Introducing Remote Sensing Concepts Using *Landsat Explorer* from Esri

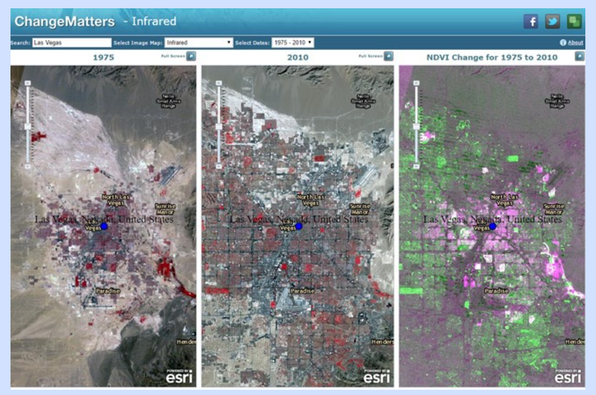
Viewing Kentucky From Space

GEOTECHCENTER.ORG

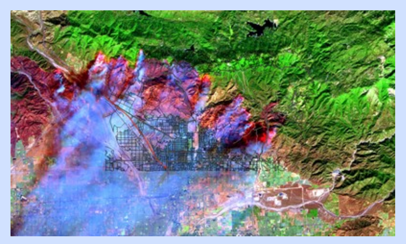
What is remote sensing?

U.S. Geological Survey Definition: Acquiring information about a natural feature or phenomenon, such as the Earth's surface, without actually being in contact with it.

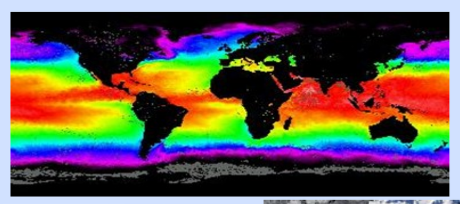
How is remote sensing used?



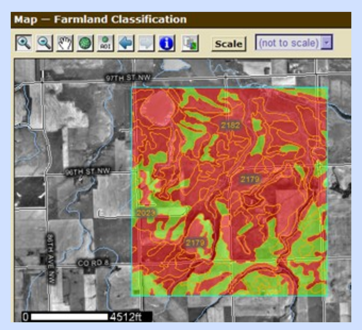
Land use change



Wildfires



Weather & Climate



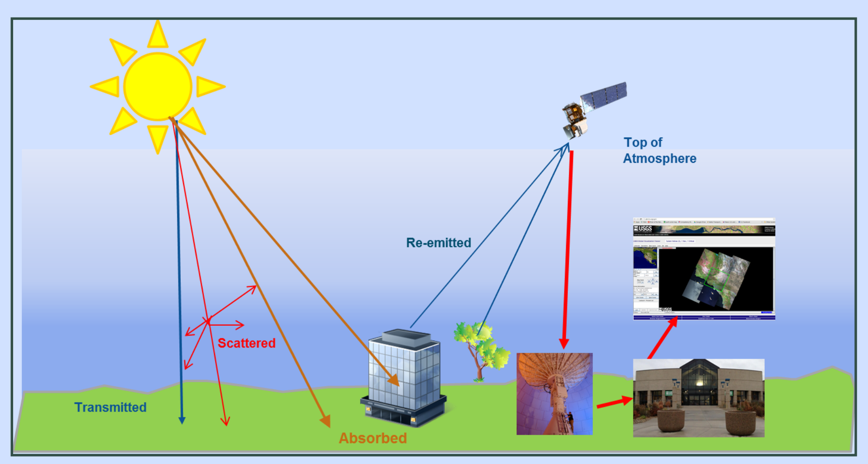
Agriculture

Two Types of Remote Sensing Sensors:

Active Remote Sensors—inputs its own energy source (LIDAR)

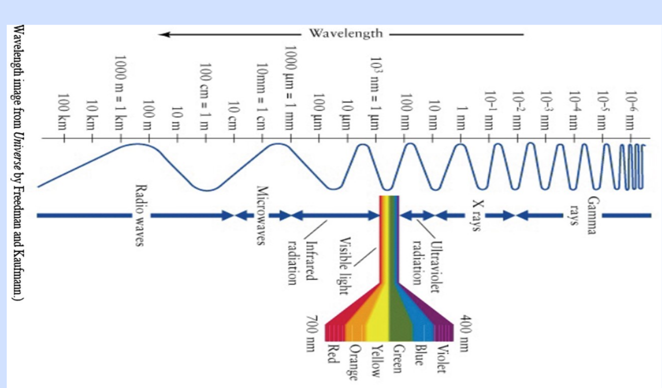
Passive Remote Sensors—uses energy from the Sun (Landsat)

