Geography 360: GIS & Mapping

Data Models and Databases

Data Collection I

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Review

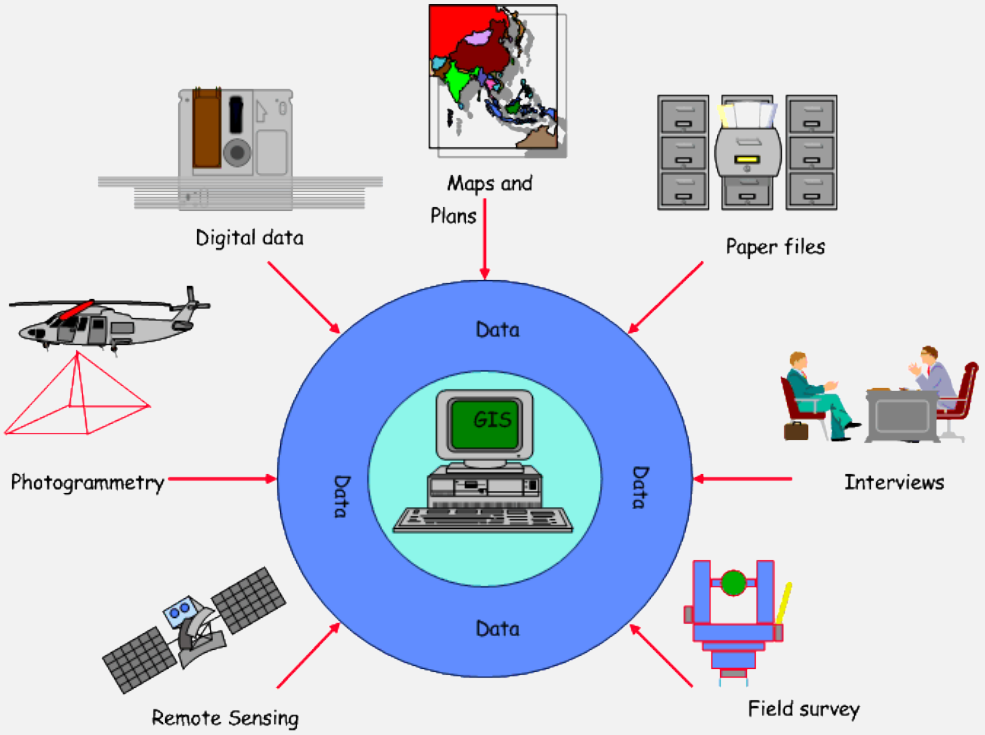
- **Uncertainty is much more than error**
- **Sources of error**
- **Uncertainties in three stages**
  - Conception
  - Measurement and representation
  - Analysis
- **Scale**

Learning Objectives

- Understand the primary and secondary **techniques of data capture**.
- Understand concepts in **remote sensing** for **raster** data capture.
- Be familiar with techniques of vector data capture e.g. scanning, manual digitizing, vectorization.
- Familiarize with new sources of spatial data.

Data Collection

- **Six components of GIS**
  - Software, hardware, network, people, procedure, and **data**
- **Can be the most expensive GIS activity**
  - Data capture costs can account for up to 85% of the cost of a GIS
- **Many diverse sources**



Source: http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/ModernSurveyingTech/lectureE_40/E_40_4.htm

Introduction

- ***Data capture*** **(direct data input)**
  - ***Primary data sources:***

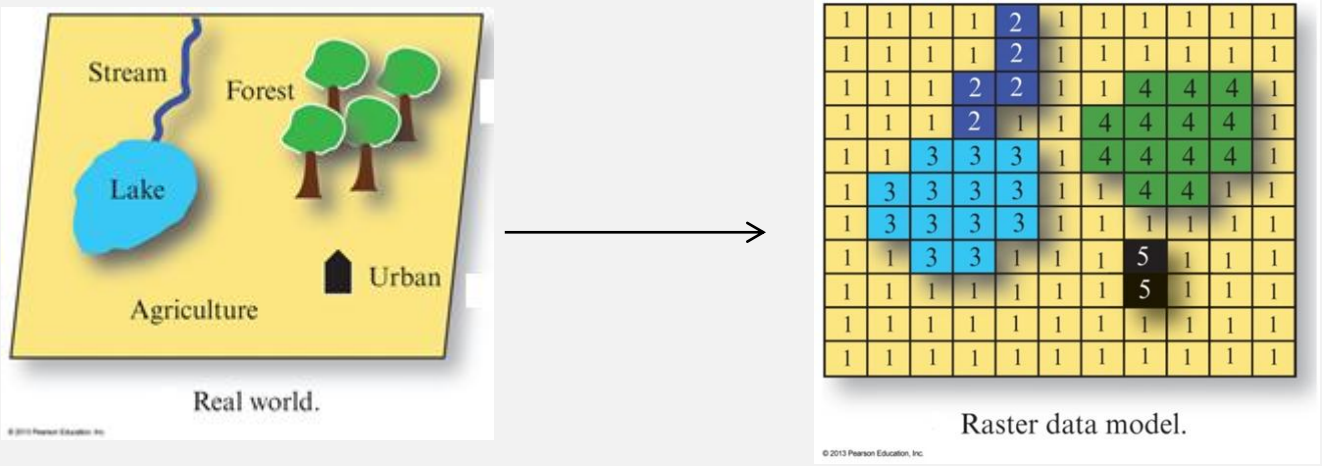
    (direct measurement): collected in digital format **specifically** for use in a GI project.
  - ***Secondary sources:***

    (derivation from other sources) : digital and analog datasets originally **captured for another purpose** and **needing** to be **converted** into a suitable digital format for use in a GI project.

