Project for the Strengthening of Spatial Data Infrastructures in Member States and Territories of the Association of Caribbean States

Capacity Building Program

Geographic Information Systems

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Topic 3:
Data Acquisition Techniques

Topic Outline

- Overview of Data Acquisition
- Fundamental Datasets required for GIS
- Sources of GIS Data
- Primary and Secondary
- Use of Terrestrial Photogrammetry
- Web-Based Data Sources
- Metadata

Data Acquisition

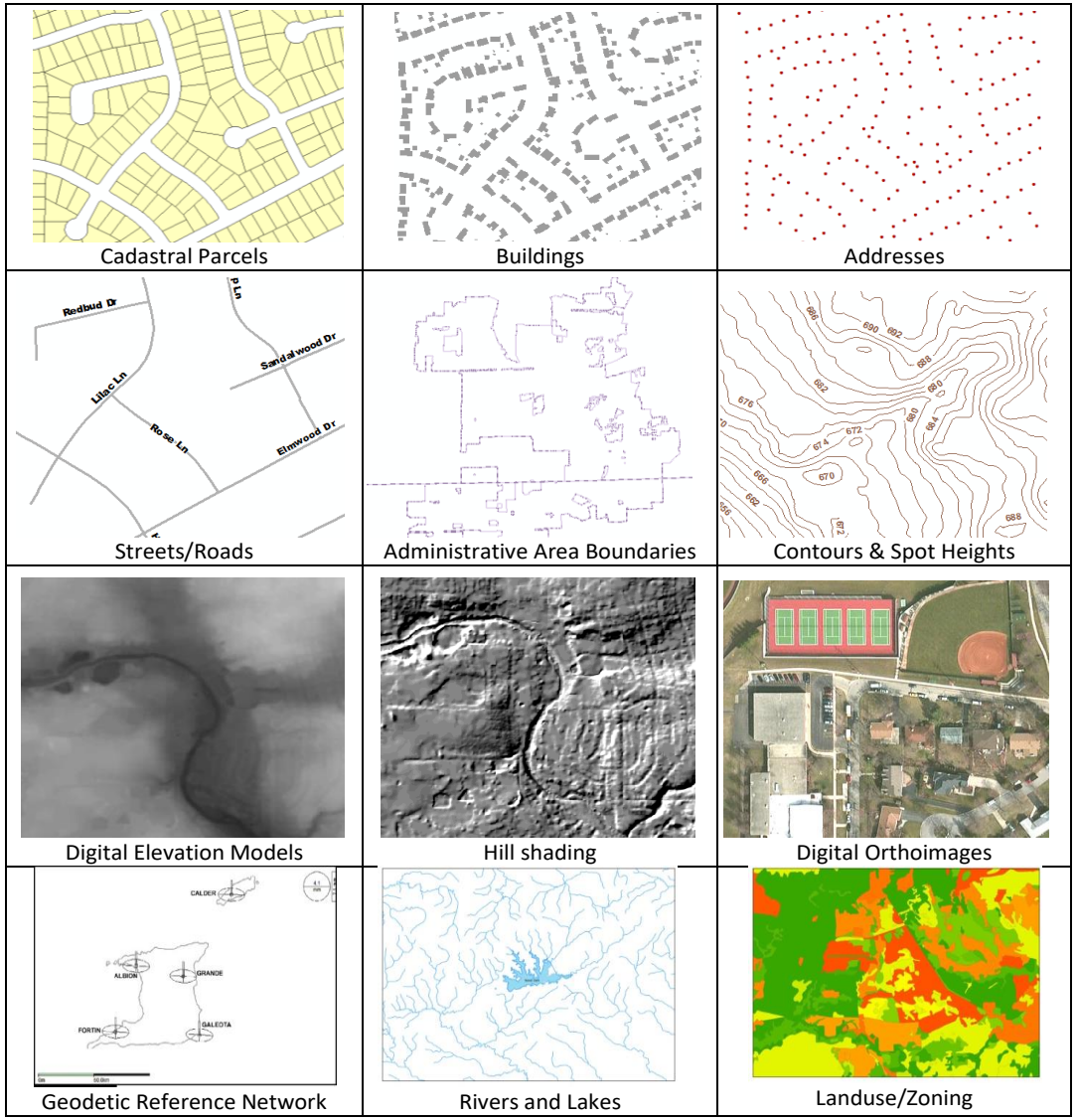
- The processes of data acquisition are also variously referred to as data capture, data automation, data conversion, data transfer, data translation, and digitizing

- When acquiring data, one must bear in mind:
  - Purpose
  - Accuracy
  - Datum and Map Projection
  - Scale

Data Acquisition

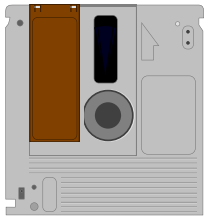
- A key success factor for any GIS is the acquisition of data appropriate for the applications identified in the needs assessment stage
- Data acquisition traditionally is the most costly component of a GIS project. (approx. 80%)
- It is important to determine exactly what data is required in terms of accuracy, resolution, scale, completeness, and consistency
- Data availability and data quality requirements affect the time taken and cost incurred in database development

Fundamental Datasets Required for GIS

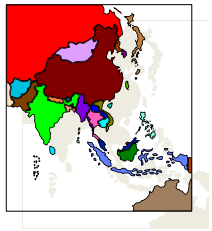


What is the most appropriate method for acquiring each of these datasets ?

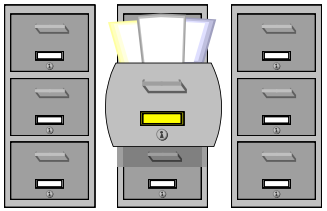
Sources of GIS Data



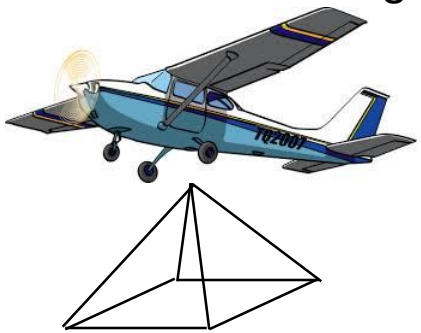
Digital data



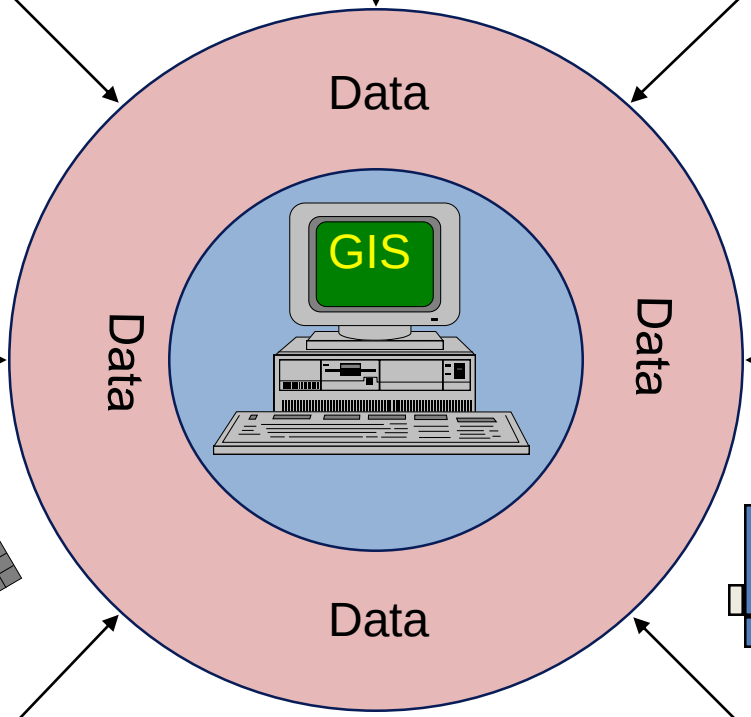
Maps and Plans



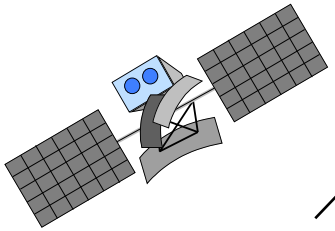
Paper files



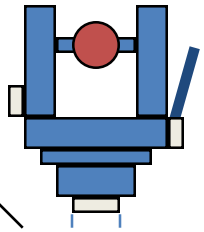
Photogrammetry



Interviews



Remote Sensing



Field survey

Primary and Secondary Sources of GIS Data

Primary Methods

Data collected directly from the field

- Field Surveying
- GNSS
- Photogrammetry
- LiDAR
- Remote Sensing
- Meteorological Sensors

