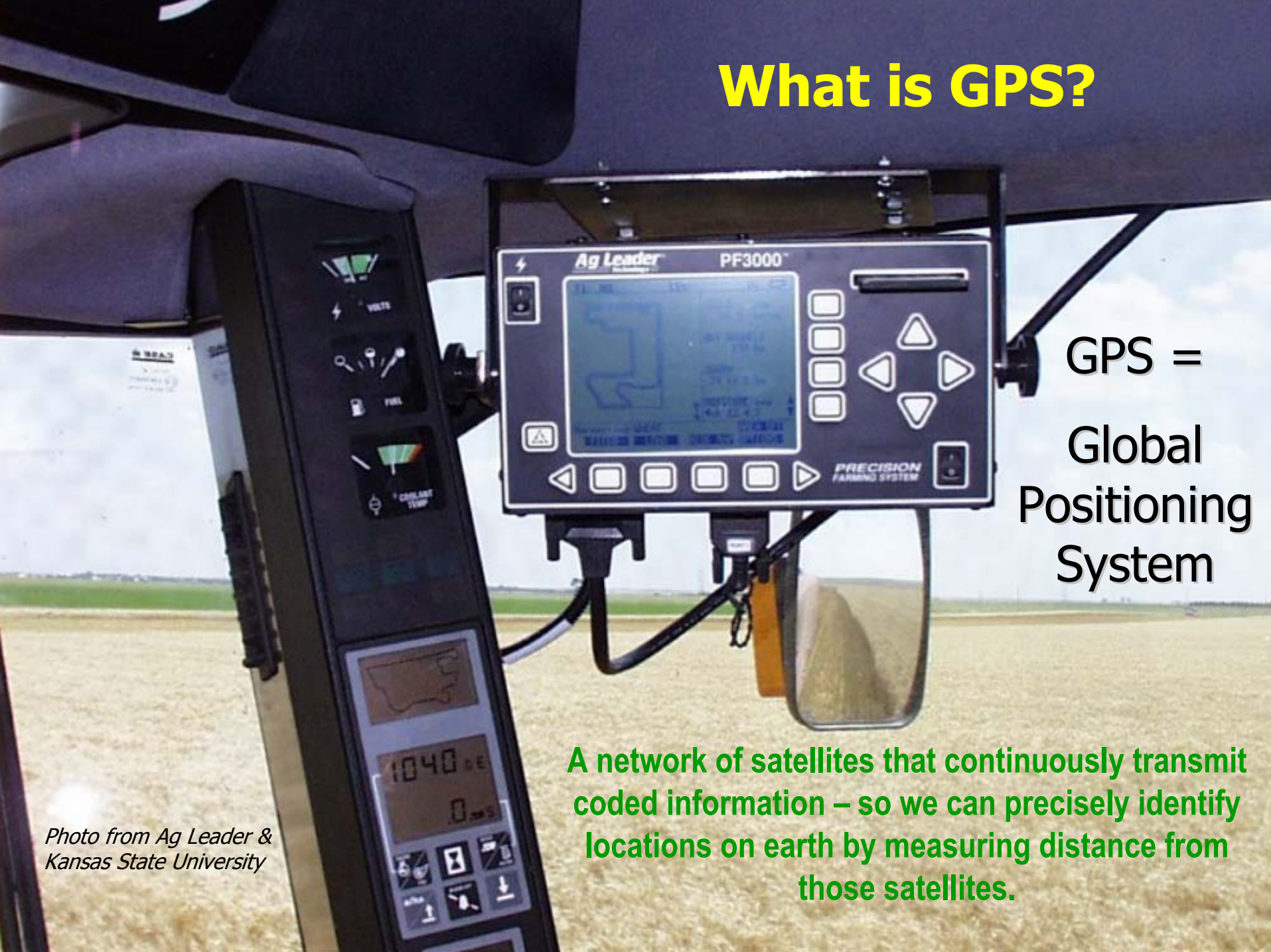
Key Elements of Geospatial Technology:

GPS

GIS

Remote Sensing

What is GPS?



GPS =

Global Positioning System

A network of satellites that continuously transmit coded information – so we can precisely identify locations on earth by measuring distance from those satellites.

Photo from Ag Leader & Kansas State University

What is GPS?