- ***Data transfer*** **(input of data from other systems)**

- **Data typically 15–50% of the total cost of a GI project**
  - If staff costs excluded, data collection can be as much as 60–85% of costs

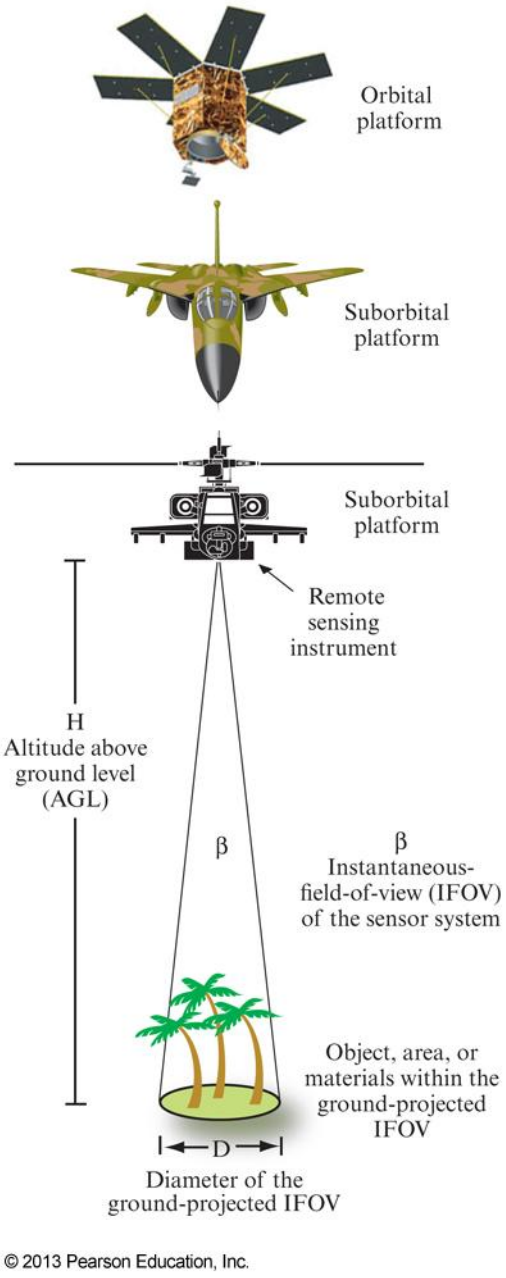
Raster Data Collection



- Remote sensing
- Vector to raster conversion
- Raster data capture using scanners
- Interpolation

Raster Data Capture

- **Remote Sensing**
  - Is the measurement of physical, chemical, and biological properties of objects without direct physical contact.
  - Remote sensing instruments can be flown onboard satellites, airplanes, helicopters, unmanned aerial vehicles, and balloon.

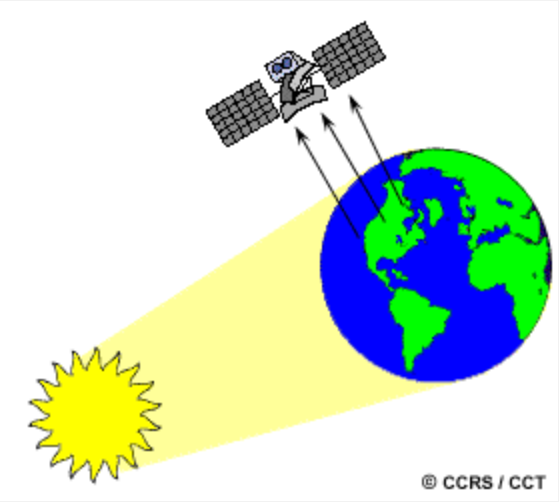


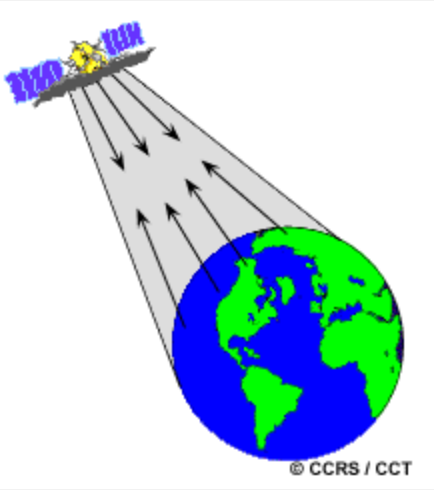
Raster Data Capture

- **Remote Sensing : Passive and Active Sensors**

  - **Passive sensors** rely on reflected solar radiation or emitted terrestrial radiation
    - Can easily be affected by cloud

  - **Active sensors** generate their own source of radiation to monitor the earth surface
    - Weather independent
    - Sunlight independent: can be operated day and night