Secondary Methods

The use of existing sources

- Digitising Existing Maps/Charts
- Paper Files

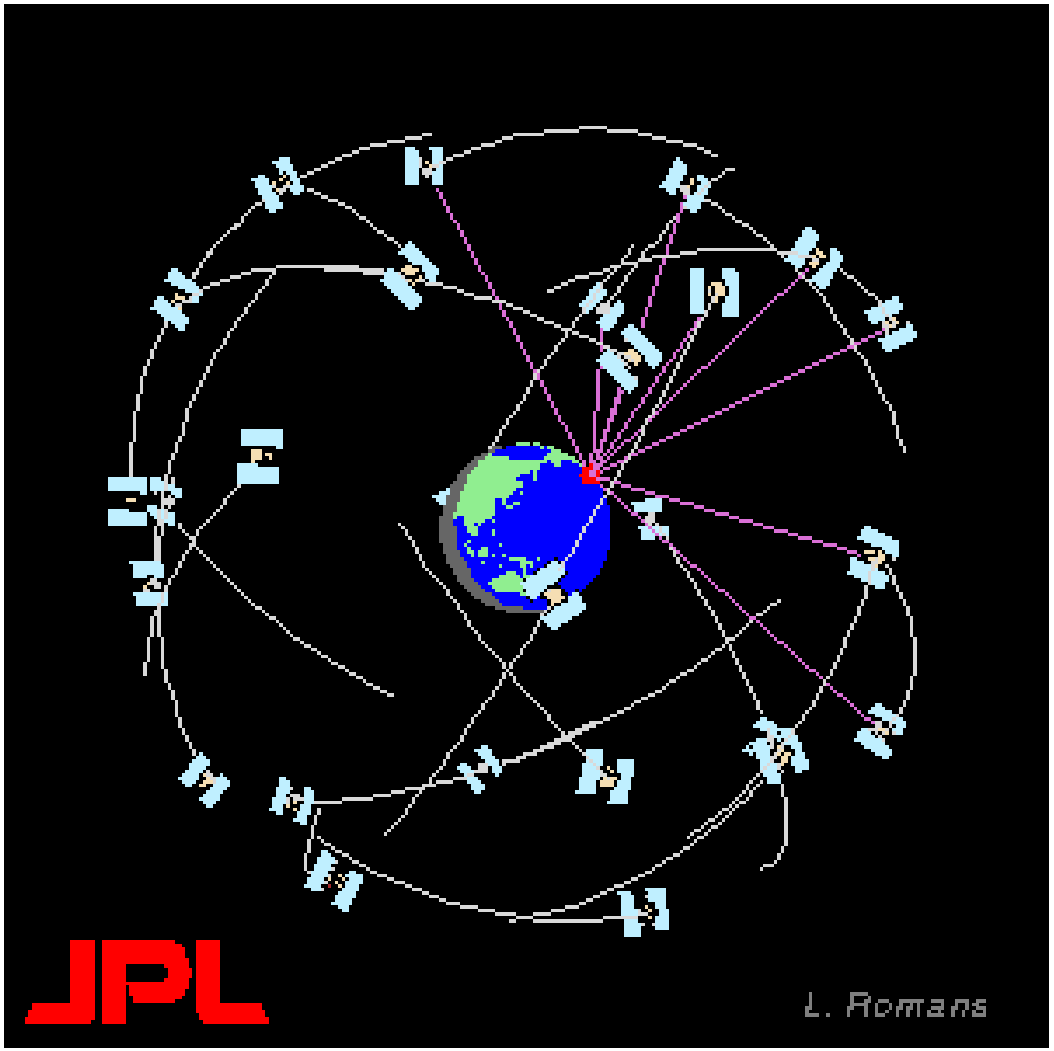
Primary Methods

- **Field Surveying**
  - Terrestrial Surveying
    - measured angles and distances from known points are used to determine the positions of other points.
    - traditional method of spatial data collection.
    - Requires skilled and experienced field personnel and checking the accuracy in-field.
    - Accuracy was a function of the equipment as well as the observational technique.
    - Convenient for smaller areas.

Primary Methods - GNSS

- The term ‘Global Navigation Satellite System’ (GNSS) refers to a constellation of satellites providing signals from space transmitting positioning and timing data.
- By definition, a GNSS provides global coverage.
- Determines location by using the timing and positioning data encoded in the signals from space
- **Global Positioning System (GPS), Navstar, USA**
  - Most widely used and recognized GNSS
  - global satellite based radio-navigation system/technology, consisting of 24 orbiting satellites at an altitude of 20,000 km in space, in six different orbital paths/plane and their ground stations.
  - They are constantly moving, making two complete orbits in less than 24 hours.

NAVSTAR GPS Satellites



Examples of GNSS worldwide

System	Country	Orbital height & period	Number of satellites	Status
GPS	United States	22,200km, 12.0h	≥ 24	operational
GLONASS	Russia	19,100km, 11.3h	20	operational
Galileo	Europe	23,222km, 14.1h	≥ 27	in preparation
Compass	China	21,150km, 12.6h	>30	in preparation

GPS Receivers

Capturing Data with GNSS/Tablets

- Trimble R2
- ArcGIS Collector
- iPad mini 4
- Bluetooth connectivity
- Data sim
- VRS connectivity
- Accuracy +/- 2cm to 1.5m

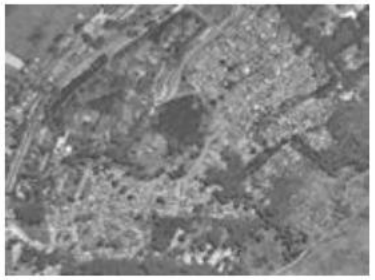
Capturing Data with GNSS/Tablets

Students from the MSc Geoinformatics programme at UWI, St. Augustine, configuring the mobile device for data capture.

