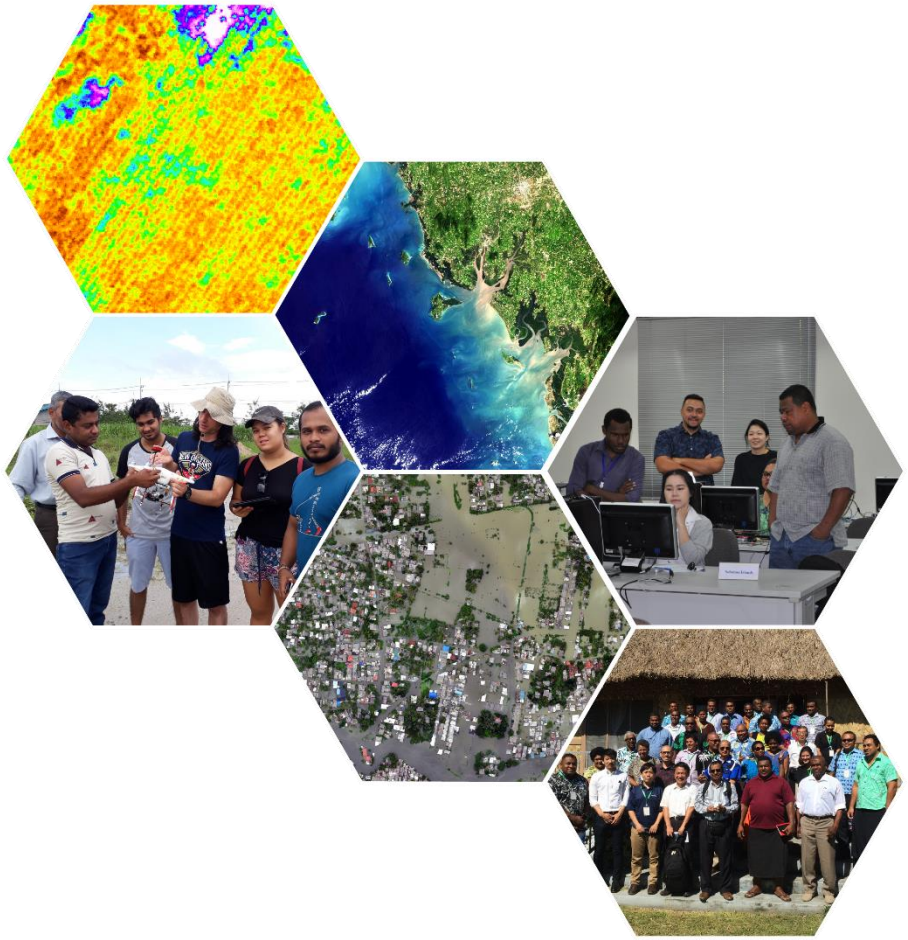
Schedule

Monday June 4, 2018

09:15 – 10:15	Introduction to UAV, Remote Sensing, and GIS
10:15 – 10:30	Tea Break
10:30 – 11:00	Drone regulations, data sharing, and data privacy
11:00 – 11:30	Break
11:30 – 12:30	Photogrammetry and Computer Vision
12:30 – 13:30	Lunch

Introduction to UAV, Remote Sensing, and GIS



Session 1: Monday June 4, 2018
09:15 – 10:15

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AIT Asian Institute of Technology

GIC

Objectives

Day 1 Session 1

1. Become familiar with UAV

2. Understand how remote sensing is related to UAV

3. Understand the basic concepts of GIS

What is a UAV?

Definitions

Unmanned Aerial Vehicle (UAV)

- an aircraft without a pilot onboard that has the ability to fly autonomously but can also be controlled by remote

Pajares, G. 2015. Overview and current status of remote sensing applications based on unmanned aerial vehicles (UAVs). Photogrammetric Engineering & Remote Sensing. 81, 281-329.

What is a UAV?

Definitions

Unmanned Aircraft System (UAS)

- UAV
- ground control station
- pilot
- visual observer
- launcher

small Unmanned Aircraft System (sUAS)

- a system in which the UAV weighs less than 55 lbs. (25kg)

Pajares, G. 2015. Overview and current status of remote sensing applications based on unmanned aerial vehicles (UAVs). Photogrammetric Engineering & Remote Sensing. 81, 281-329.