http://www.seos-project.eu/modules/remotesensing/remotesensing-c02-p02.html

Raster Data Capture

- **Resolution is the key consideration**
  - Spatial
  - Temporal
  - Spectral

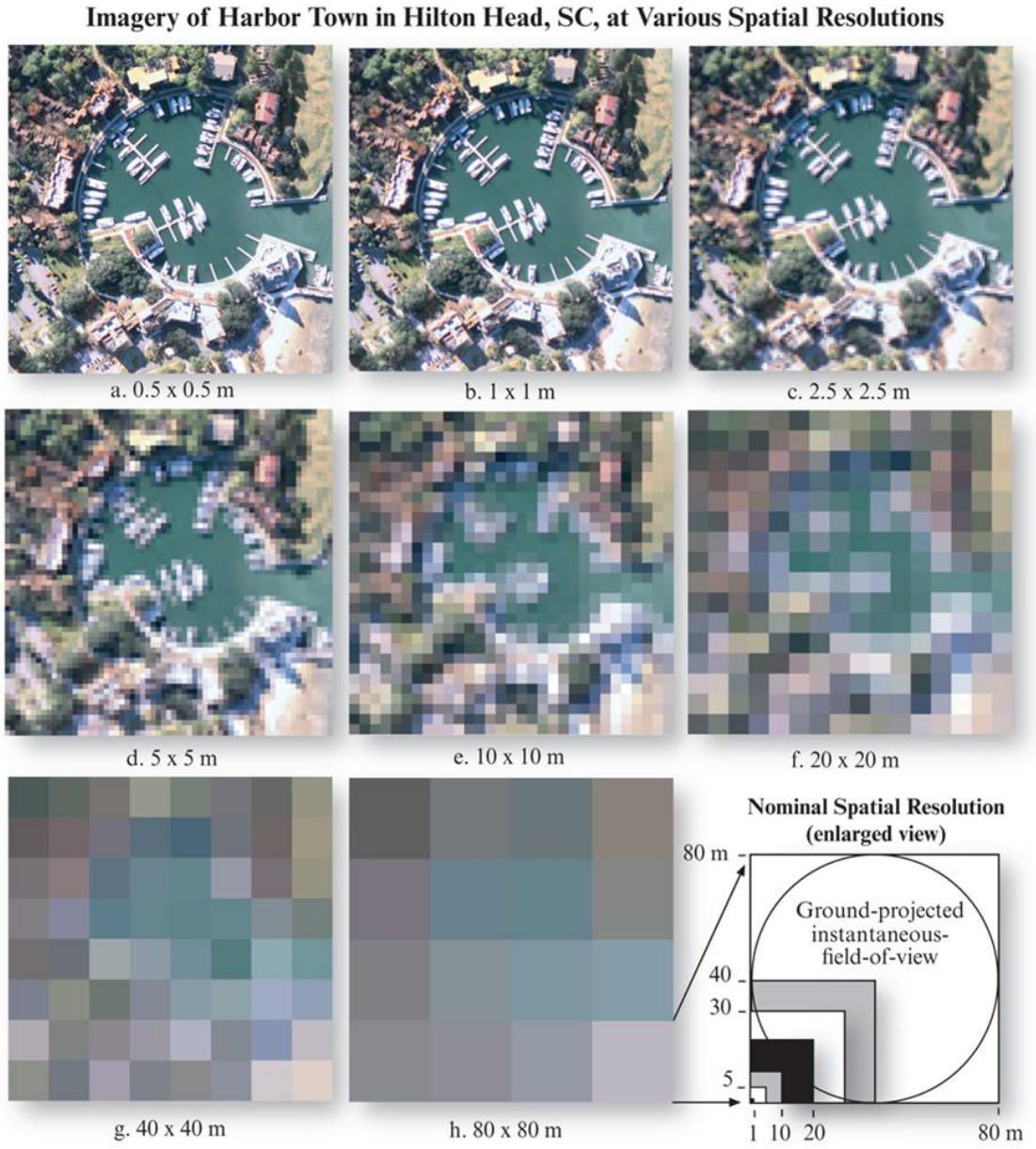
Spatial Resolution

- **Spatial resolution :**
  refers to the size of smallest possible objects that can be detected.

- **The most usual measure is the pixel size.**

- **For urban analysis, the spatial resolutions greater than 10m are practically useless**
  - E.g., Landsat MSS data (79m) are of little value for most urban applications

- **In ArcGIS,**
  - right-click the raster layer, go to property/source to check the spatial resolution



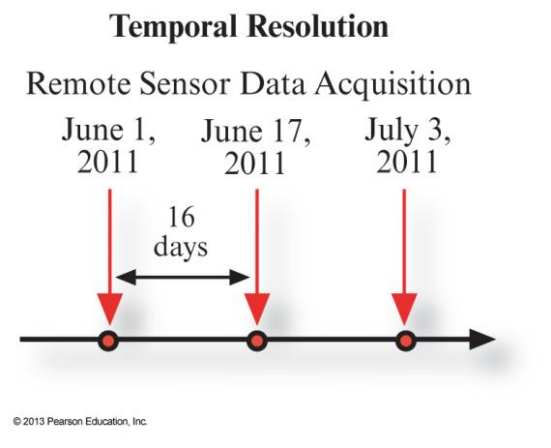
Temporal Resolution

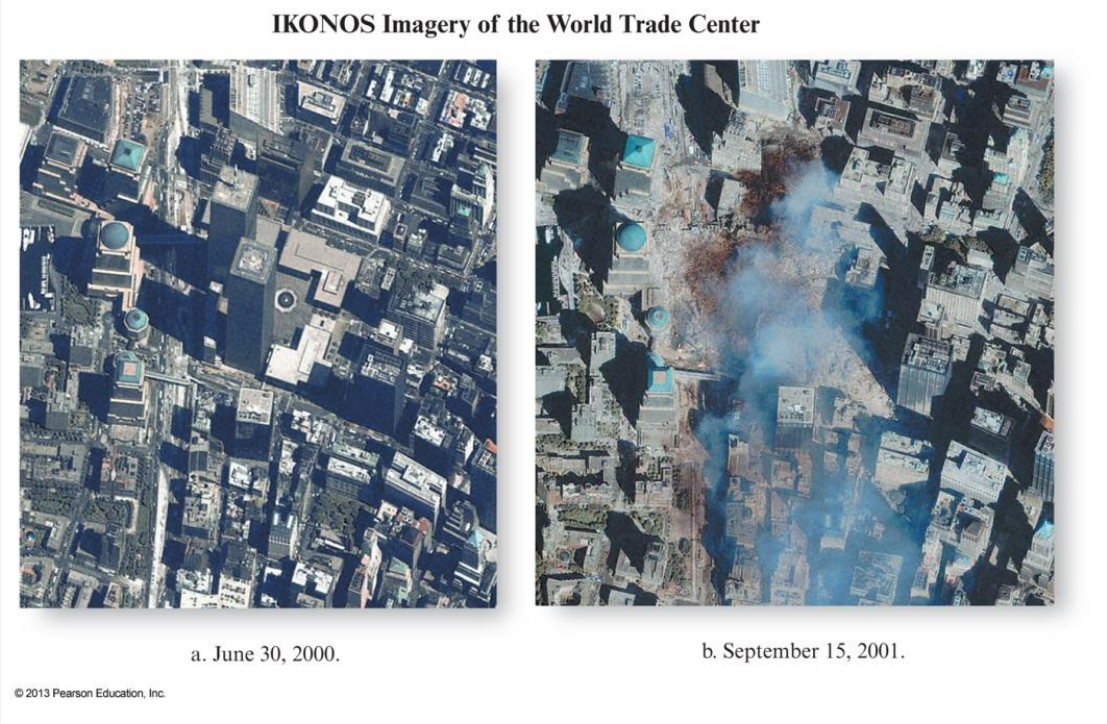
- **Temporal resolution:**

  generally refers to how often the remote sensor records imagery of a particular area.

  e.g., every 16 days

- Multiple records of the same area obtained through time can be used to identify change and make predictions.