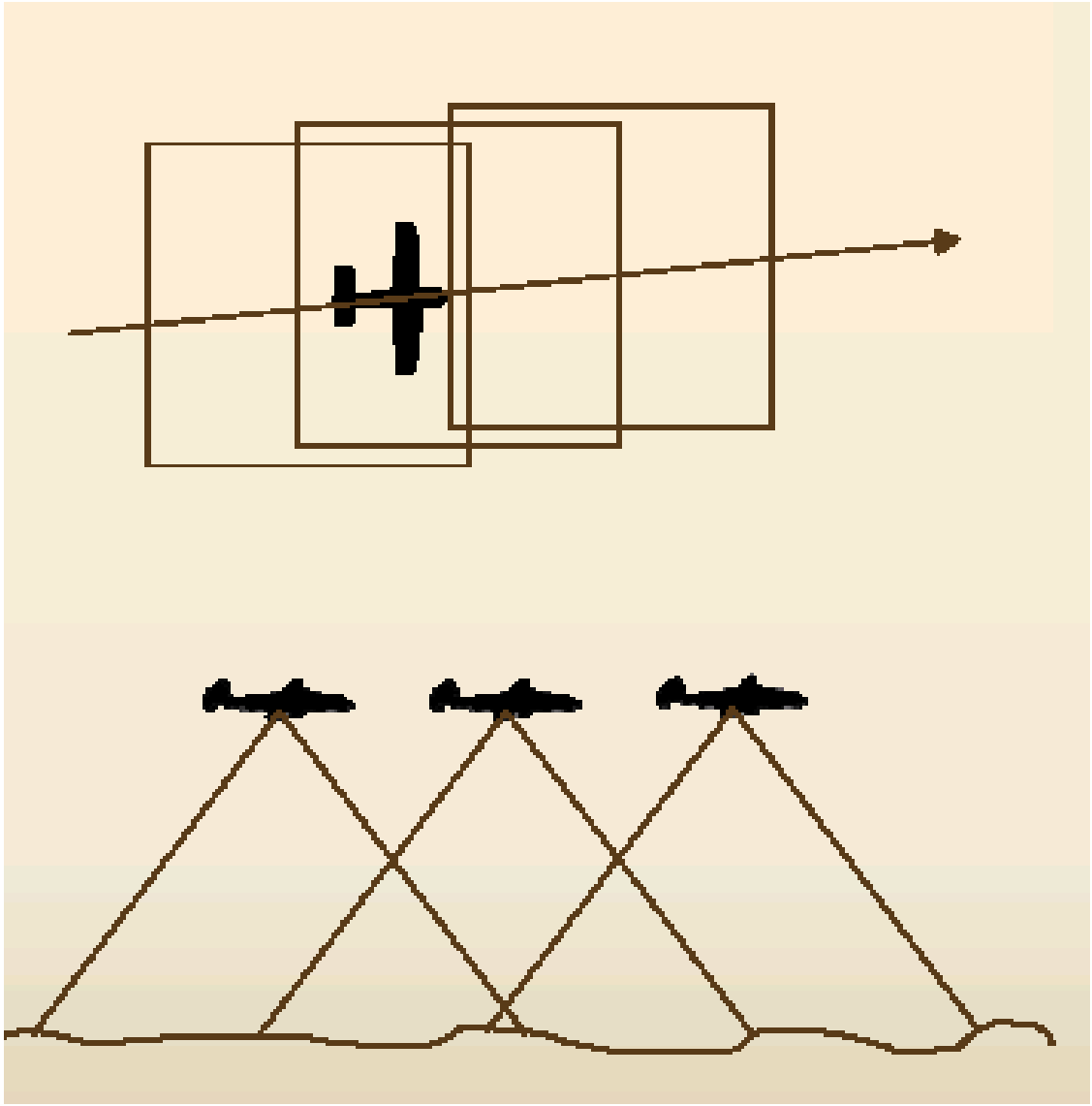
Primary Methods

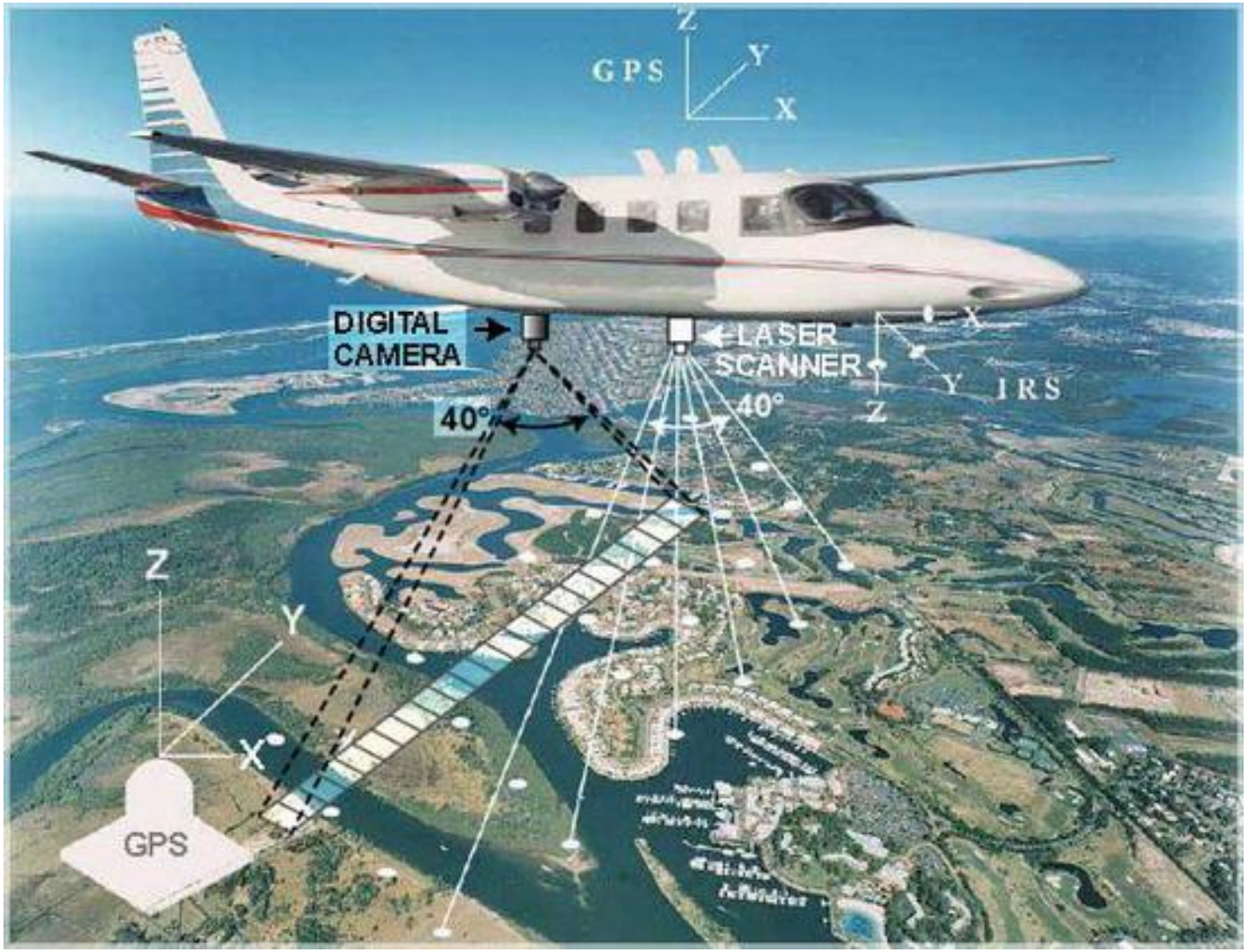
- **Photogrammetry**
  - Involves estimating real world coordinates (X,Y,Z) for ground based objects in 2 or more 2D images based on the approximate perspective and location of the sensor.
  - Overlapping images enable stereo viewing
    - Active: Stereo pair images are alternately flashed on the monitor
    - Passive: both images on monitor simulataeneously, stereo view achieved with anaglyph or polarised.
  - Products: Planimetric maps, orthophotos, DTM, etc.

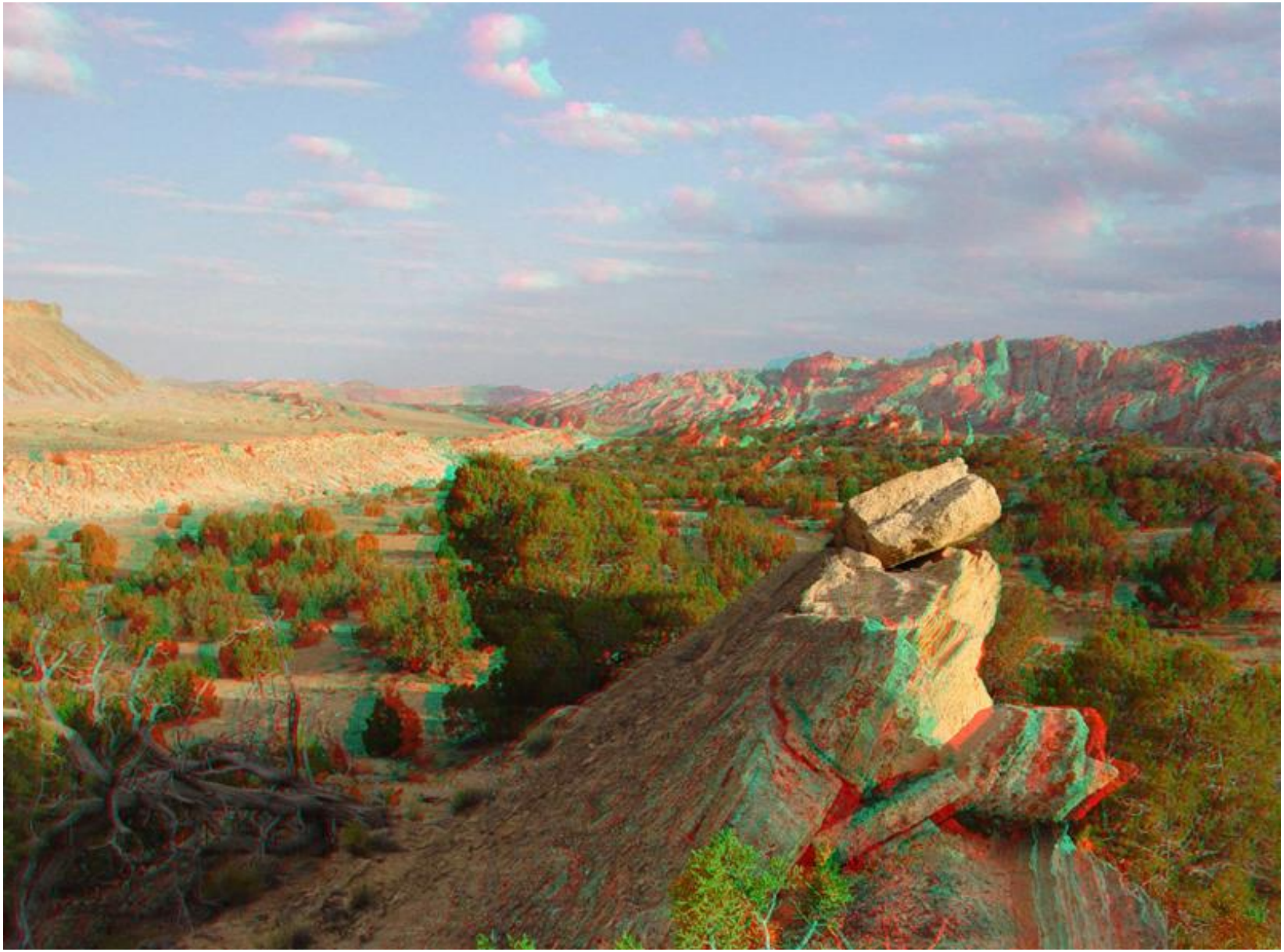
Single photograph + Sensor parameters = 2D measurements