Early Days of UAV

Military Applications

1918

Kettering Bug
U.S. Army

1936

DH.82B Queen Bee
U.S. Navy

Vietnam War Era

Firebee

Keane, J. & Carr, S. 2013. A brief history of early unmanned aircraft. Johns Hopkins APL Technical Digest. 32, 558-571.

Types of UAV

Choose the right tool

Trimble ZX5

Rotary Wing / Multirotor

Advantages	Disadvantages
VTOL	Shorter battery life
Surveillance or Surveying	Multiple points of failure

DJI Phantom 3 Professional

Altavian Nova F7200

Fixed Wing

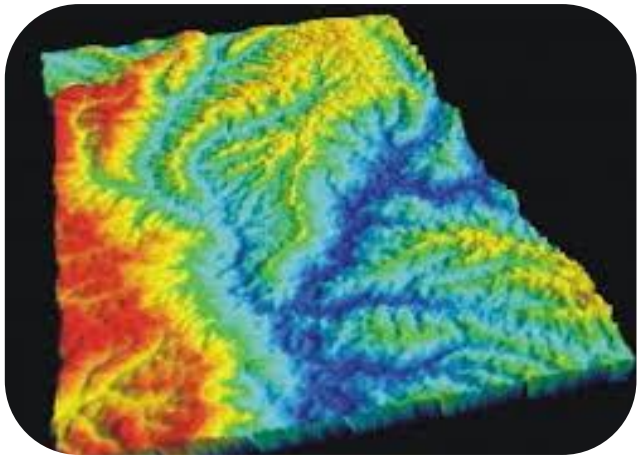
Advantages	Disadvantages
Longer Battery life	May need launcher device
Better for large areas	Needs open area for takeoff/landing