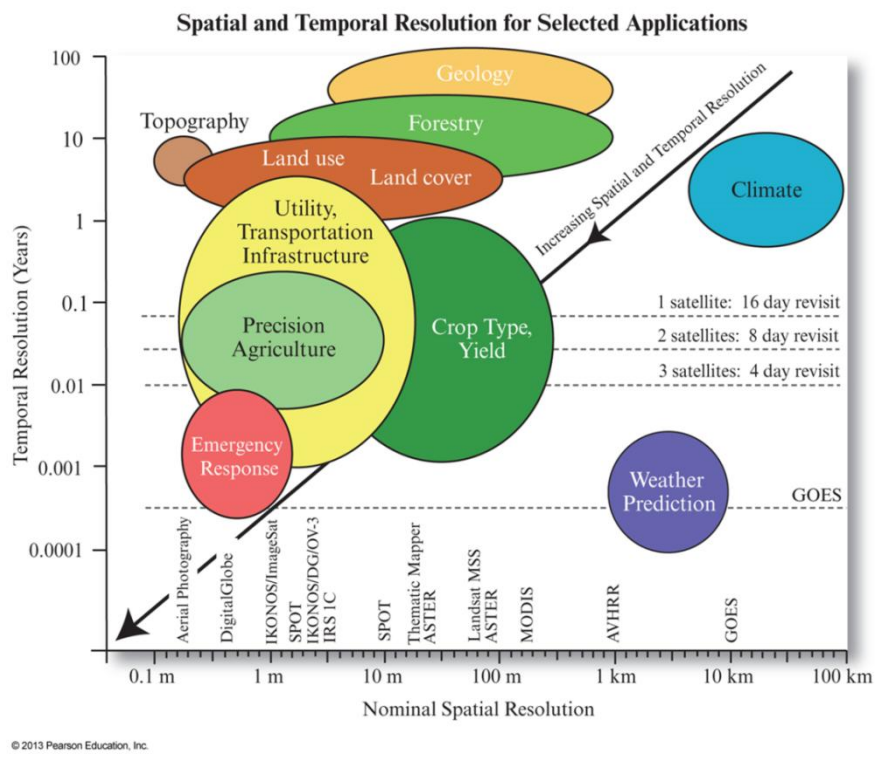
E.g.,

- **16-day** revisit cycle - NASA Landsat Thematic Mapper
- **Every half hour** - GEOS (Geostationary Operational Environmental Satellites)

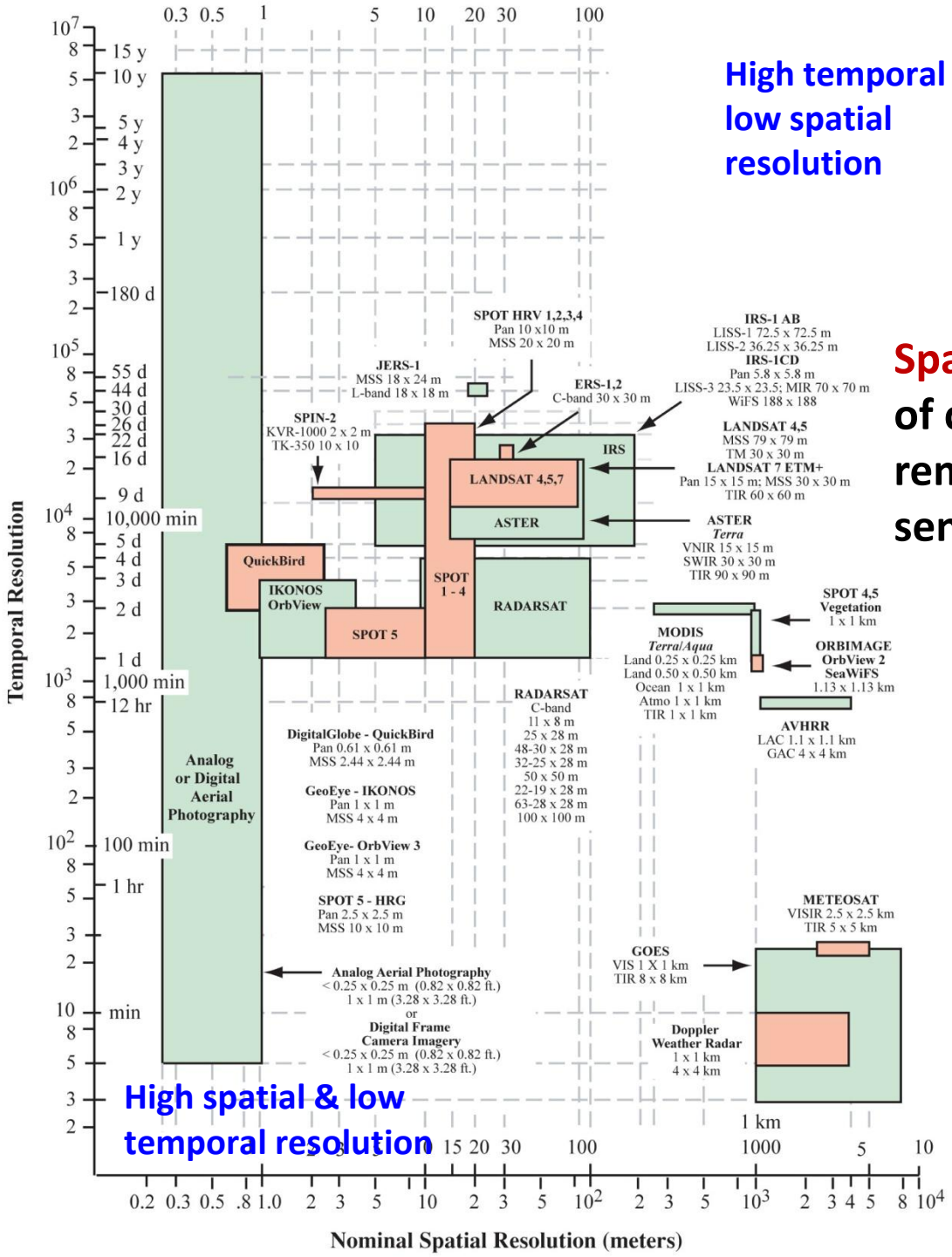
Trade-Off Between Spatial and Temporal Resolution