Multiple photographs + Sensor parameters = 3D measurements




GPS
Z
Y
X
DIGITAL CAMERA
LASER SCANNER
40°
40°
Z
Y
X
IRS
Z
Y
X
GPS



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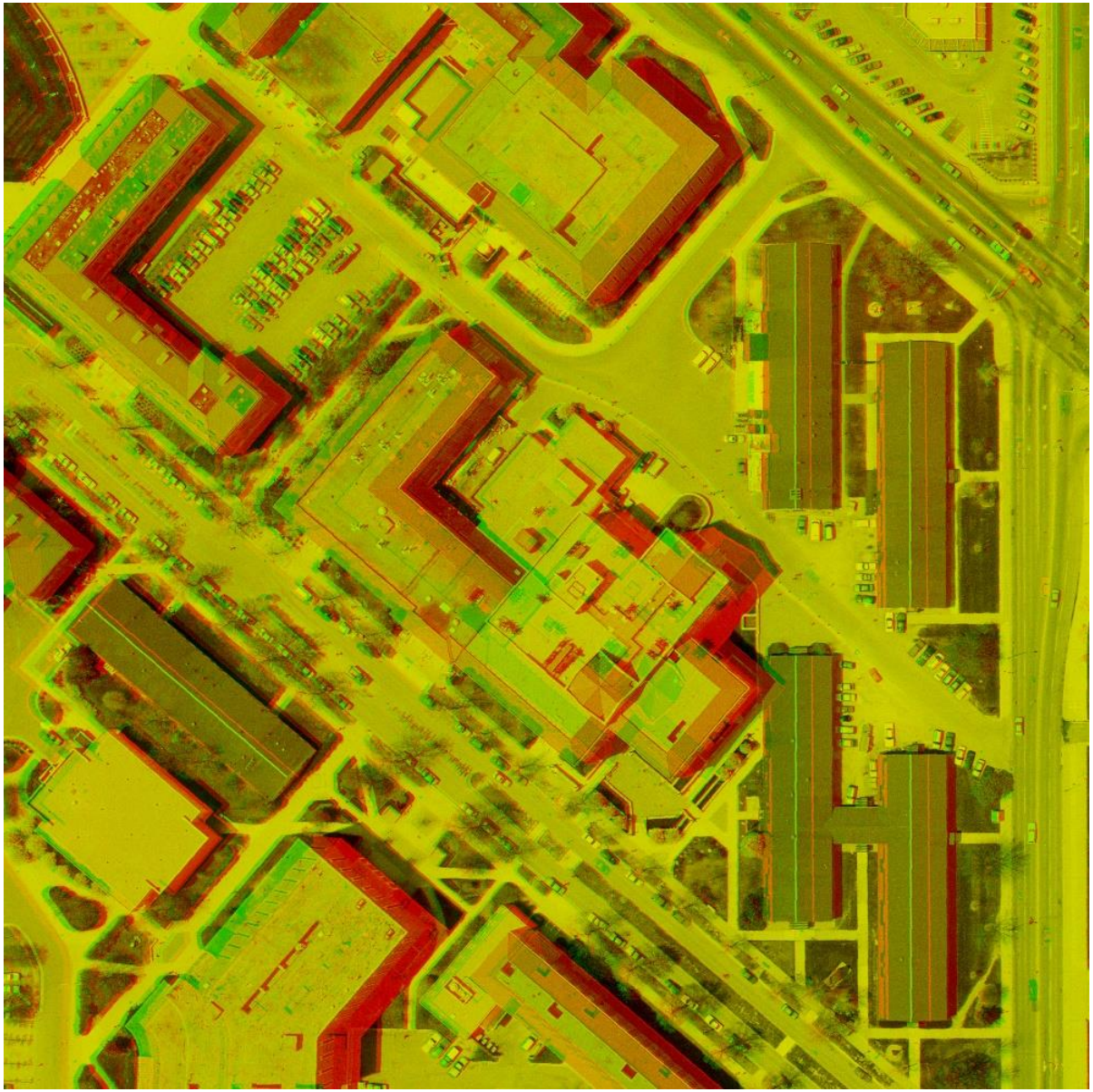
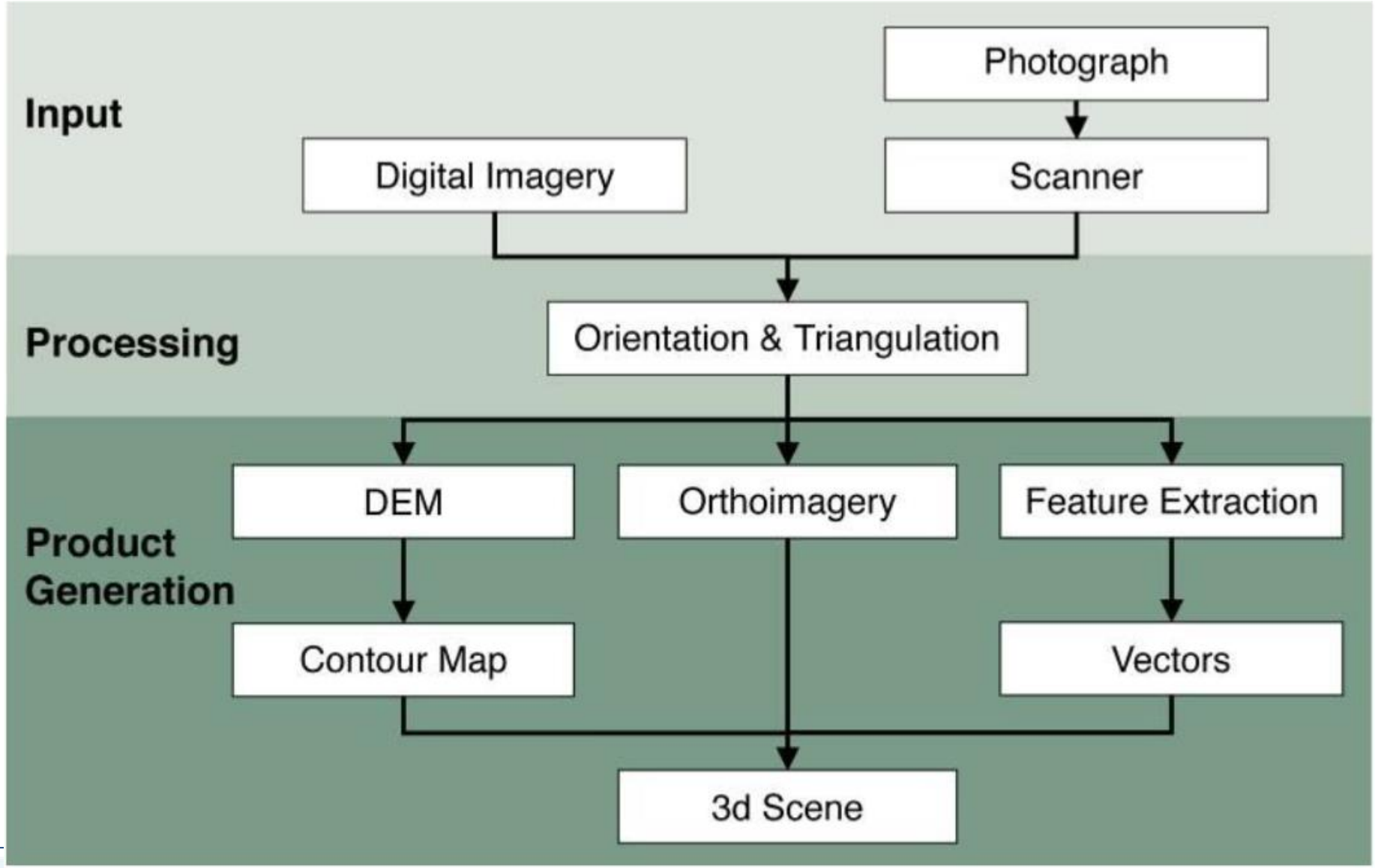
Anaglyphic View