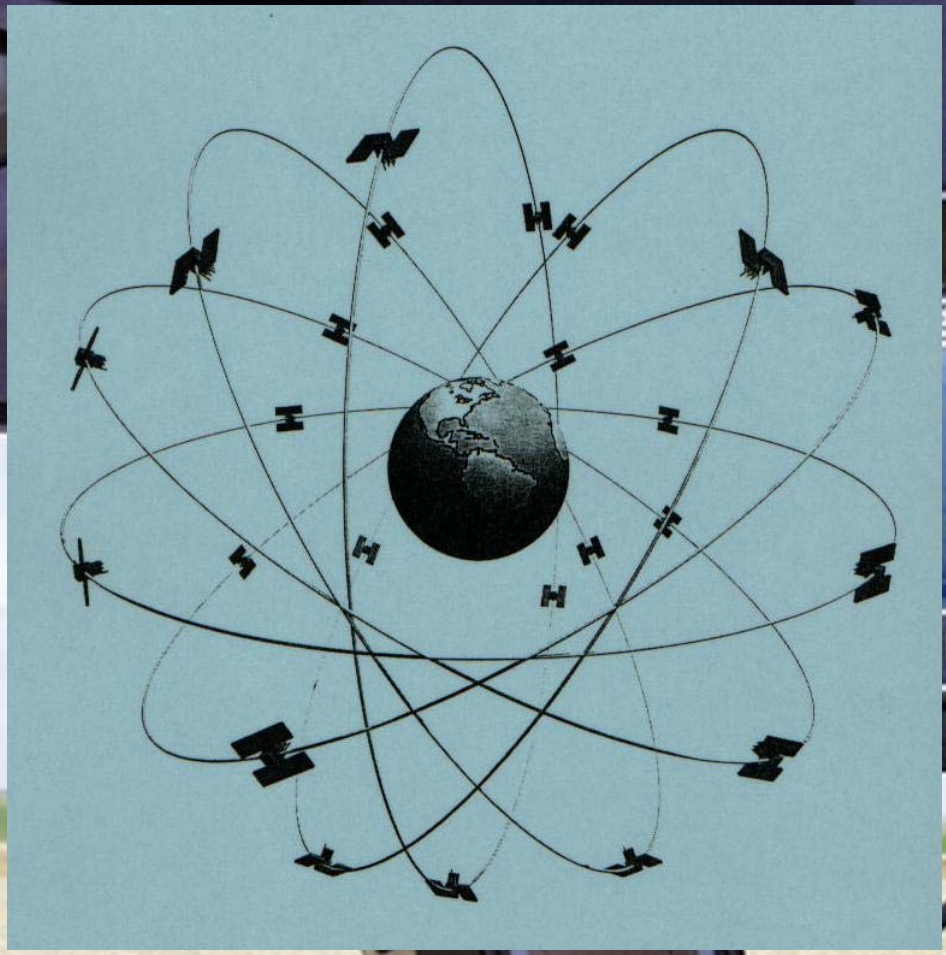


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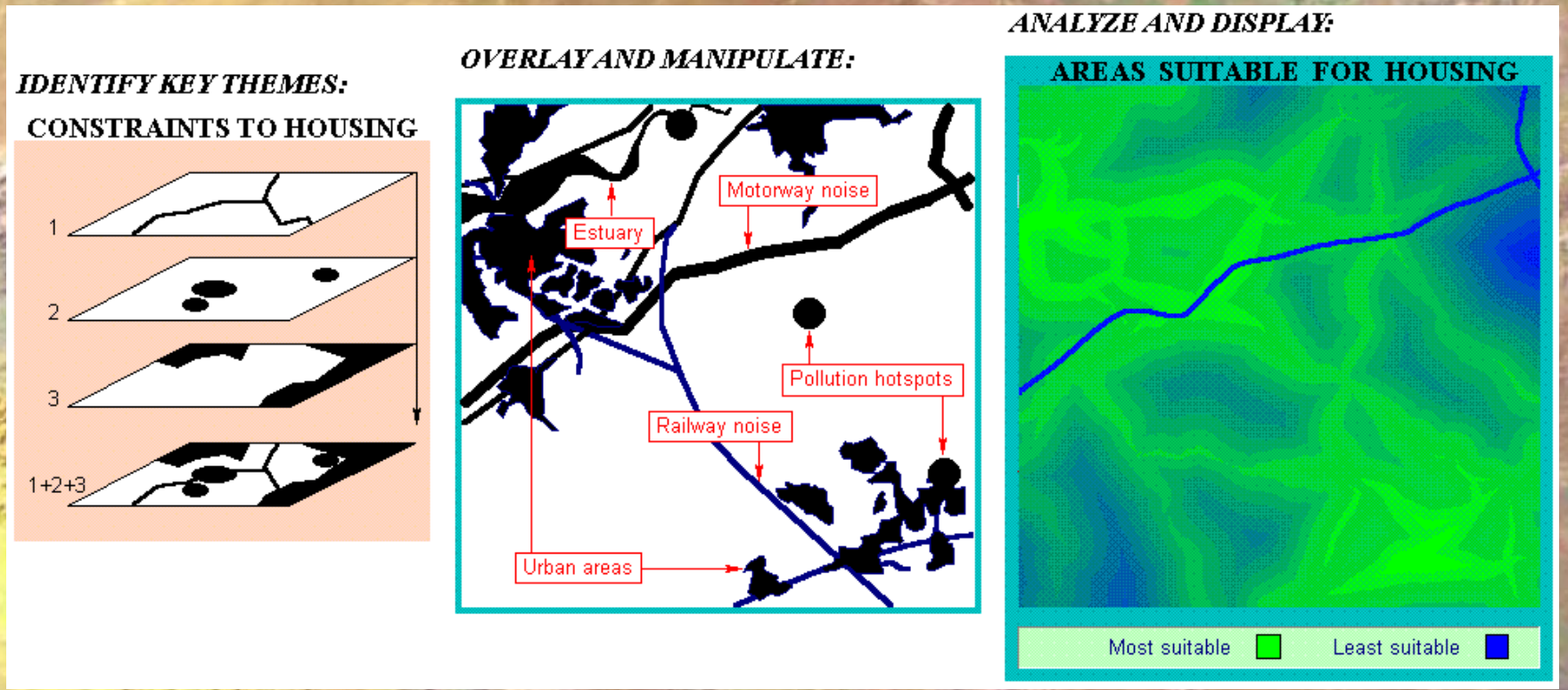
Photo from Ag Leader & Kansas State University

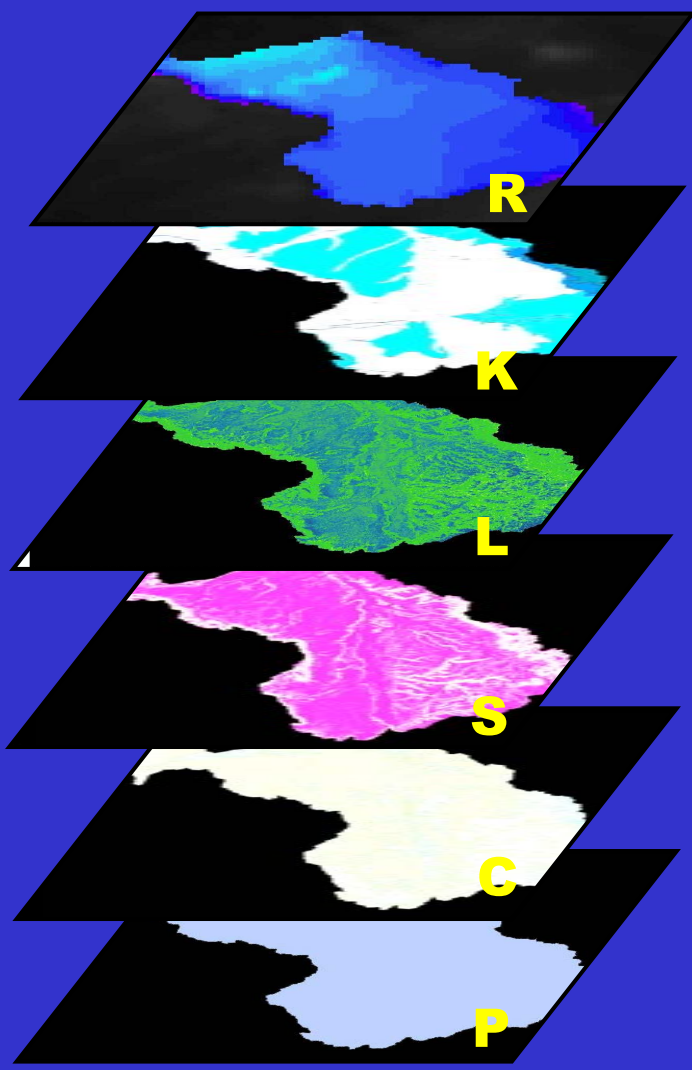
What is a Geographic Information System (GIS)?