Applications

- **Weather predication**
  - Require very high temporal (e.g., every half-hour) resolution but low spatial resolution (e.g., 4 to 8 km)
- **Emergency response**
  - Require very high spatial (e.g., 0.5m) resolution and high temporal resolution (e.g., daily)
- **Land use mapping**
  - Generally require high spatial resolution imagery (1 to 5m) at relatively low temporal resolution (1 to 10 years)



- Pointabel Satellites - can acquire imagery off-nadir. (Nadir = point directly below the spacecraft.)
- Obtain imagery during an emergency,
- E.g., SPOT, IKONOS, Quick Bird, ImageSat



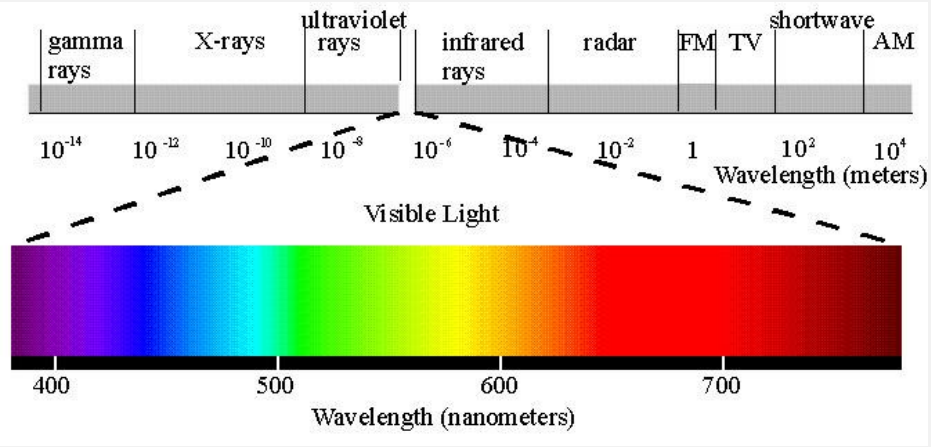
High temporal & low spatial resolution

High spatial & low temporal resolution

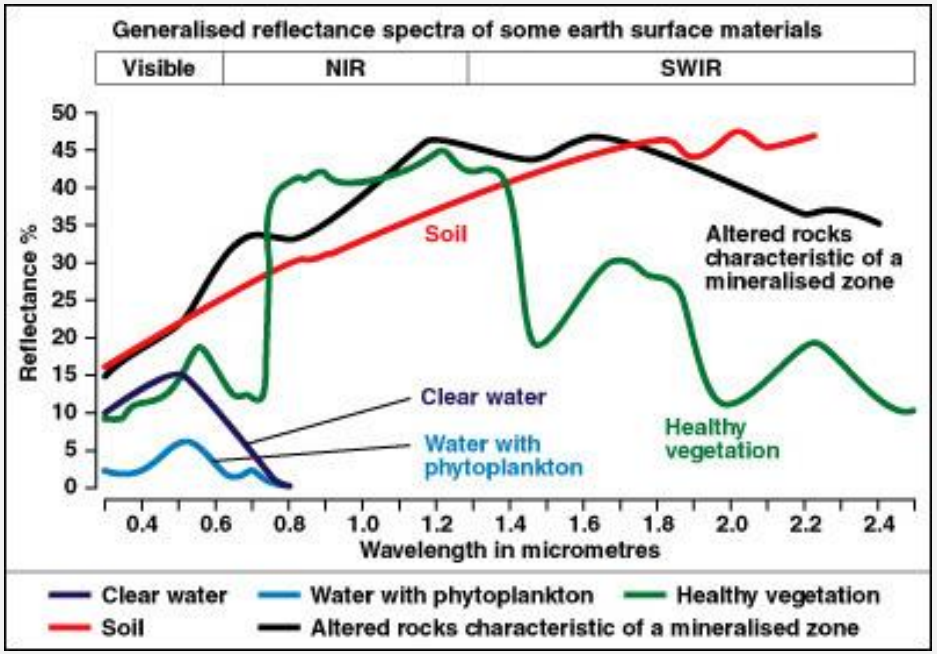
Spatial and temporal characteristics of commonly used Earth observation remote-sensing systems and their sensors

Spectral Resolution

- Spectral resolution refers to the **parts of the electromagnetic spectrum** that are measured .
- Different objects **emit and reflect** different **types and amount** of **radiation**.