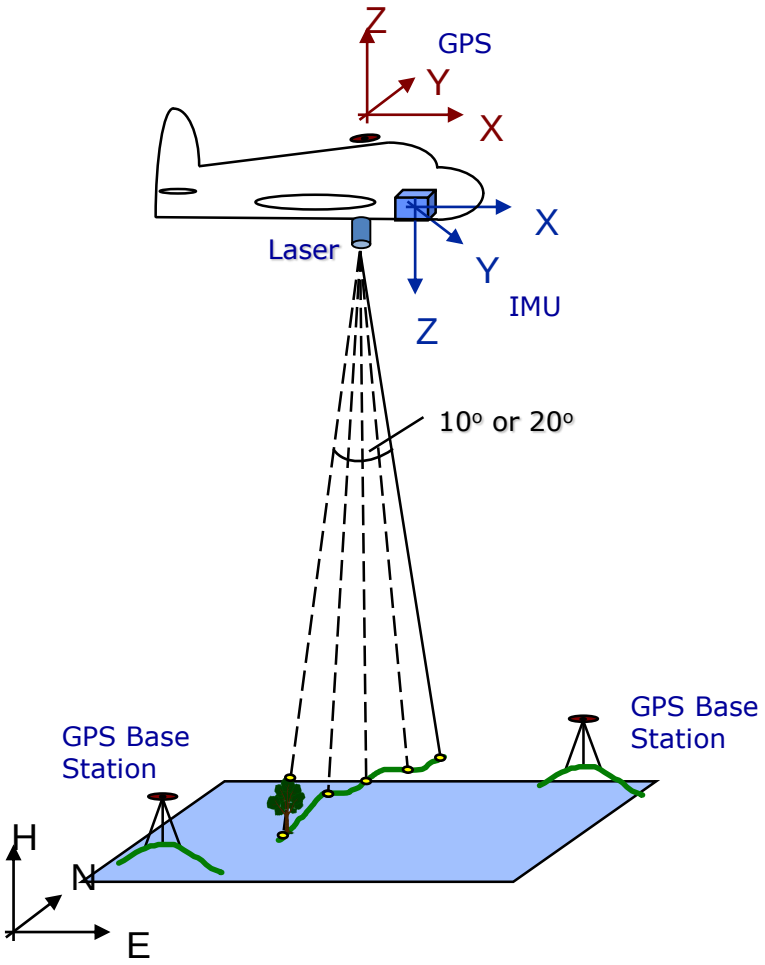
Anaglyphic View

Photogrammetry Workflow



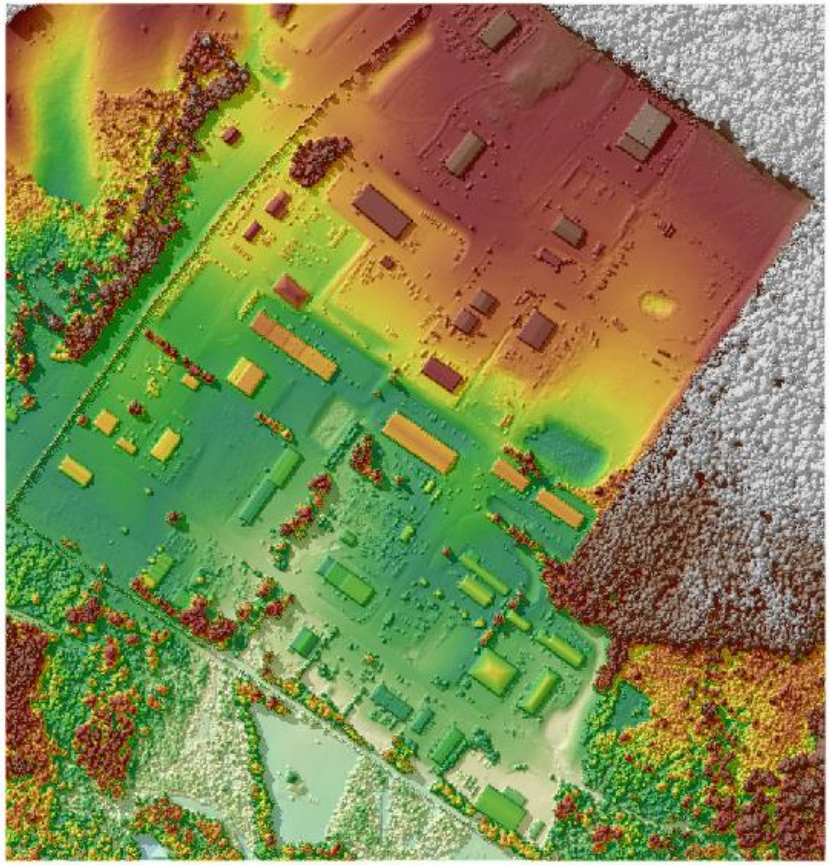
Primary Methods

LiDAR

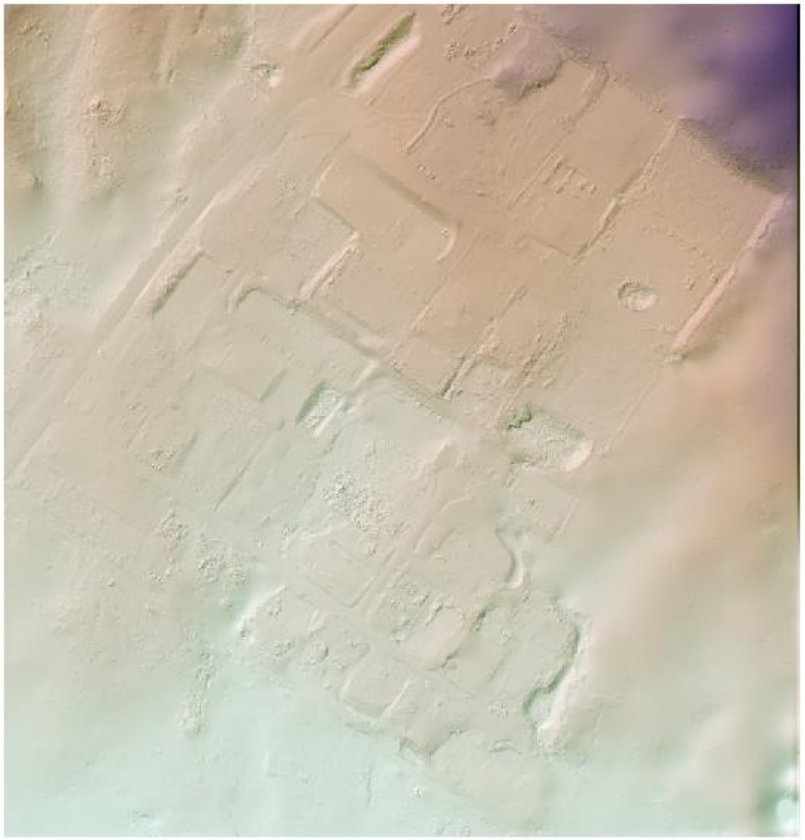


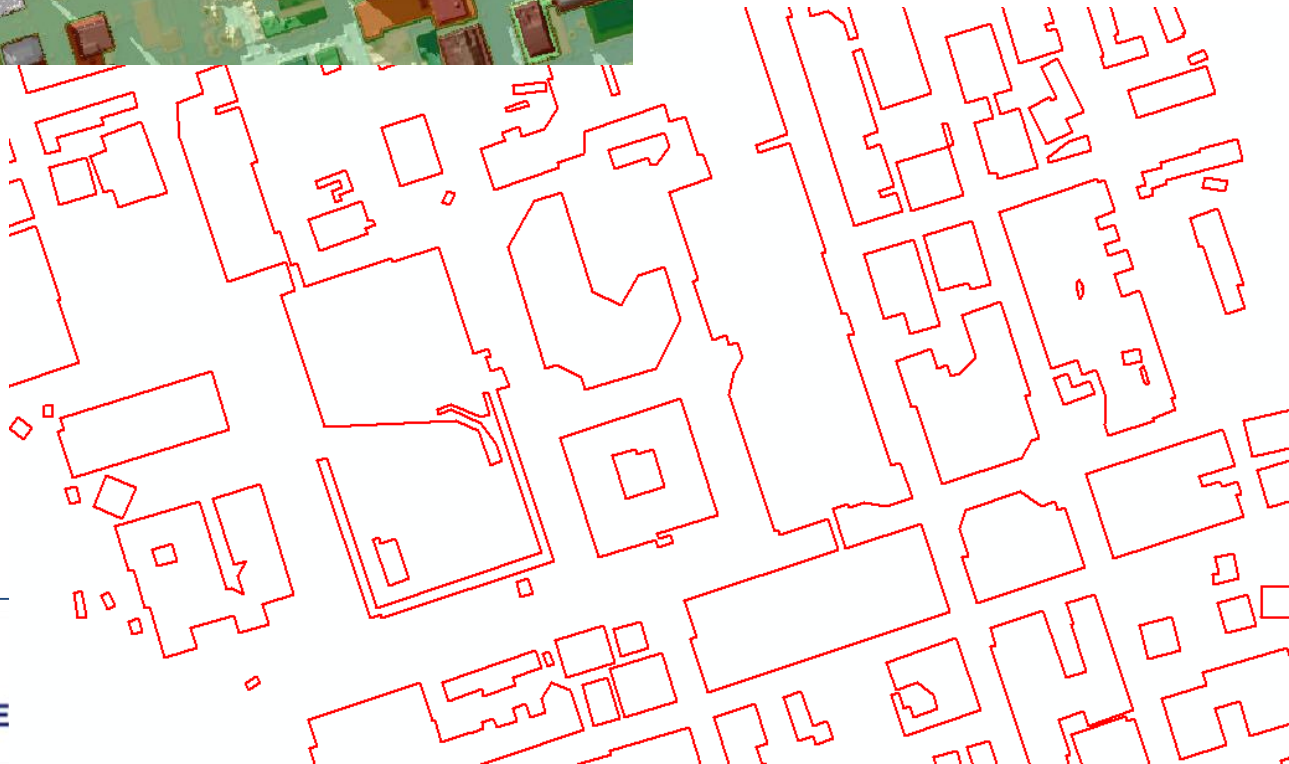
- Light Detection And Ranging (LiDAR)
- System components
  - Laser scanner emitting more than 100,000 pulses per sec
  - GPS for measuring platform position
  - Inertial Measurement Unit (IMU) for platform orientation
  - Data processing and data storage unit (PC)
- Records first, last or multiple pulses
- Horizontal accuracy: 1/1000th of flying height
- Vertical accuracy: 5 – 20cm
- Operates day or night
- Cannot operate above clouds