A computer system for capturing, managing, integrating, manipulating, analyzing, and displaying data which is spatially referenced to the Earth. -- International GIS Dictionary

A decision support system involving the integration of spatially referenced data in a problem solving environment. -- Dr. David Cowen, University of South Carolina



An Example of a GIS: Calculating the Universal Soil Loss Equation



USLE: ***A = RKLSCP***

=

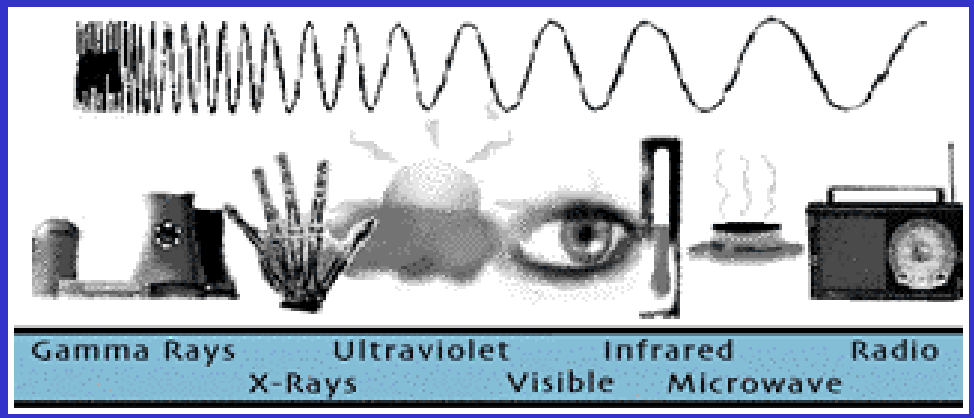
A = average annual soil loss in t/a (tons per acre)
R = rainfall erosivity index
K = soil erodibility factor
LS = topographic factor
L = slope length & S = slope
C = cropping factor
P = conservation practice factor

What is Remote Sensing?

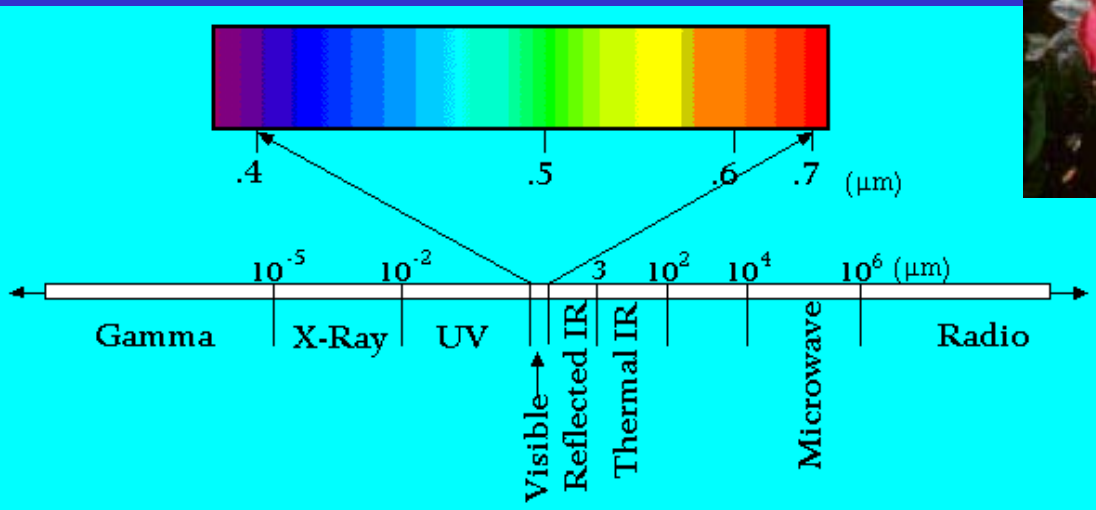
- Earth Observation, Tele-detection
- This is the process of collecting, processing and analyzing data to extract information from the Earth's surface without coming into physical contact with it
  - Satellite, Aircraft, ground-based data
  - Optical or Radiometric Imagery
  - Thermal Imagery
  - Photographs
  - Radar Images, Laser Profiles
  - Ground-based Sensors

- Remote Sensing is a tool, not an end in itself

Photos on the right are from Shwartz Electro Optics – the TS2 sensor system for orchards



Eyes are our
"remote sensors"