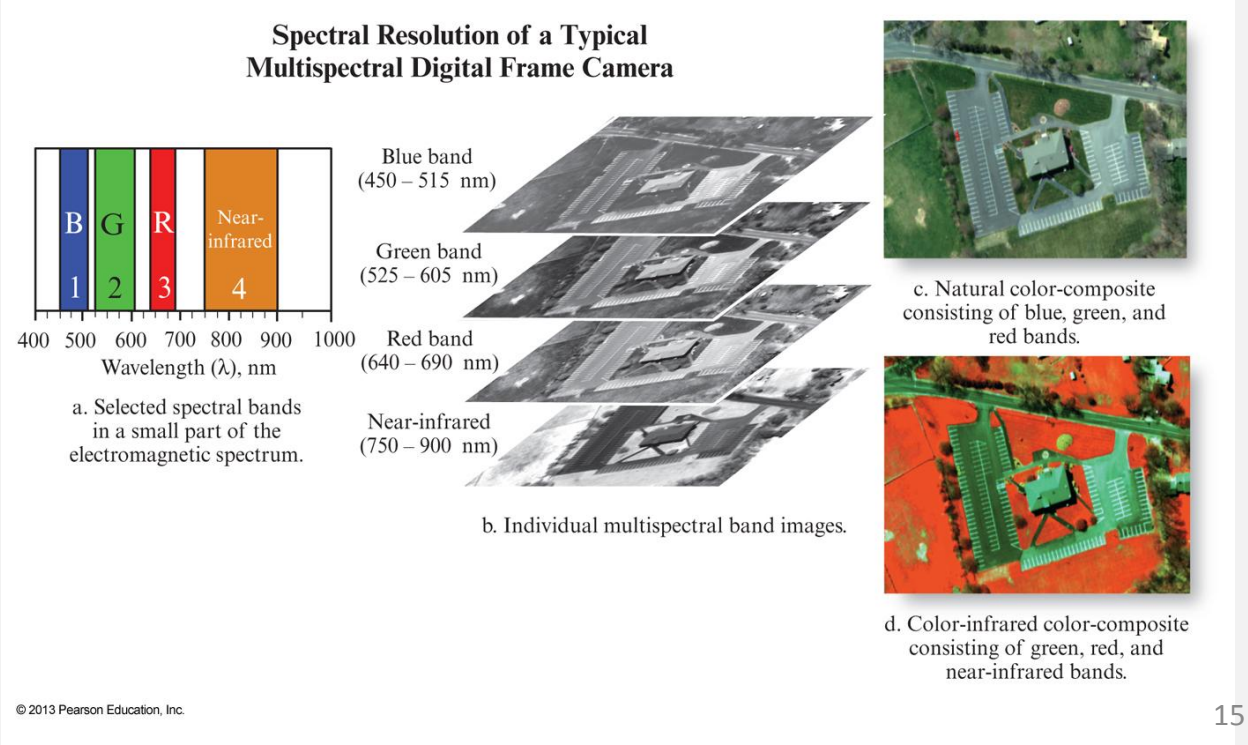
http://news.satimagingcorp.com/2007/05/characterization_of_satellite_remote_sensing_systems.html



Source: http://www.rsacl.co.uk/rs.html

Spectral Resolution

- Spectral resolution
  - Is the number and size of specific wavelength interval (referred to as bands) in the electromagnetic spectrum to which a remote sensing instrument is sensitive .
  - Multispectral remote sensing
    - Records energy in multiple bands
  - Hyperspectral remote sensing
    - Records in tens to hundreds of spectral bands



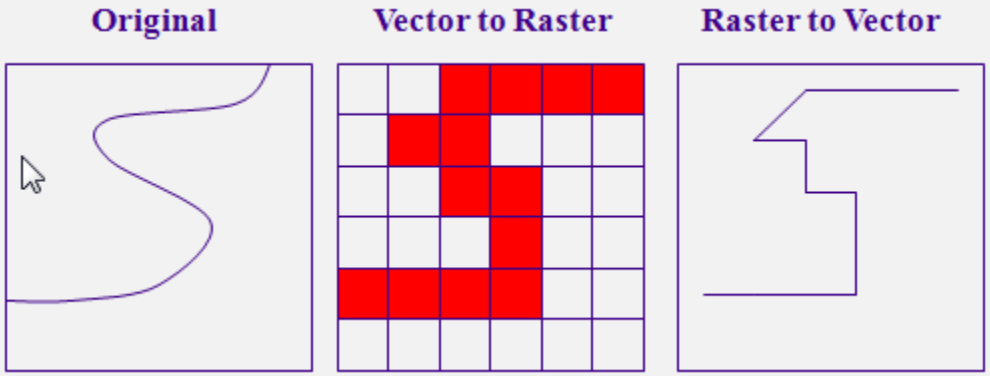
Vector to Raster Conversion

Point vector to raster conversion:

- If there is only a single point in a cell, that point's value is assigned to the cell.
- node x,y assigned to closest raster cell .
- locational shift almost inevitable; error depends on raster size.
- two points in one cell indistinguishable
- If more than one point in a cell

  - Sum, Mean, Minimum, Maximum, Range, Most frequent
- not transitive; cannot retrieve original data without error

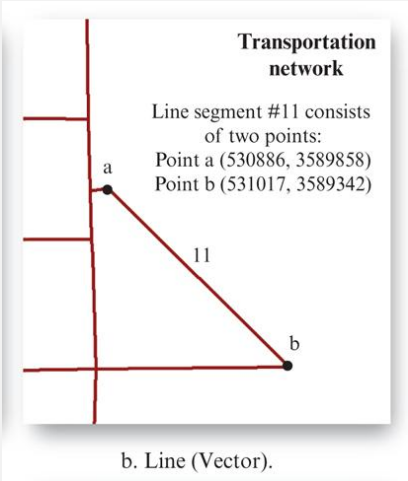
Transitive: the ability to reproduce the original data after conversion.