DSM



DTM





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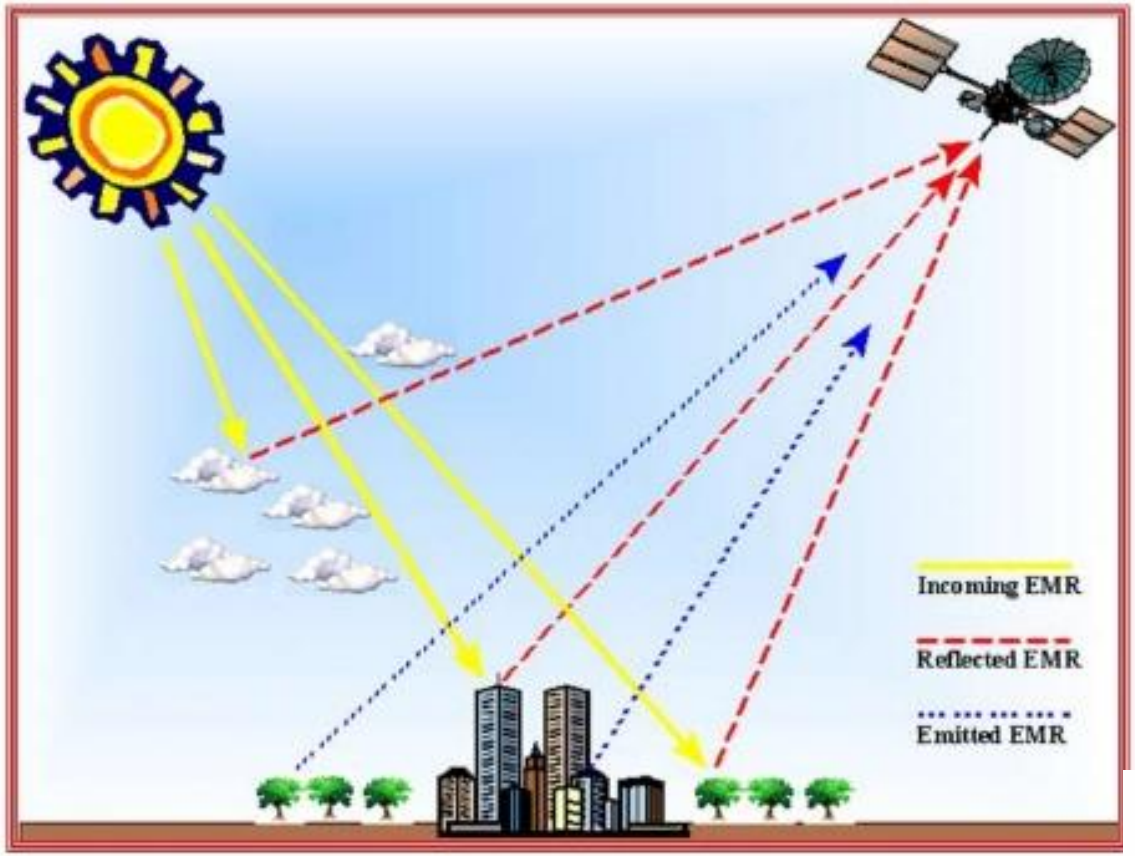
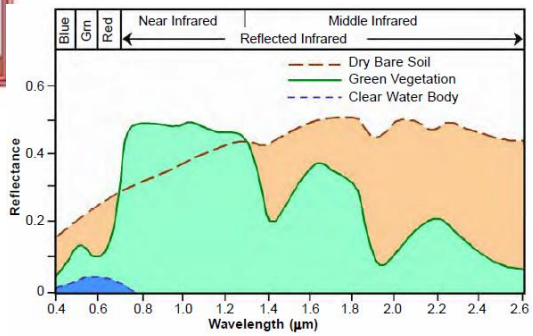
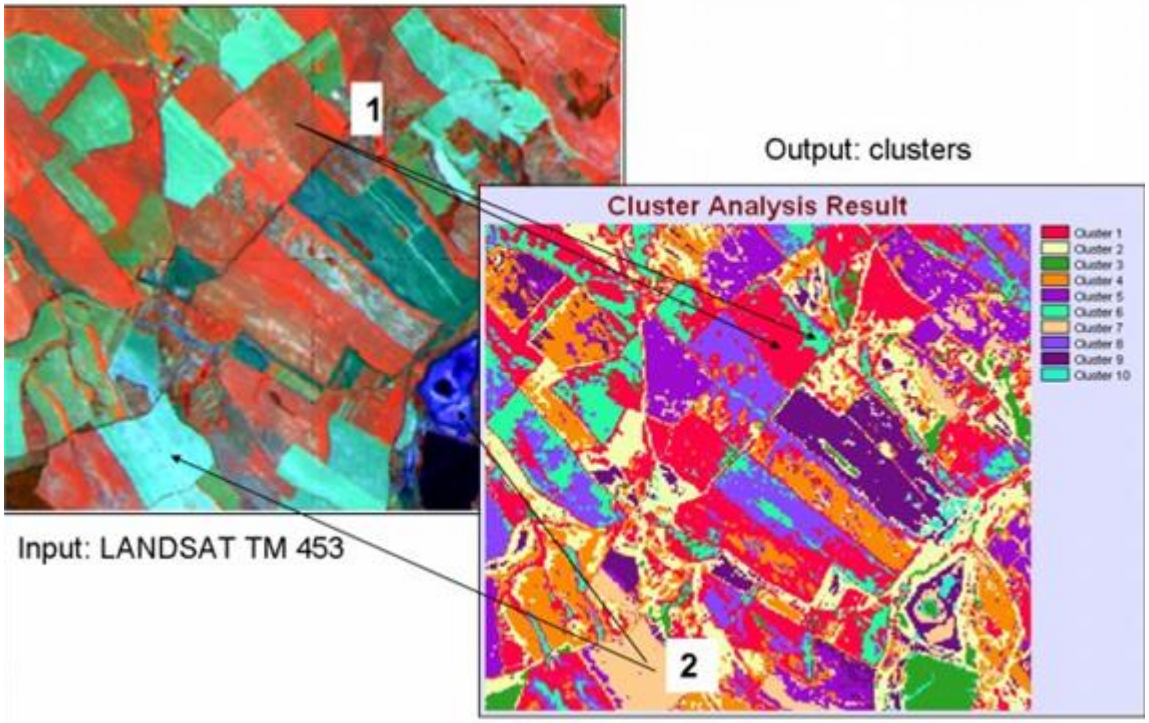
Primary Methods

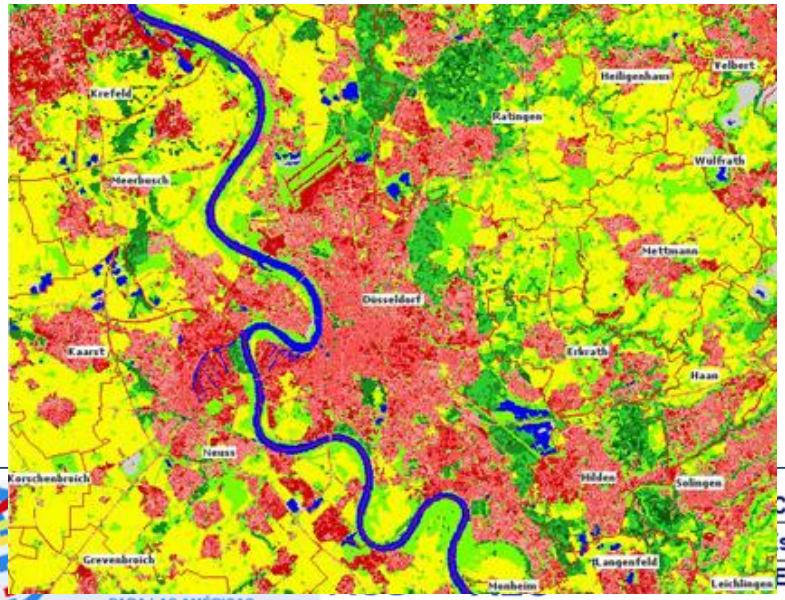
- **Satellite Remote Sensing**
  - Remote sensing is closely related to photogrammetry. Both fields deal with images of the earth.
  - It includes all information collected from sensors which are physically separate from the object.
  - Remote sensing instruments rely on the detection of energy emitted from or reflected by the object under consideration.