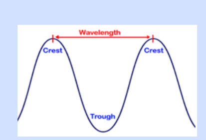
Passive Remote Sensing



The Sun's energy can be absorbed, reflected or reemitted by objects on Earth's surface. For example, Landsat sensors collect reemitted wavelengths from discrete regions (bands) of the Electromagnetic Spectrum (EMS). Data is transmitted to ground stations, processed and made accessible on the web.

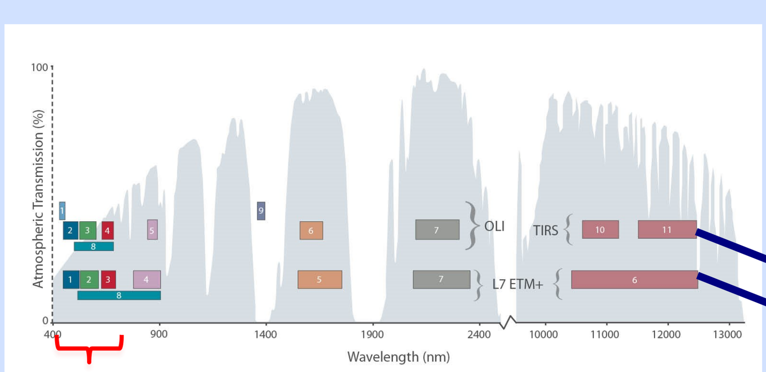
Electromagnetic Spectrum





Wavelength is measured from one crest to the next crest.

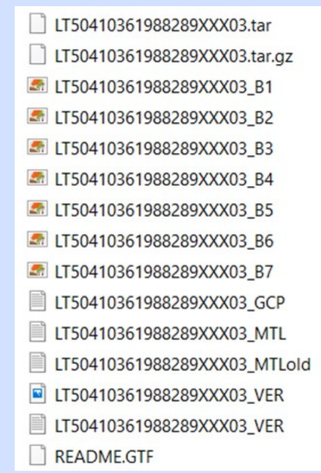
The shorter the wavelength, the greater the frequency and the higher the energy. Our eyes only visualize a small region of the EMS. Sensors can collect data from outside the visual part of the EMS.



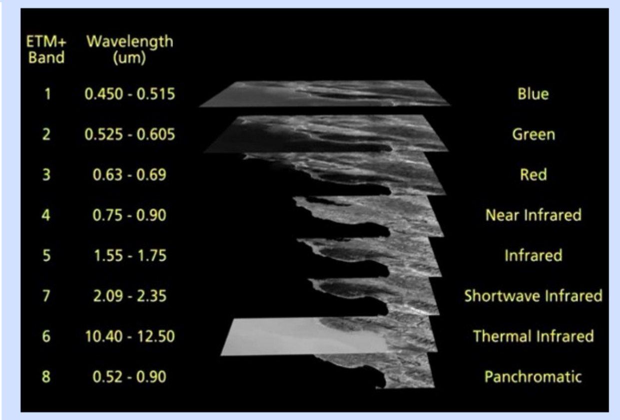
Part Our Eyes "See"

The Earth's atmosphere can block some wavelengths from reaching the satellite sensors so sensors collect in regions of the EMS where there are "atmospheric windows". The gray areas on the graph indicate those windows. Sensor bands are numbered on the graph with: Landsat 8 (top row) and Landsat 7 (bottom row) bands.

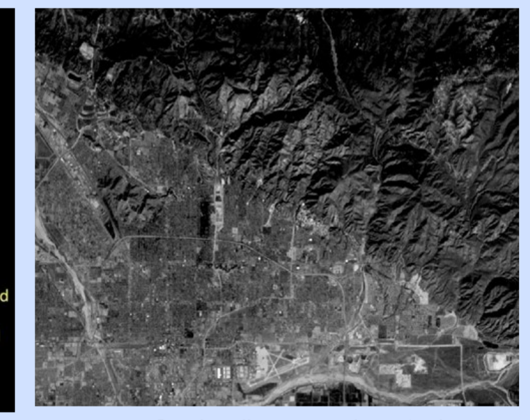
What does a Landsat Band Data Look Like?