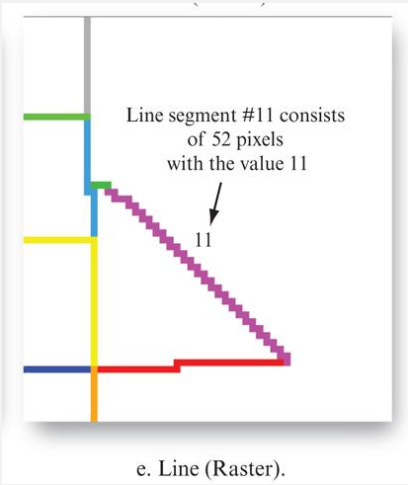
Vector to Raster Conversion

Line vector to raster conversion:

- Cells assigned if touched by line .
- Stair step appearance of diagonal lines (called aliasing).
- If there is more then one line in the cell, then:
  - Maximum_Length
  - Maximum_Combined_Length
  - If the priorities are adopted, then select the one with the highest priority.



b. Line (Vector).



e. Line (Raster).

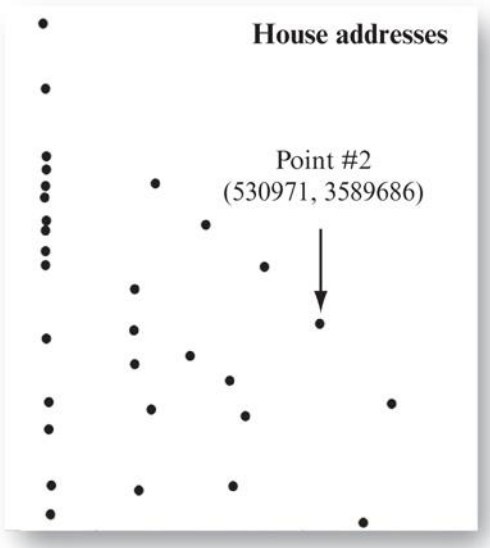
Vector to Raster Conversion

Polygon vector to raster conversion:

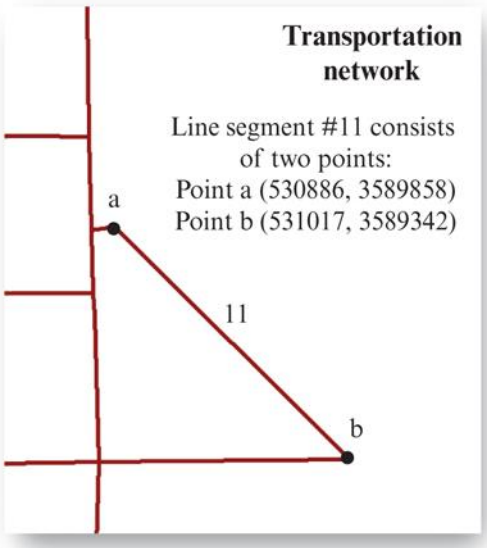
There are three ways to control how the cell will be assigned a value when more than one feature falls within a cell.

- CELL_CENTER
- MAXIMUM_AREA
- MAXIMUM_COMBINED_AREA

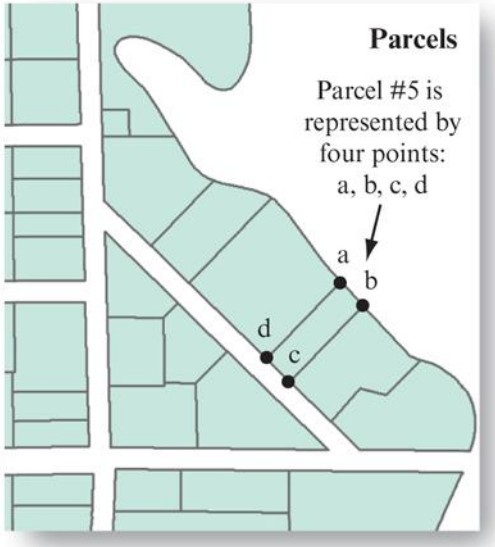
Vector to Raster Conversion



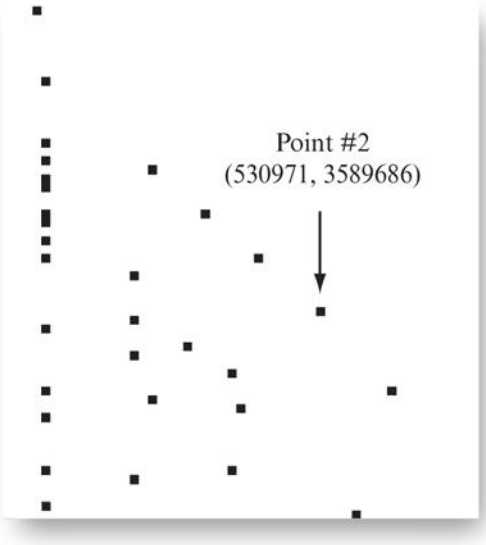
a. Point (Vector).



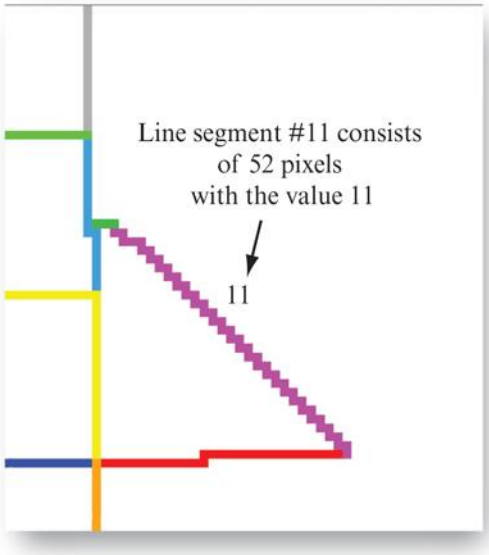
b. Line (Vector).