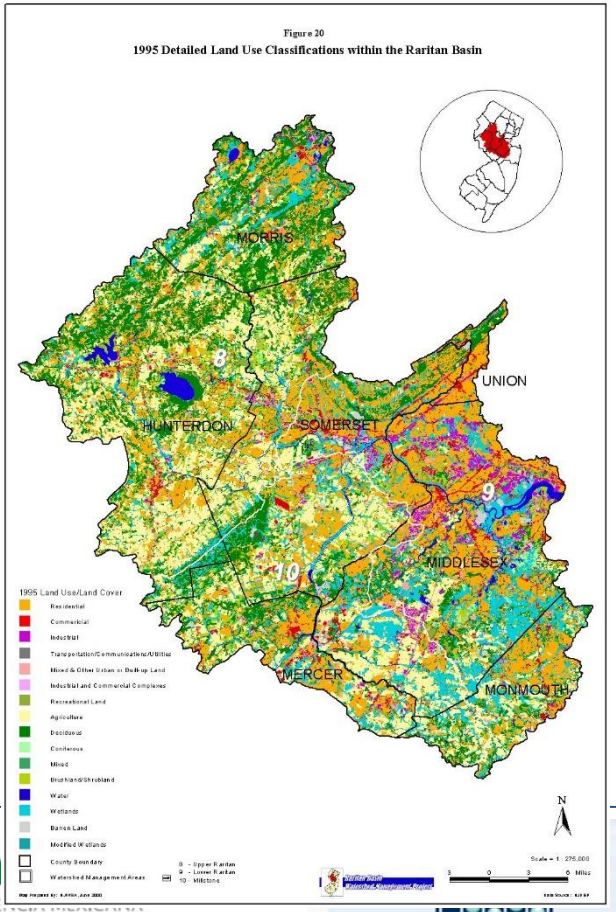
REMOTE SENSING











Secondary Methods
Scanning and Digitizing Legacy Datasets

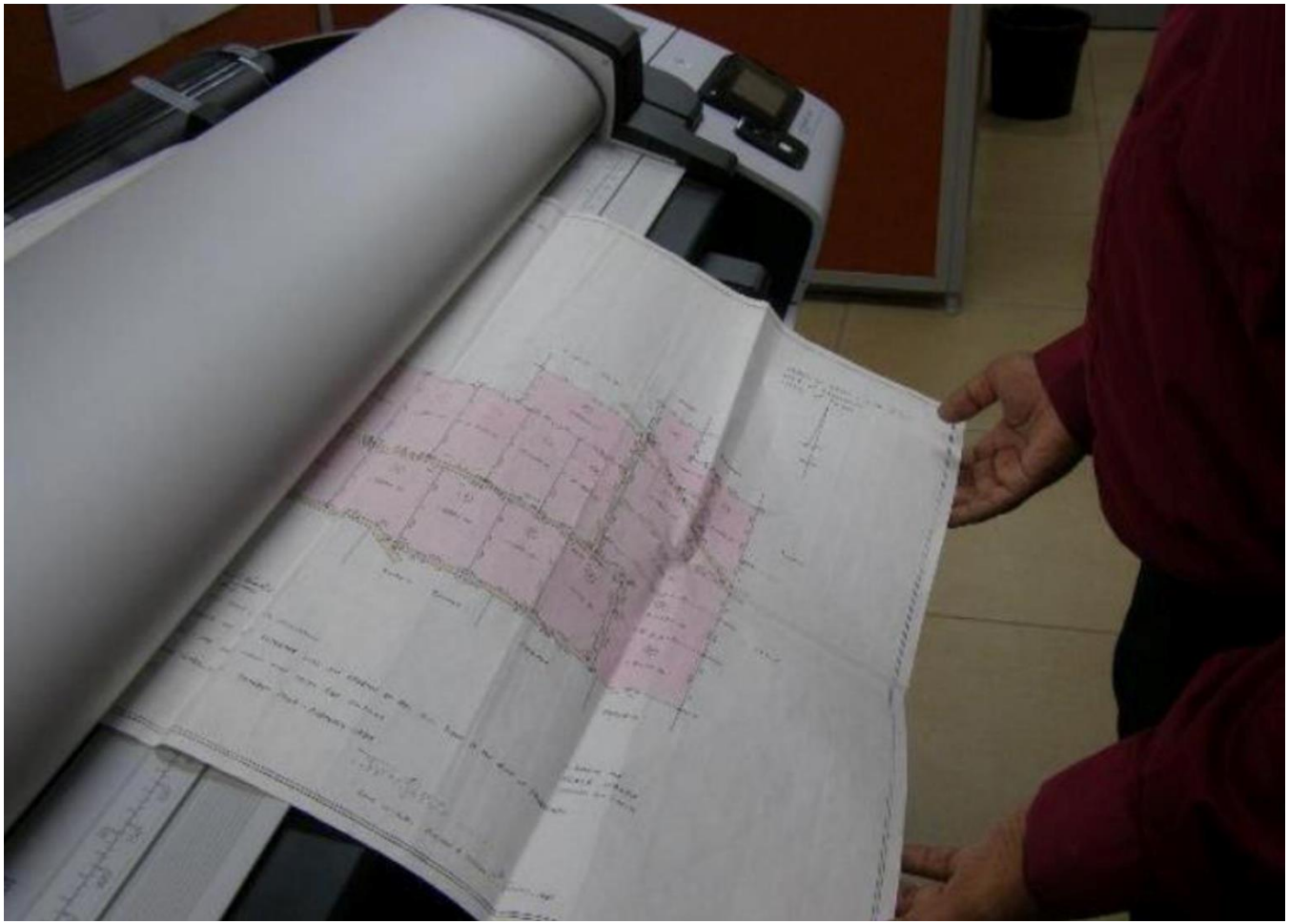
Scanning

- The process of converting existing maps to digital form (raster format)

Setbacks in Scanning

- Editing can take nearly as long as manual digitizing would have taken

Scanning



Digitizing

- Digitizing is the process of capturing knowledge of a feature's geometry and attributes into a digital format stored on the computer's hard drive.

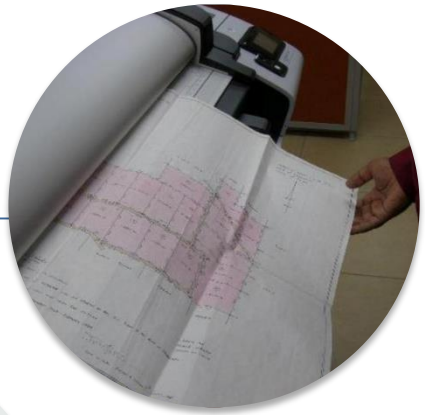
- Digitizing can be:
  - Manual: Heads-down or heads-up
  - Semi-Automated: data automatically recorded while manually following a line- by distance along the line, offset distance or time
  - Fully automated- line following

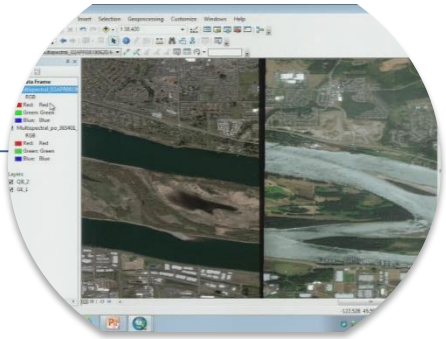
Heads-Up Digitizing

- Heads-up digitizing is a combination of scanning and manual digitizing.
- The main steps in heads-up digitizing typically include:
  - ***Scanning the map***: a user can scan the map at a high resolution
  - ***Registering the map***: using transformation methods, the user can enter control points on screen and transform the scanned image to real world coordinates.
  - ***Digitizing the map***: the user can zoom to specific areas on screen and trace points, line or polygons on the map.
    - Because the maps are already in the correct geographic coordinate system anything digitized on top of the map will also be in the correct coordinate system.