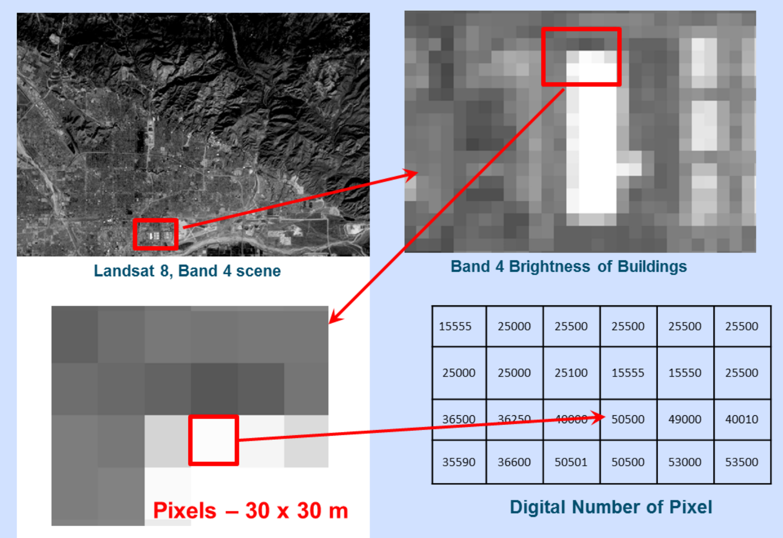
Original and unzipped bands



Landsat imagery is LARGE – Up to 1 GB!



One band's gray scale raster layer



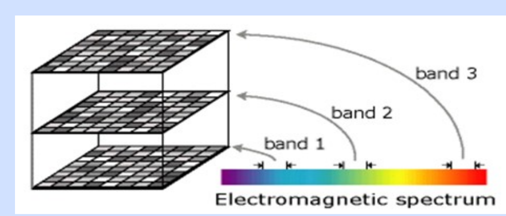
Landsat 8 Band 4 with 30 m pixels

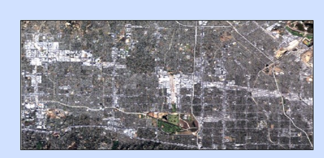
Each band is made up of a grid of equal-sized cells or pixels. Each pixel covers a certain area on the ground and has a digital number (DN) that represents the amount of Electromagnetic energy being reflected. Higher DN values mean more reflectance and brighter pixels. Until assigned a color on a computer monitor, they are displayed in shades of gray (white to black).

Creating Visualizations of Band Data

Brightness values (DN) from three Bands are combined and assigned to either blue, green or red color guns on a computer monitor creating a Composite Image.

Landsat 8 Band Numbers





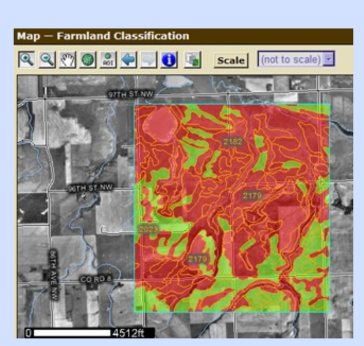
True or Natural Color Using Bands 4, 3, 2

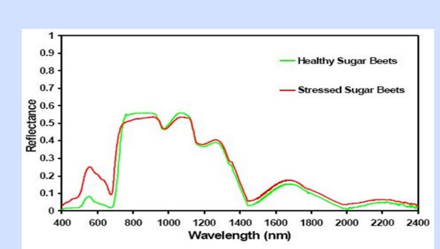
False Color Using Bands 5, 4, 3

False or Pseudo Color Using Bands 7, 6, 4

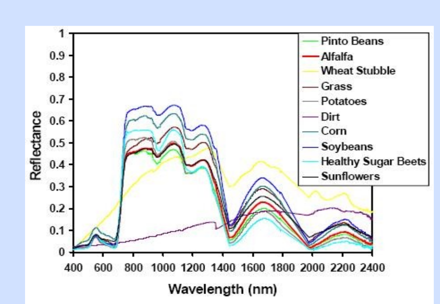
What Can A Pixel Can Tell You?

Spectral Signature graphs can be created by plotting brightness (DN) values (or reflectance) versus wavelength of bands for one individual pixel. Signature Graphs are unique for different types of surfaces (soil, vegetation, buildings, etc.). Spectral Signature graphs can also be useful in helping to identify features for land use classification analysis.