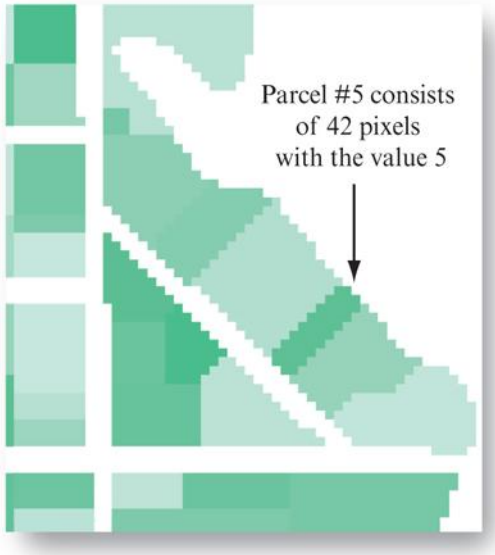
c. Area (Vector).



d. Point (Raster).



e. Line (Raster).



f. Area (Raster).

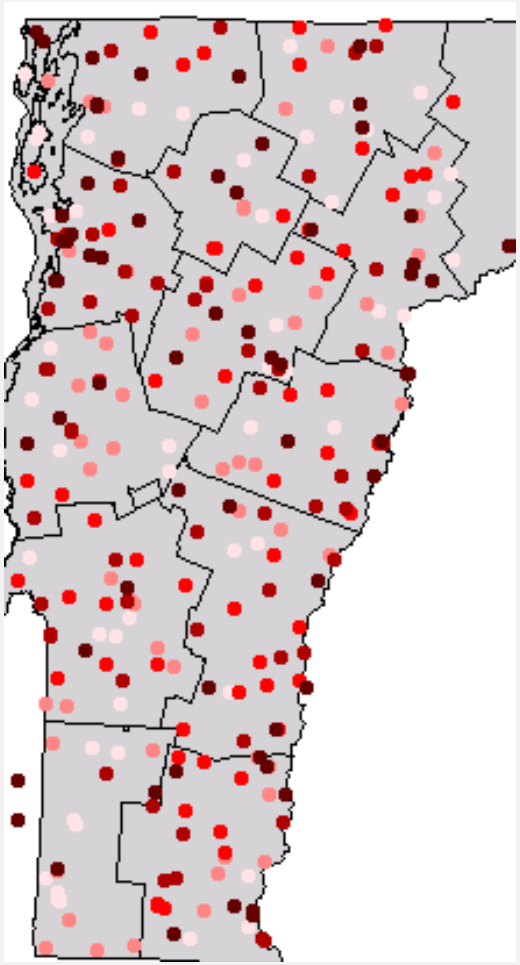
Raster Secondary Data Capture

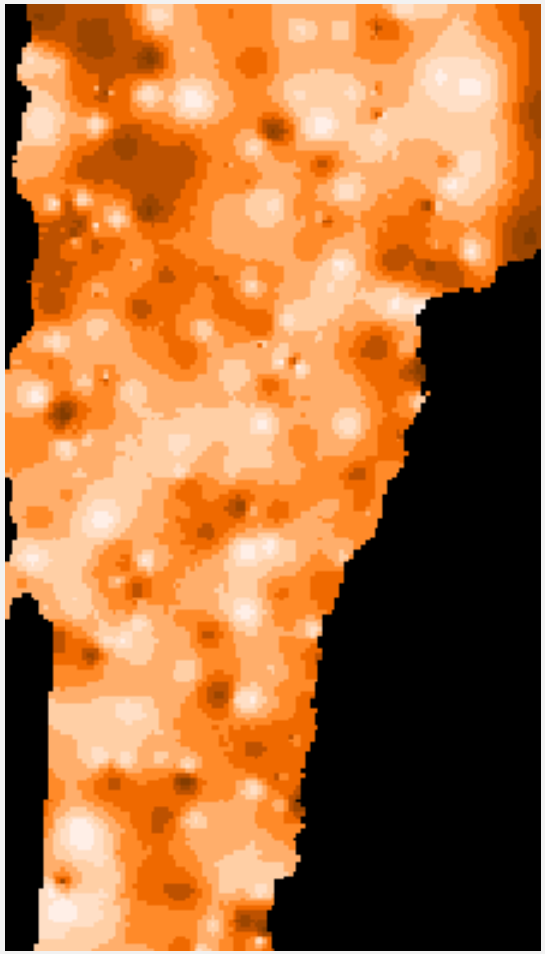
- **Raster data capture using scanners:**
  - Scanning of maps, aerial photographs, and other hard-copy documents into digital images.
    - Most GIS scanning is in the range 400-900 dpi (dot per inch).
  - The larger the dpi, the higher the resolution, the longer it takes to scan a map.
  - After scanning, the images have to be georegistered so that they provide geographic context for other spatial data.

Several terms are used to describe the act of assigning locations including **georeference**, geolocate, geocode, or tag with location.

Interpolation

- Process of creating a continuous surface based on values at isolated sample points.





Conclusion

- **Primary geographic data capture**
  - direct measurement of objects
- **Secondary geographic data capture**
  - the process of creating raster and vector files and databases from maps, photographs, and other hardcopy documents.
- **Raster data capture** (Primary & Secondary)
- **Vector data capture** (Primary & Secondary)
- **New sources of spatial data**

Questions ?

https://www.google.com/url?sa=i&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwihuqvgkpjcAhU3IDQIHZbqB8QQjRx6BAgBEAU&url=http%3A%2F%2Fwww.cityofrockhill.com%2Fdepartments%2Finformation-technology-services%2Fmore%2Finformation-technology-services%2Fgeographic-information-systems-gis-%2Fgis-frequently-asked-questions&psig=AOvVaw2fEUXAIjbJY26W-bnjS0wY&ust=1533436220322311

Upcoming

- Lecture : Data Collection II
- **Lab 03 due** (Check Syllabus)
- Readings updated on canvas.
- Exam in Week 6
- DRS accommodations