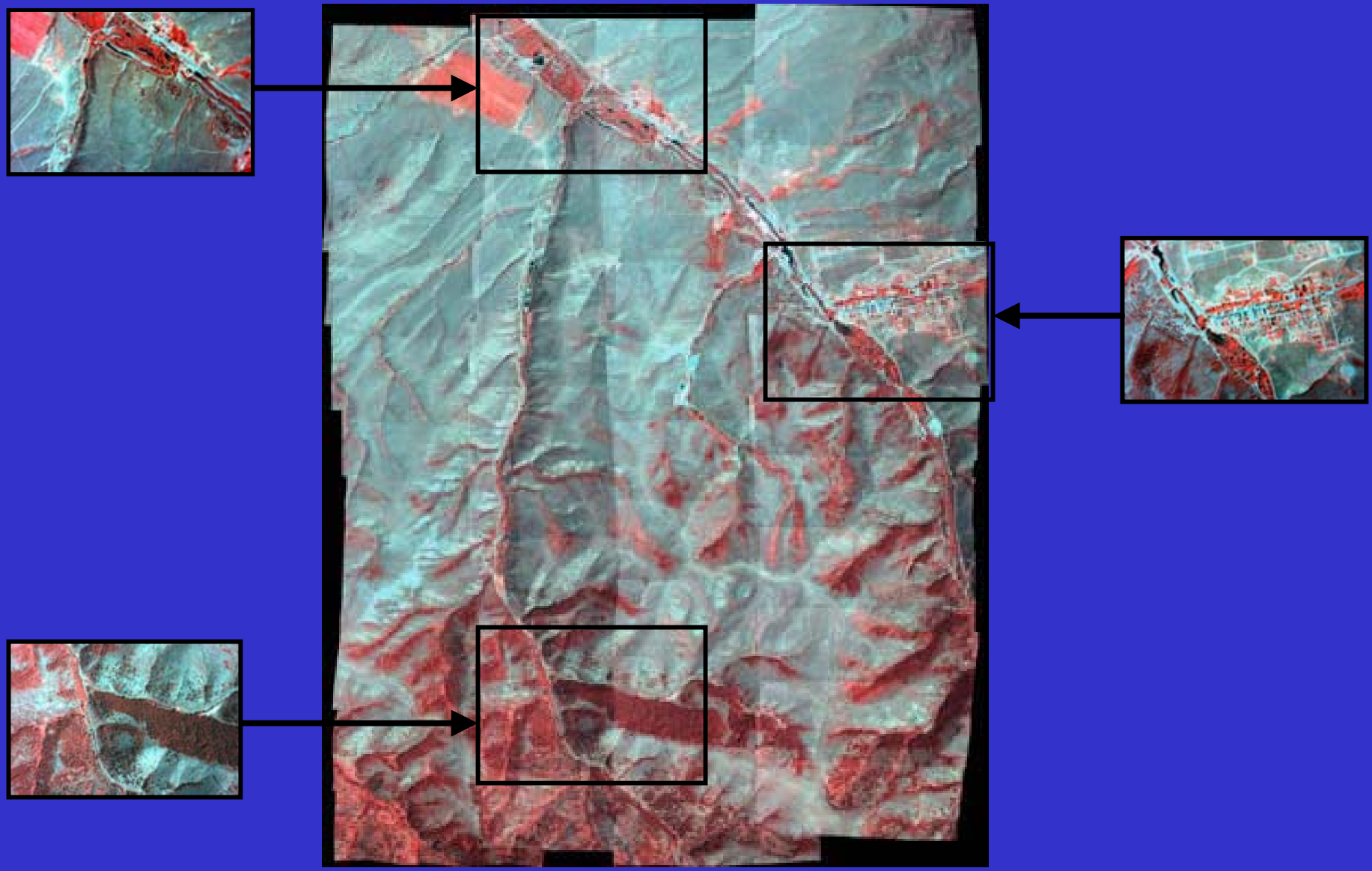


They detect *visible* electromagnetic energy

Other sensors enable us to detect more than the eye can see

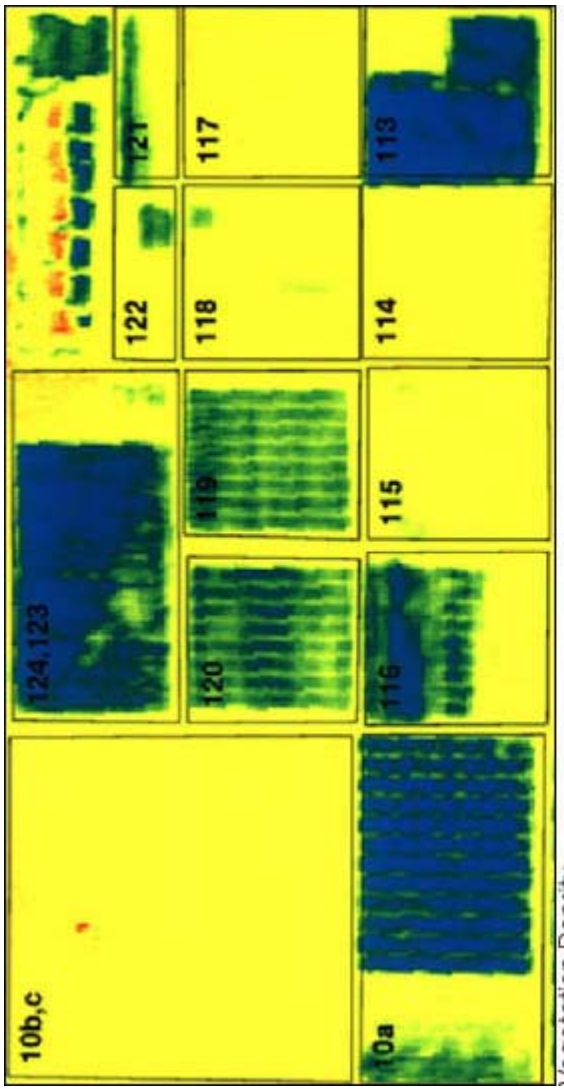
Data Pre-Processing

Mosaicking

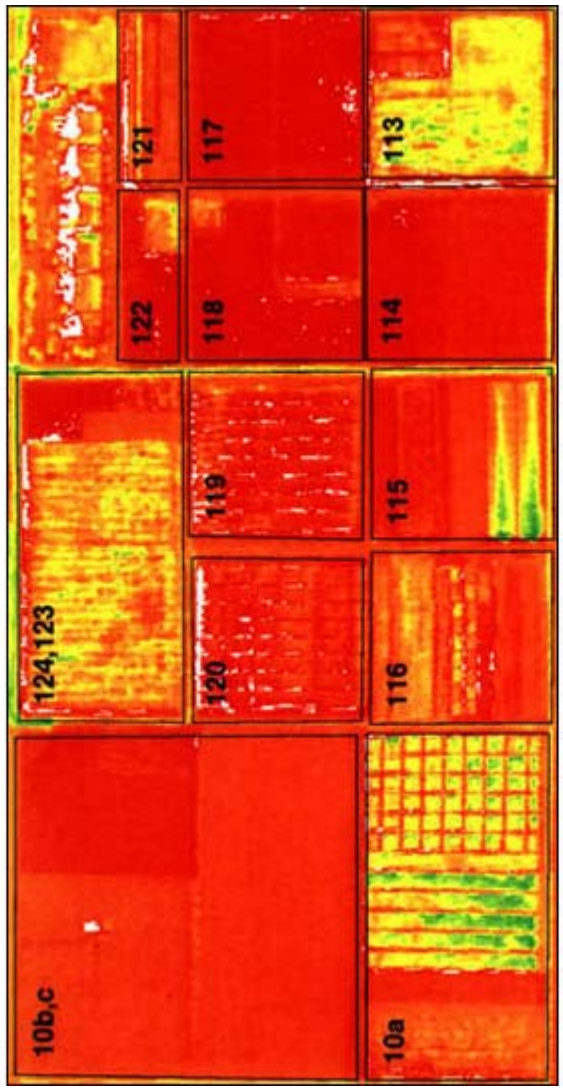


Slide information provided by Shana Driscoll (Montana)