Comparison of graphs for pixels of healthy or stressed sugar beets (0 for non-reflective to 1 for maximum reflectance).



Comparing Spectral Signature graphs of reflectance for different surfaces.

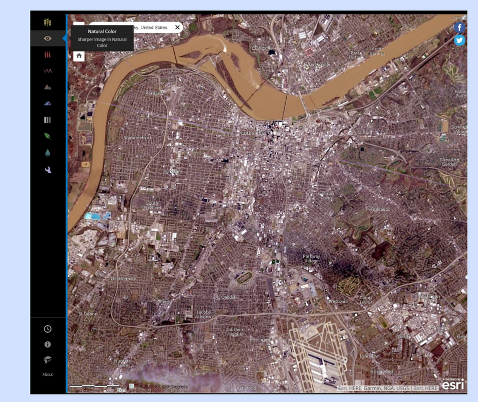
Imagery Resolutions

Spatial – size of area on the ground of one pixel and area of image on the ground
Temporal – how often data (imagery) is acquired for the same location
Radiometric – the sensitivity of sensor to discriminate and collect slight differences in emitted or reflected energy (its bit depth)
Spectral – specific wavelengths of spectrum collected by sensors

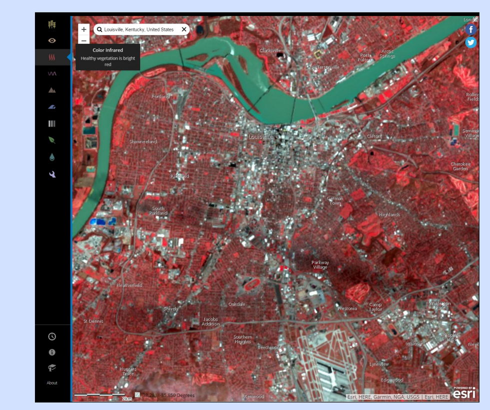
Landsat is generally 30 m resolution with collection on 16 day repeat cycles. Radiometric and Spectral resolutions vary for different Landsat missions. Other imagery sources will have different resolutions.

Investigating Louisville, KY Using Landsat Explorer

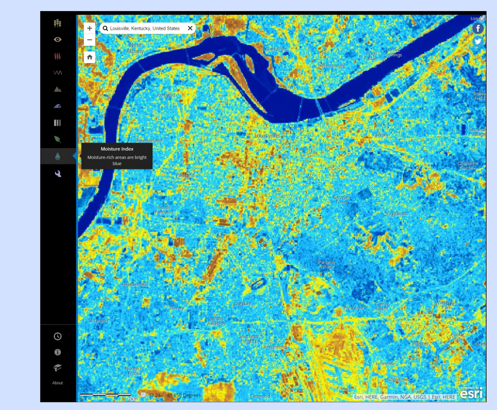
(http:/Esriurl.com/LandsatOnAWS Unlocking Earth's Secrets and Landsat Explorer)



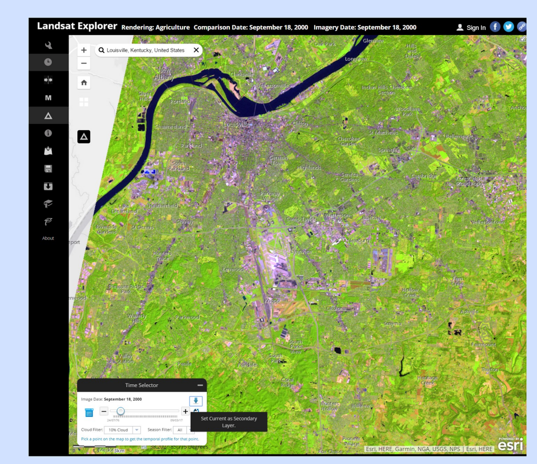
True Color Landsat 8. 30 m Bands 4, 3, 2 + panchromatic 15 m Band 8, March 2017