Trimble UX5

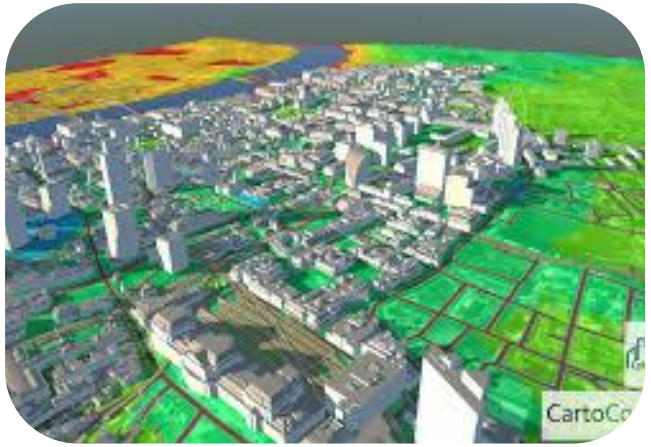
Applications of UAV

Land Surveying

2D Maps



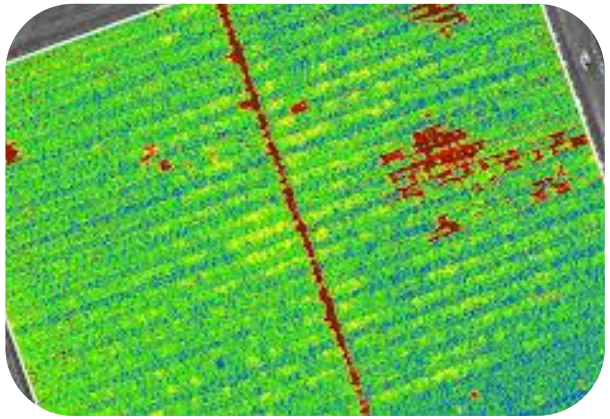
Terrain

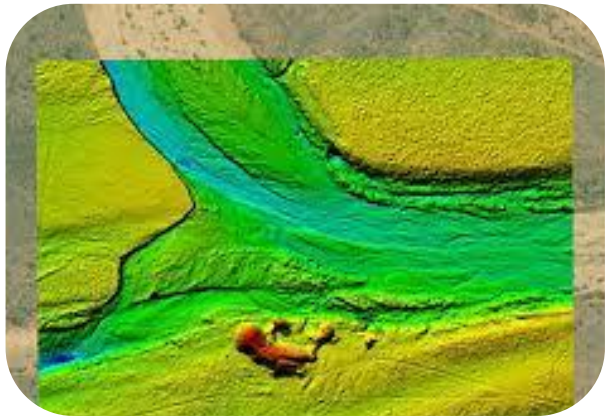


GIS

Applications of UAV

Agriculture

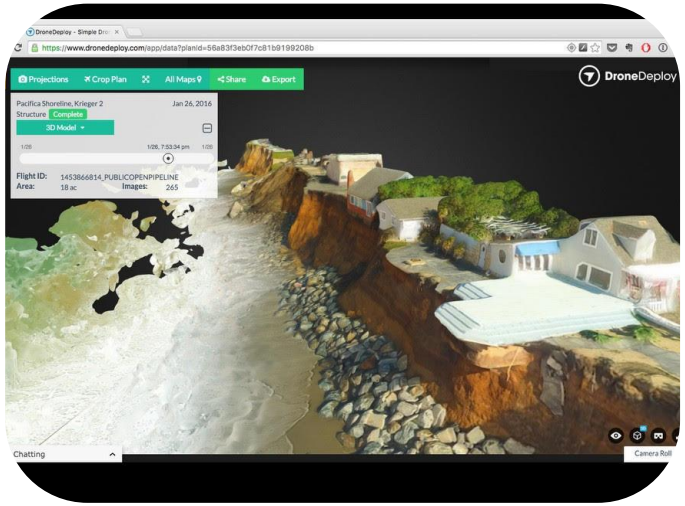




Crop Monitoring	Chemical Application	Land Management
Diseases	Fertilizer Application	Drainage Issues
Insects	Pesticide Application	Replanting Decisions
Weed		Yield Estimations
Crop Progress		Soil Moisture
Crop Stress		

Applications of UAV

Environmental Studies



Forests	Coastal	Wildlife
Forest Fire Deforestation	Coastal Erosion	Animal Counting

Applications of UAV

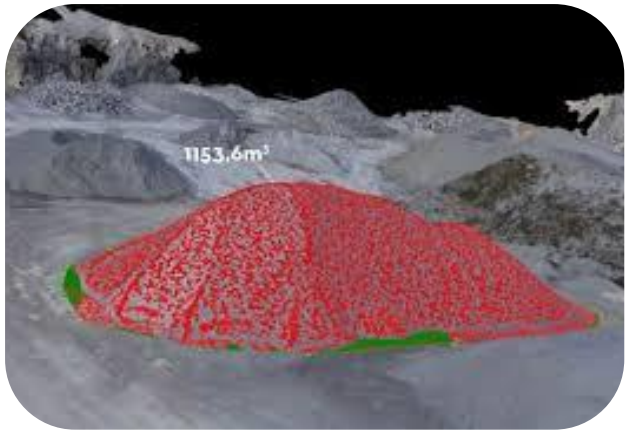
Civil Engineering

Infrastructure Inspection

Bridges
Cell Phone Towers
Power lines
Solar Panels

Feasibility Surveys

Transportation Routes



Mining

Volume Calculation

Applications of UAV

Humanitarian Efforts

Disaster Mapping	Hazard Monitoring	Emergency Delivery
Emergency response coordination Search and Rescue Post disaster assessment	Volcanos Glaciers Floods	Medicine