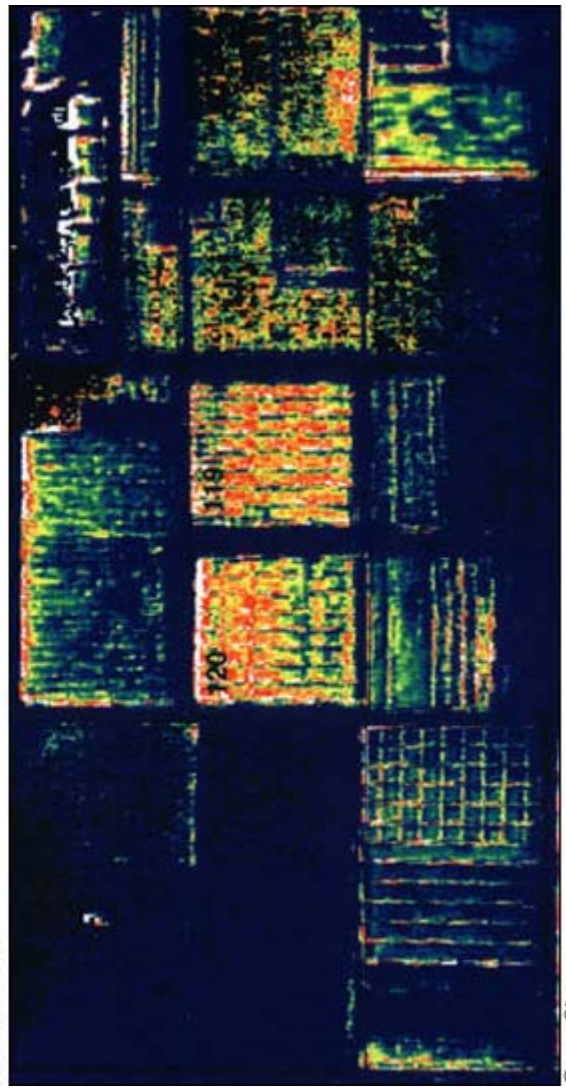
A Role for Remote Sensing



Vegetation Density



Water Deficit



Crop Stress

Vegetation Density

Water Deficit

Crop Stress

Soil survey maps

- One of the first applications of remote sensing.
- Often used by NRCS to define soil mapping units.
- Soil mapping units are appropriate for many applications; however, often lacks the resolution needed for precision crop management.

← 1 mile →

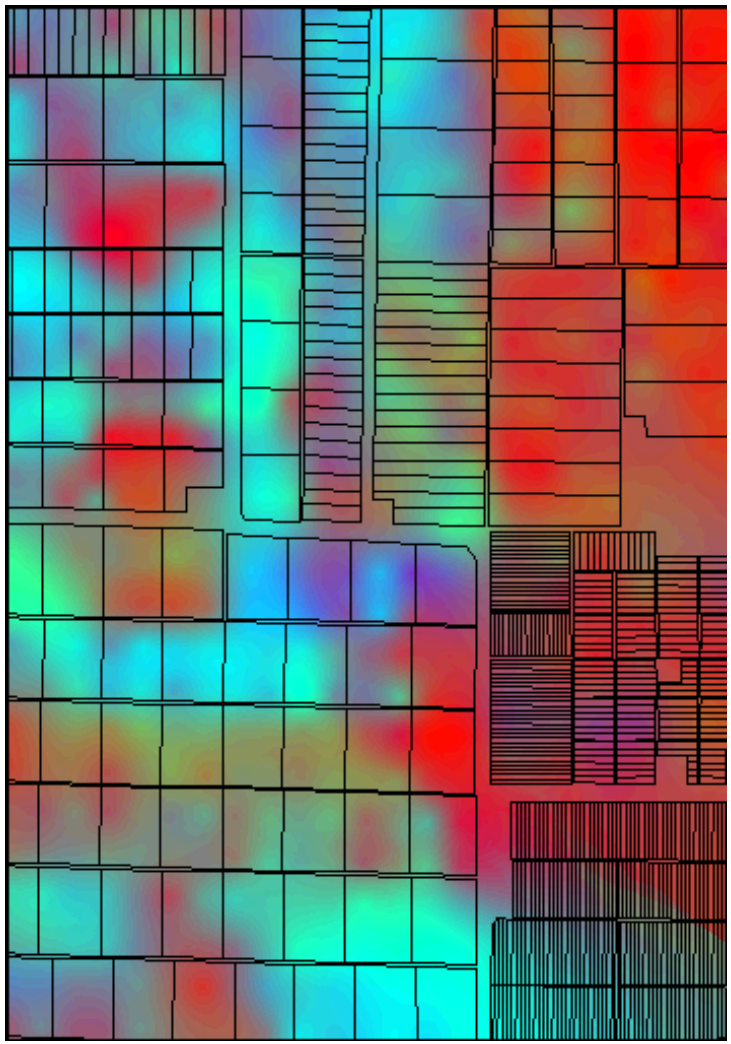
Spatially Interpolated Soil Maps

Left:

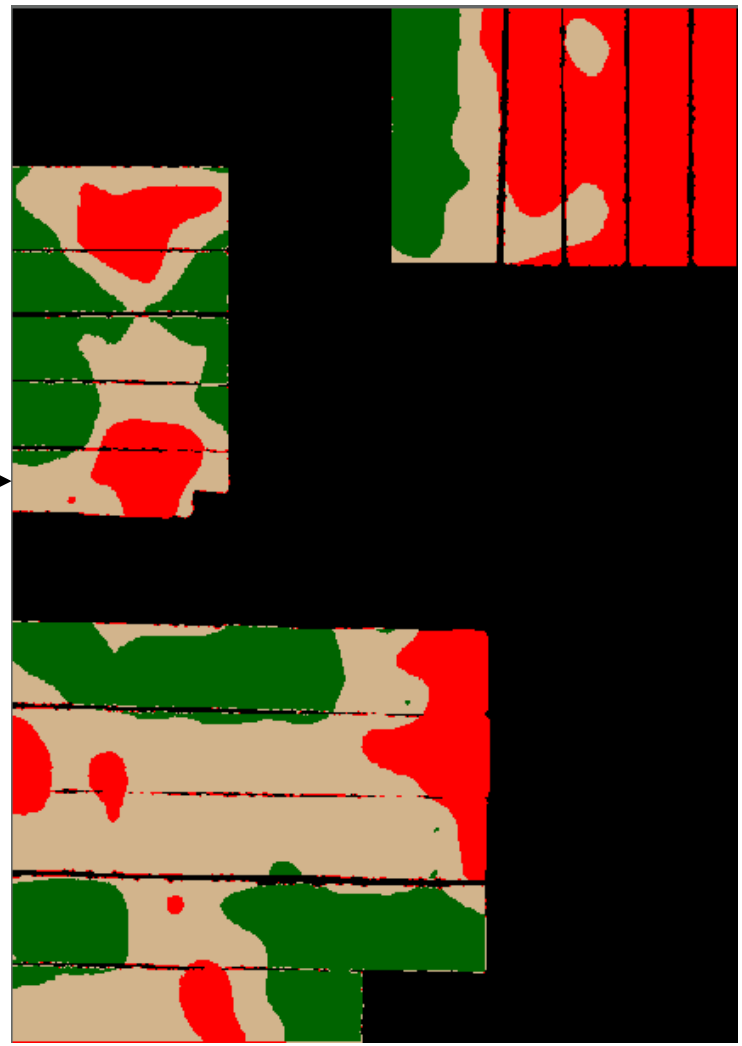
R= Sand
G= Silt
B = Clay

Right:

Red=SL
Tan=SCL
Grn=CL



Estimated Soil Texture
(color levels correspond to %)

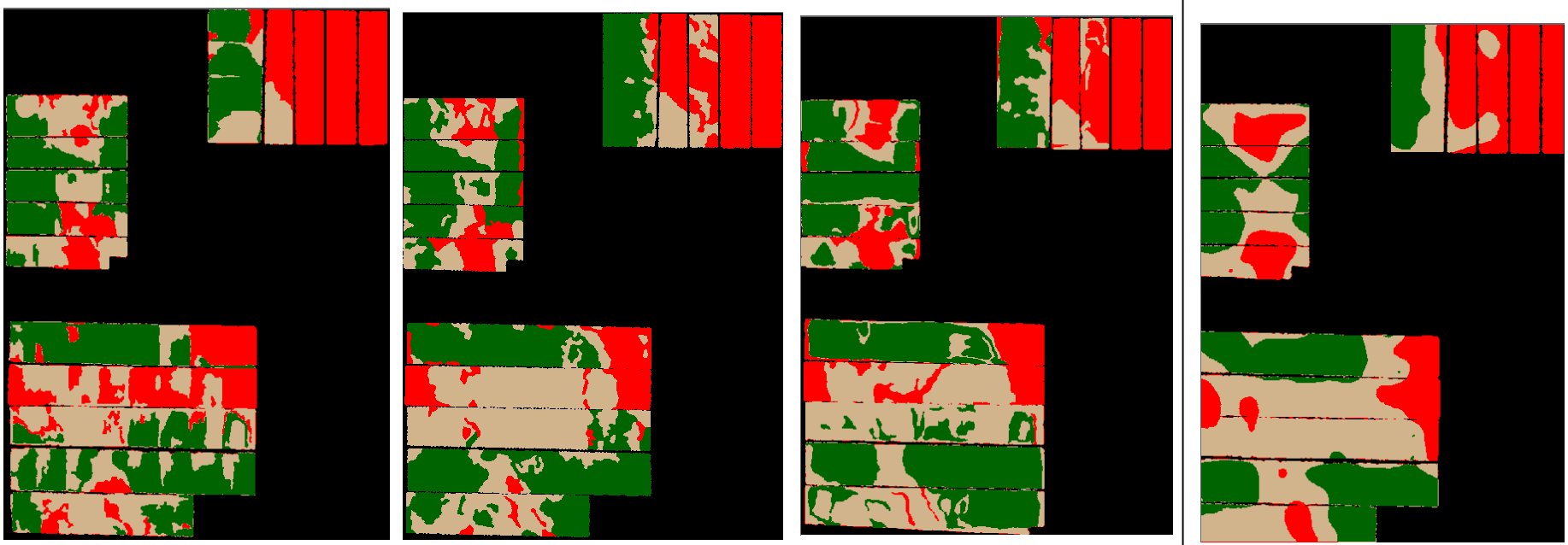


Transformed into a Map of
Soil Texture Classes

Classification Maps

Interpolated Ground Samples

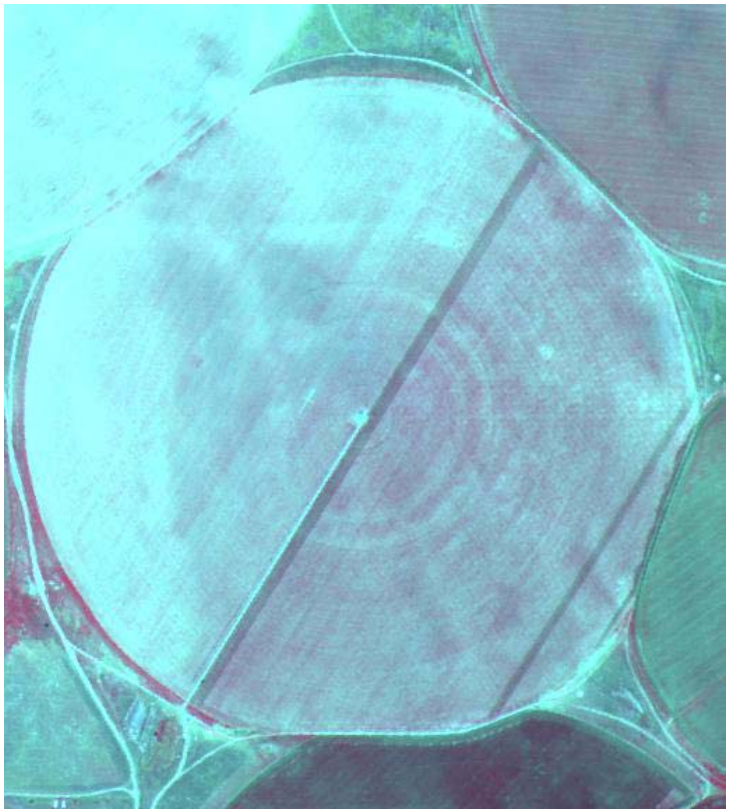
Airborne **SPOT** **LandSat** **Kriged**