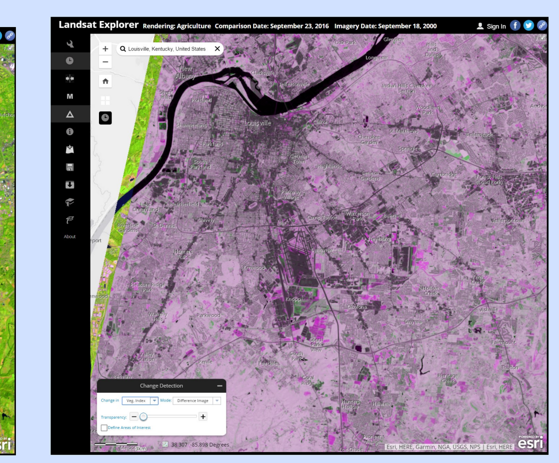


False Color (color infrared) Landsat 8, 30 m, Bands 5,4, 3 March 2017

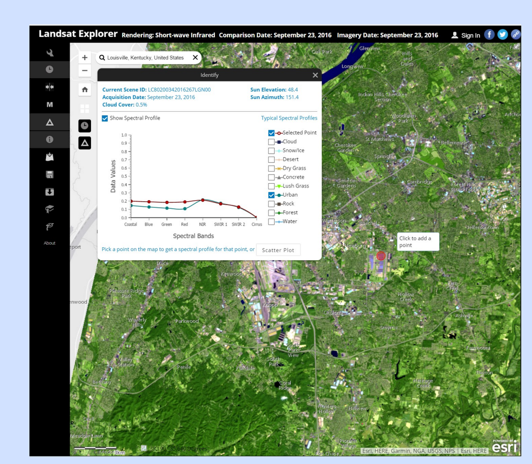


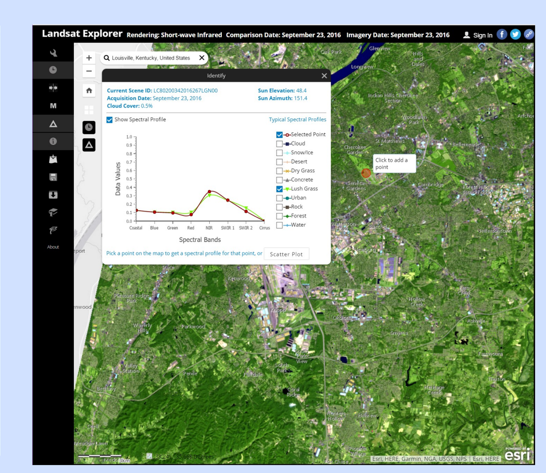
Moisture Index: Normalized Difference Moisture Index (NDMI) March 2017 (Band5-Band6/Band5+Band6)



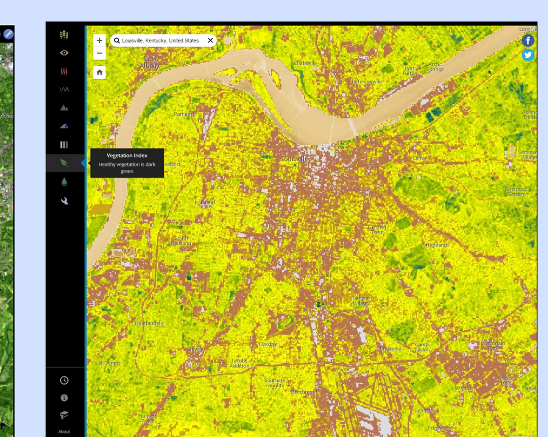


Agriculture Highlighted with agriculture in bright green, Band 6, 5, 2— Image on left is from September 2000 and image in middle is September 2016. Note areas where there is urban development or other changes between those dates. Image on right highlight changes with pink indicating greening loss and green indicating gain.



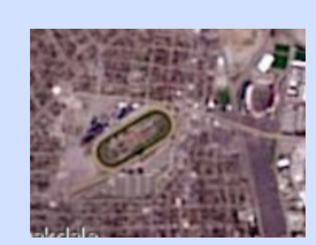


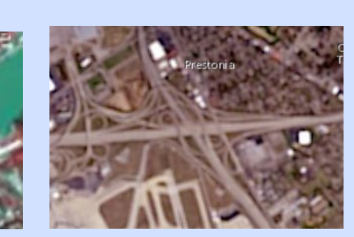
Two images have Spectral Signature graphs identifying the type of surface feature at the red dot on each image (Landsat 8, Bands 7,6,4 Short Wave Infrared)



Vegetation Index: Normalized Difference Vegetation Index (NDVI) (Band5-Band4/Band5+Band4)

Can You Identify These Features?





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Ann Johnson 2019