Heads-Up Digitizing

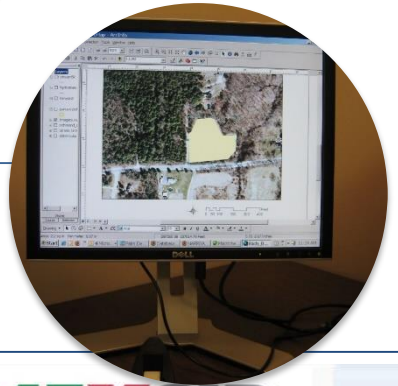
1. Scan





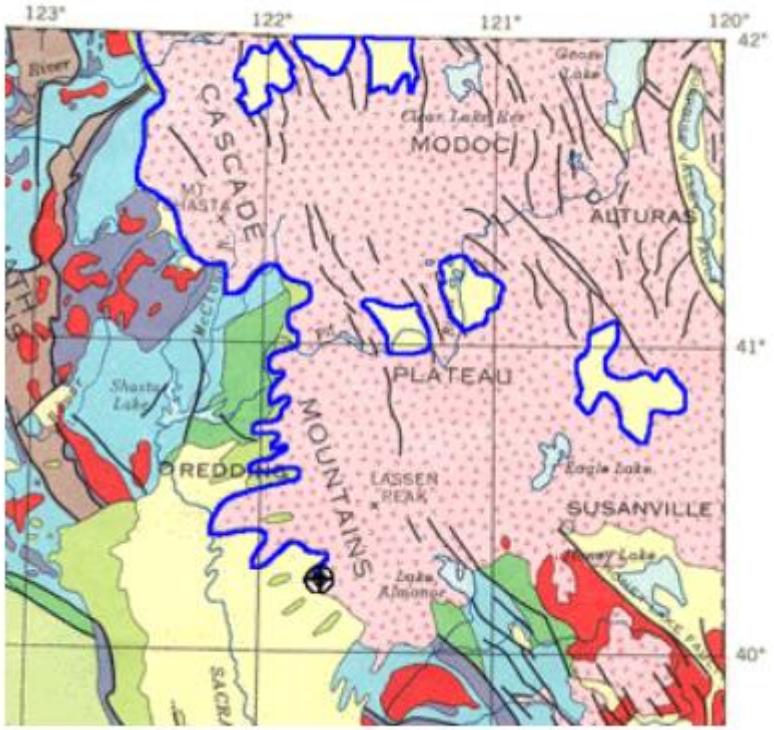
2. Georeference

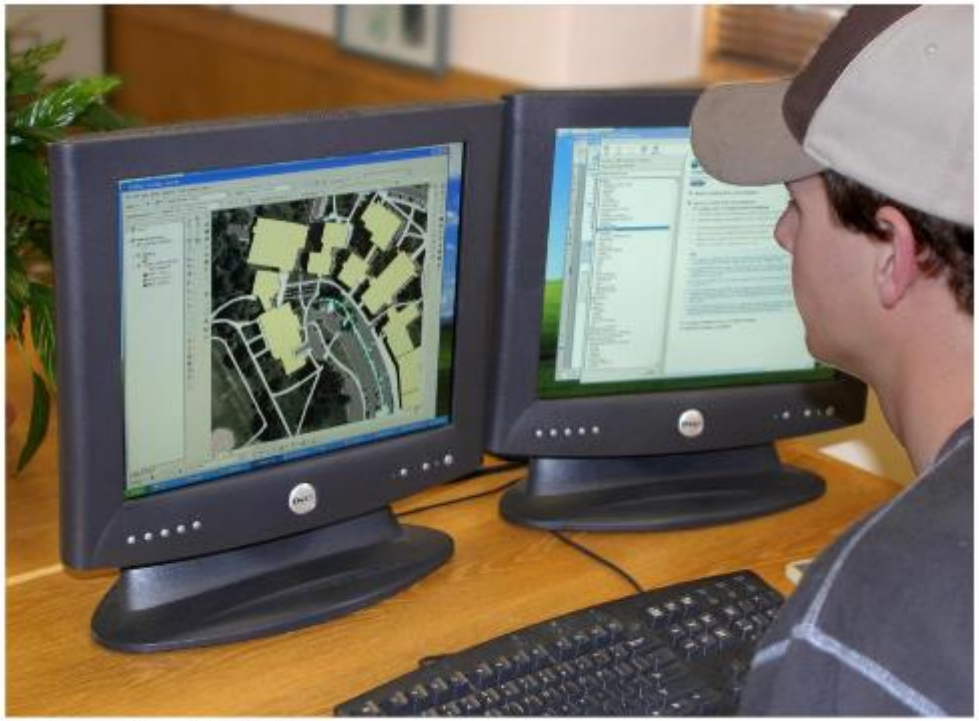
3. Digitize



Final Map

Heads-Up Digitizing



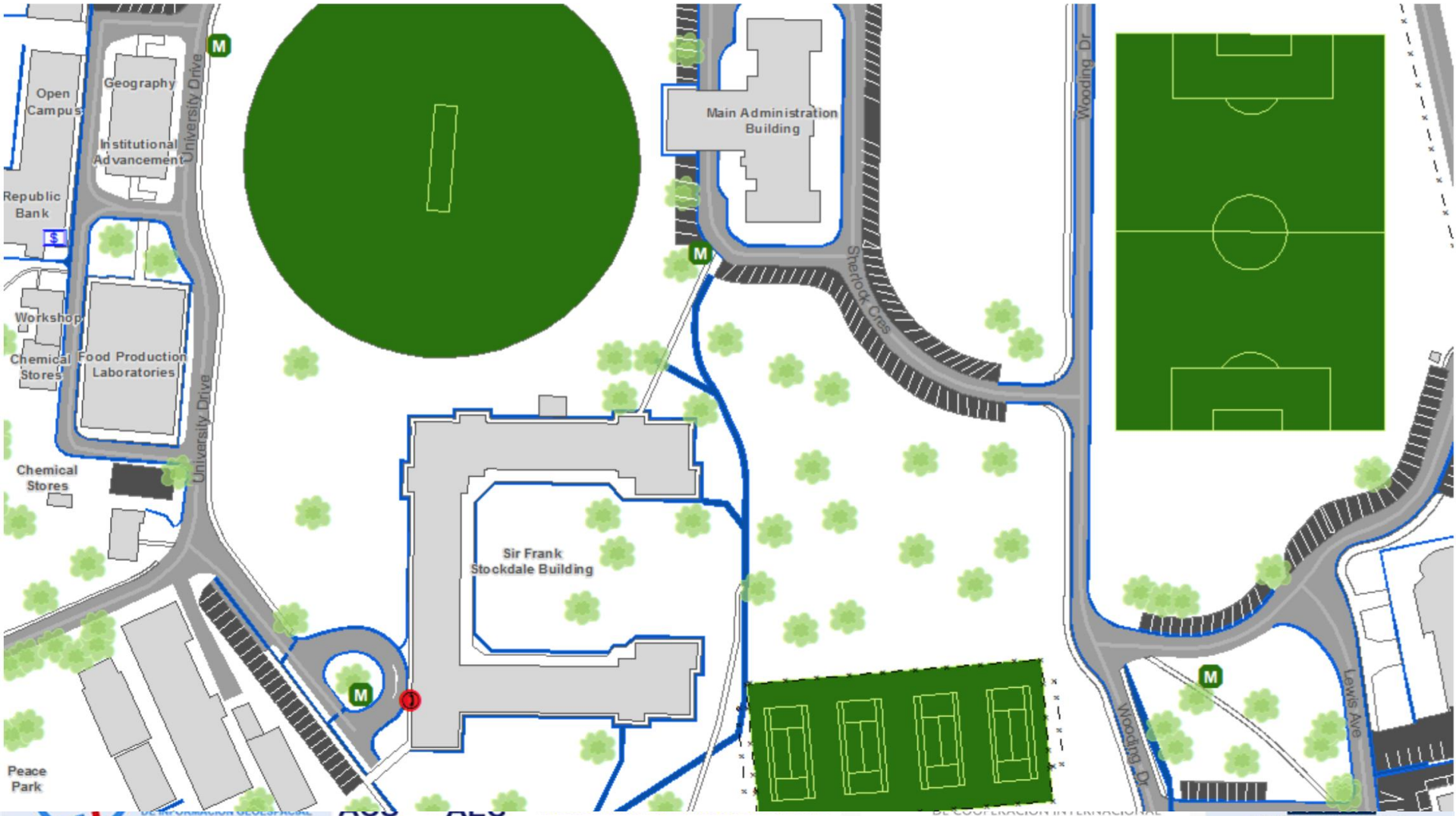


Materials by Austin Troy © 2008

Example using Orthoimage

Digitizing Features of Interest

Final Product



Plan Before Digitizing

- There are many issues to consider before digitizing commences:
  - For what purpose will the data be used?
  - What coordinate system will be used for the project?
  - What is the accuracy of the layers to be associated?
  - What is the accuracy of the map being used?

A useful rule of thumb is that positions measured from maps are accurate to about 0.5 mm on the map. Multiplying this by the scale of the map gives the corresponding distance on the ground.

Map scale	Ground distance corresponding to 0.5 mm map distance
1:1250	62.5 cm
1:2500	1.25 m
1:5000	2.5 m
1:10,000	5 m
1:24,000	12 m
1:50,000	25 m
1:100,000	50 m
1:250,000	125 m
1:1,000,000	500 m
1:10,000,000	5 km

Terrestrial Photogrammetry

Terrestrial Photogrammetry

Example: Google Street View

Web-Based Data Sources

OpenStreetMap

Mapbox

esri

bing™ maps

MapQuest + Developer

As of July 11, 2016, direct tile access has been discontinued.

Please visit our blog post for more information:
http://goo.gl/xB0xXt

Have questions?
Contact us:
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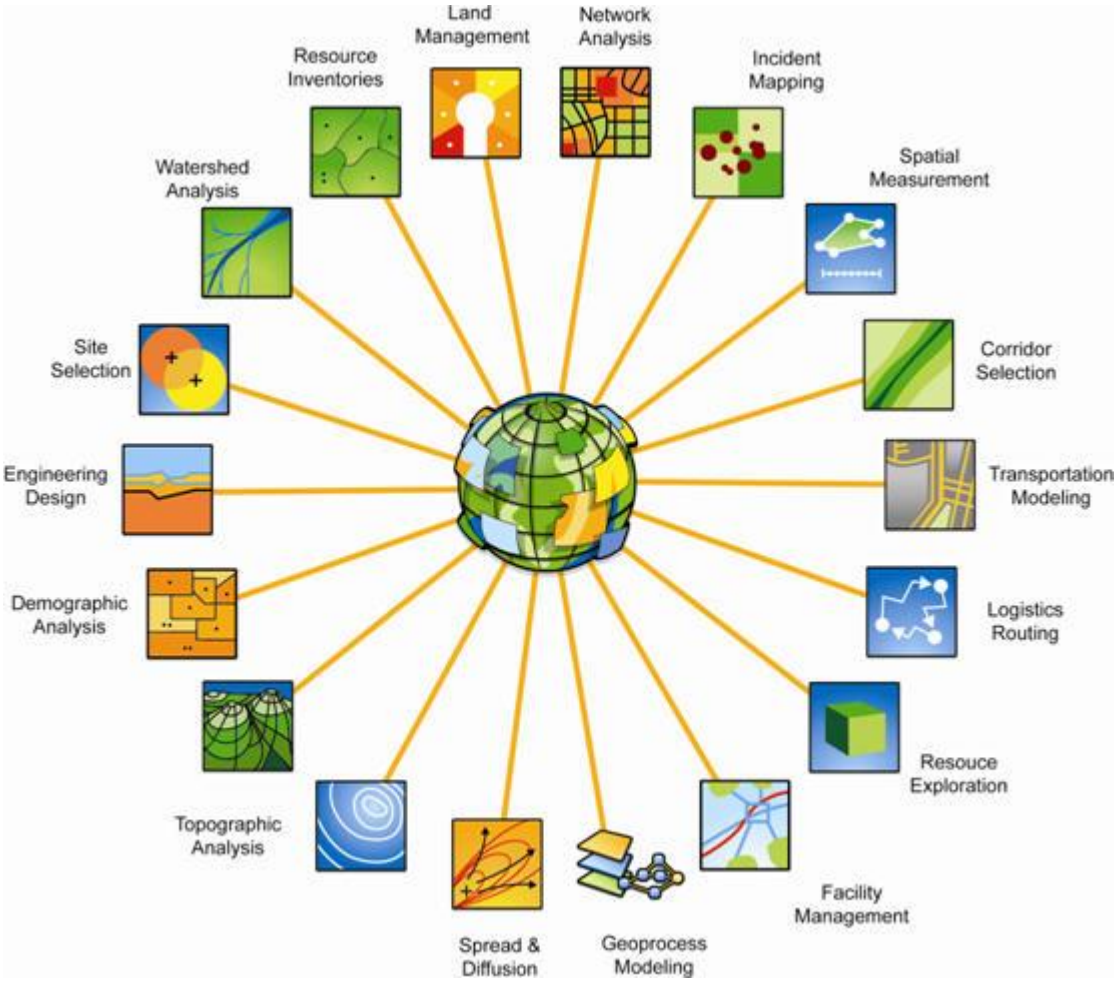
Can these sources provide **AUTHORATIVE** data for our GIS ???

Applications Requiring Spatial Data



Metadata

- Data acquisition process is not complete until the appropriate metadata has been recorded
- Who, what, why, when, where, how ??????
- Metadata elements should include:
  - Spatial data quality
  - Spatial reference system

Metadata Elements

Identification

Title? Area covered? Themes? Currency? Restrictions?

Data Quality (5 aspects)

Positional & Attribute Accuracy? Completeness? Logical Consistency? Lineage?

Spatial Data Organization

Indirect? Vector? Raster? Type of elements? Number?

Spatial Reference

Projection? Grid system? Datum? Coordinate system?

Entity and Attribute Information

Features? Attributes? Attribute values?

Distribution

Distributor? Formats? Media? Online? Price?

Metadata Reference

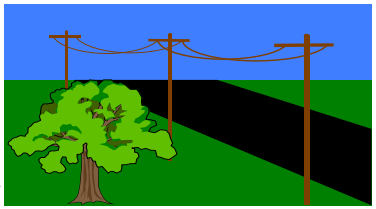
Metadata currency? Responsible party?

Choosing an appropriate data source

- What are the considerations in choosing a data source?
  - Purpose
  - Scale
  - Resolution
  - Accuracy
  - Datum transformation and map projection
  - Completeness
  - Content
  - Costs

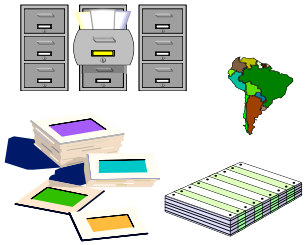
The GIS Process

Geospatial Information processing begins and ends with the real world



Real World

Data Collection



Data Sources

Data Input

Data Management

Data Retrieval & Analysis

Analysis

Information for Decision Making

Users

Implementation

Source: Aronoff (1991)

UP NEXT …..

Topic 4: Augmenting Data Acquisition using sUAVs