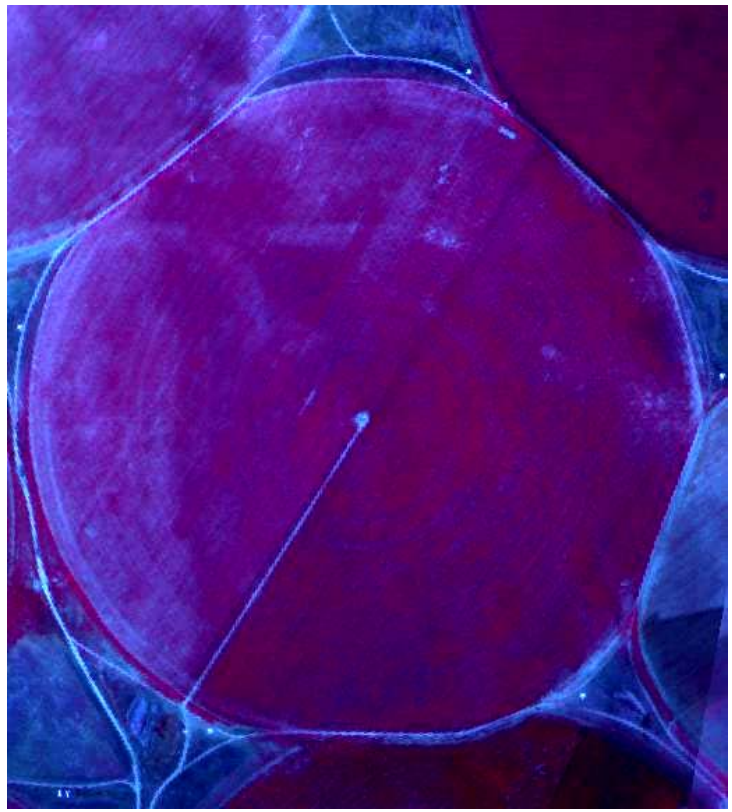
Red = SL, Tan = SCL, Green = CL

<u>Soil Sample Locations:</u> **Spectral Data: ~60**
Interpolated Ground Samples: 300

Management Zones



Corn 32 cm high



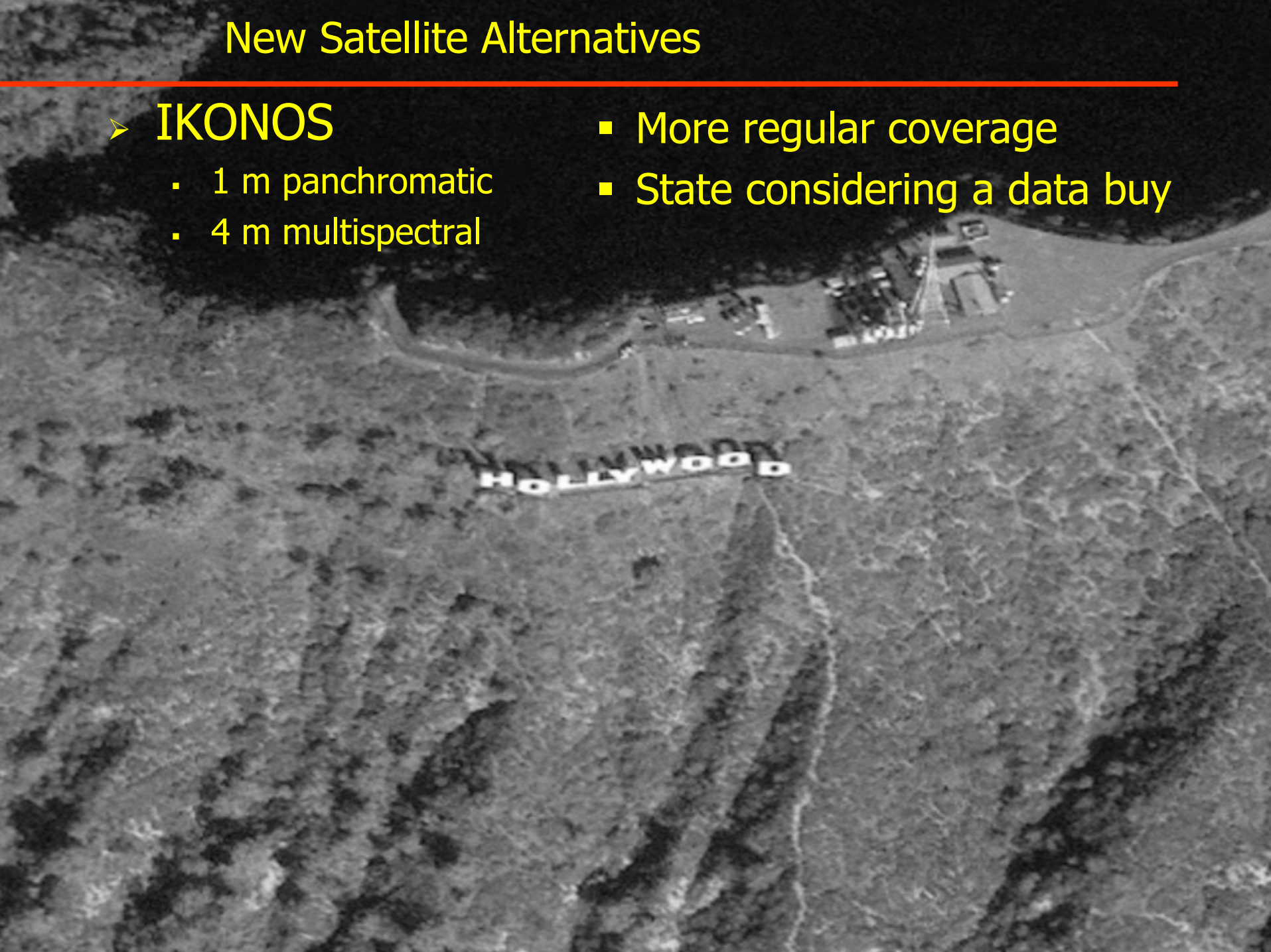
Corn 70 cm high

The patterns in the image from early season (left) are due to differences in soil type. The later image (right), these same patterns are still present in the crop. Different soil types warrant different management practices.

Images from Walter Bausch – Colorado corn under a center pivot irrigation system.

New Satellite Alternatives

- IKONOS
  - 1 m panchromatic
  - 4 m multispectral
- More regular coverage
- State considering a data buy



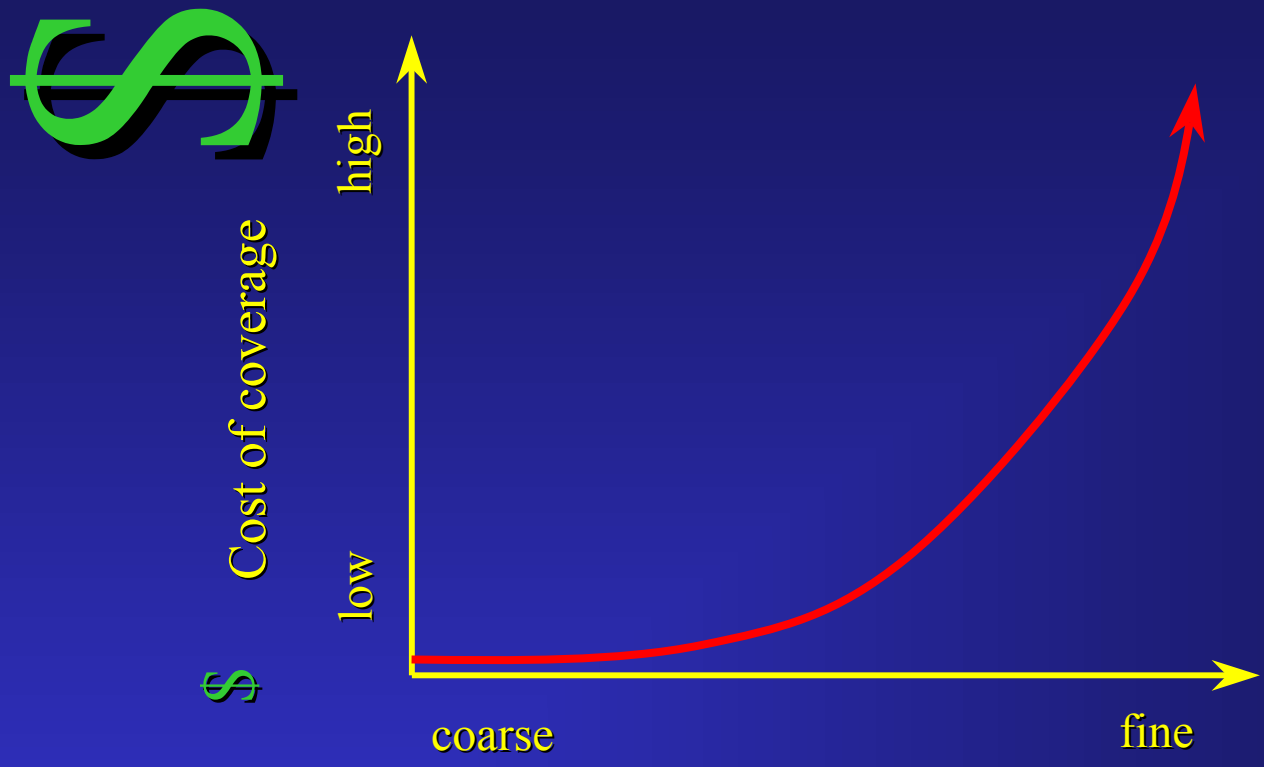
Remote Sensing Data Sources

Microsoft TerraServer
http://terraserver.homeadvisor.msn.com/default.aspx

EarthScan Image Network
http://www.earthscan.com/

Arizona Regional Image Archive
http://aria.arizona.edu/

Spatial Resolution and Cost



How much can you afford?

Adoption of Precision Ag

Jess Lowenberg-DeBoer of Purdue's Site Specific Management Center (http://mollisol.agry.purdue.edu/SSMC/)

- **Roughly 28,000 yield monitors in use in 1998 (18% of corn and soybean area)**
- **USDA research suggest 60% of U.S. farms using precision ag are in the corn belt**
- **In a 1999 survey, Ohio researchers found that only 6% of all farmers use yield monitors, but over 50% of all farms with gross sales over $1 million**
- **Larger farms more likely to adopt, but this peaks at 1600 acres**
- **From Fall 1999 to 2001, use of GPS guidance by custom applicators grew from 5% to 42% (with most growth in Midwest) (Whipker and Akridge, 2001).**
- **Leveling off? In 2001, 36% of all fertilizer retailers offered soil sampling with GPS, mostly 2.5 acre grids. It was 45% in 1999. 30% of all dealers offered variable rate application services in 2001 compared to 38% in 1999.**

Features of Adopters in Arizona

- "National Agricultural, Food, and Public Policy Preference Survey" by Farm Foundation (September 27, 2001)
- Farm Population AZ - 6,138*
- Survey Response AZ - 113 (Represents 1.8%)

***Farm population is taken from Farm Foundation, "The 2002 Farm Bill: U.S. Producer Preferences for Agricultural, Food, and Public Policy".**

Technologies Adopted

- **Precision Agriculture*$_1$** **12**
- **Precision Irrigation*$_2$** **44**
- **Both** **10**
- **Either** **46**

- *1: Global Positioning Systems, Variable Rate Applications, and GPS-linked yield monitors
- *2: laser leveling, Drip Irrigation and Low-pressure sprinkler systems

Features of Adopters

- **Adopters of precision technologies in Arizona tend to be…**
  - **45 years old and up**
  - **Large farmers* (some small farmers for irrigation)**
- **Adopters tend to grow…**
  - **Wheat**
  - **Cotton**
  - **Forages**
  - **Beef cattle**
  - **Vegetables**

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*Large Farmers: Average Annual Gross Sales >= 100K
*Small Farmers: Average Annual Gross Sales < 100K

Features of Adopters

- Adopters tend to have…
  - Some college education and above
  - Most adopters derive 76% or more of their income from Agriculture
  - Most adopters own 76% or more of the land they farm or ranch
- In the future, adopters would like their farm/ranch to be operated by their children
  - Others preferred someone outside of current operation or to convert the land to non-farm use
- Adopters tend to be…
  - 1st or 2nd generation on the farm/ranch operation

THANK YOU !!

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