Applications of UAV

Real Estate

Construction Management

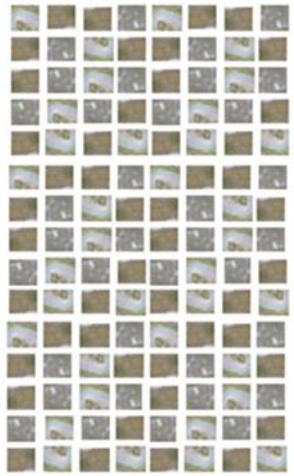
Marketing

Landscape designing
Site analysis
Architectural designing

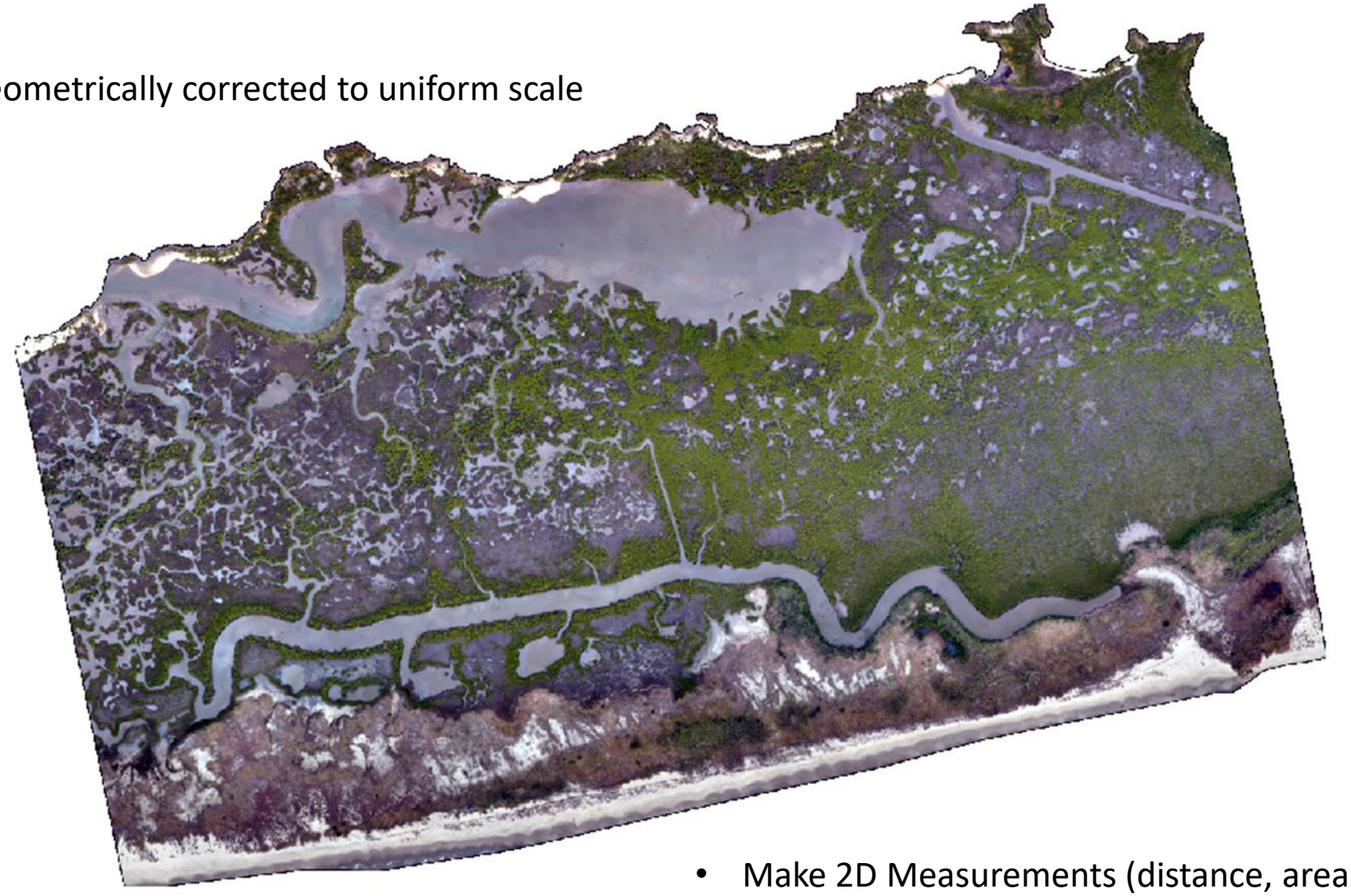
Deliverables from UAV

Orthomosaic

A photo map that has been geometrically corrected to uniform scale



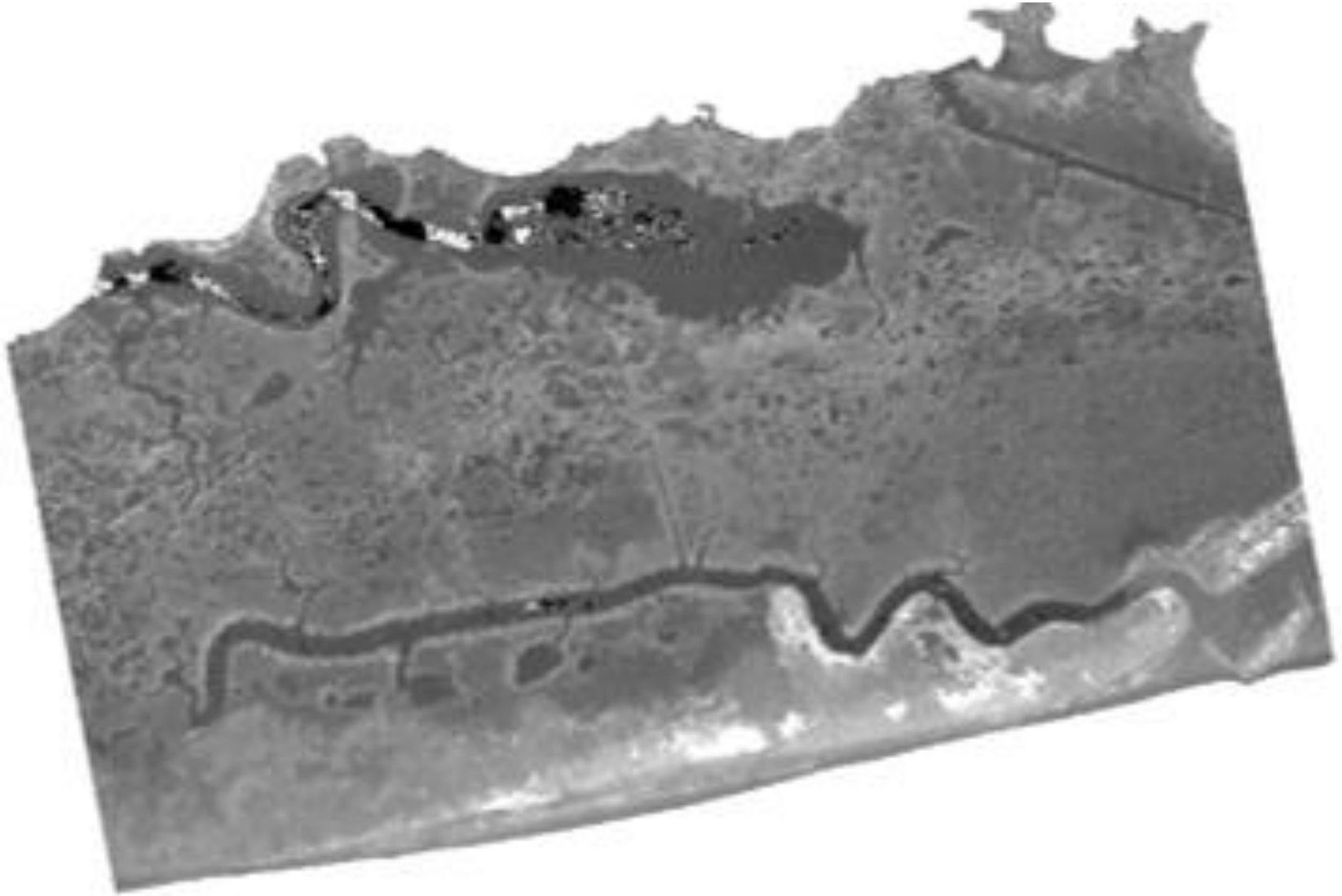
Numerous Overlapping Images



- Make 2D Measurements (distance, area)
- GIS integration

Deliverables from UAV

Digital Surface Model



Expresses elevation data

Deliverables from UAV

3D Model

Composed of points in 3D space

Useful for 3D measurements, Volumetric Calculations

Applications of UAV at GIC

1. Mapping AIT
2. Tree Canopy Extraction
3. Construction Monitoring

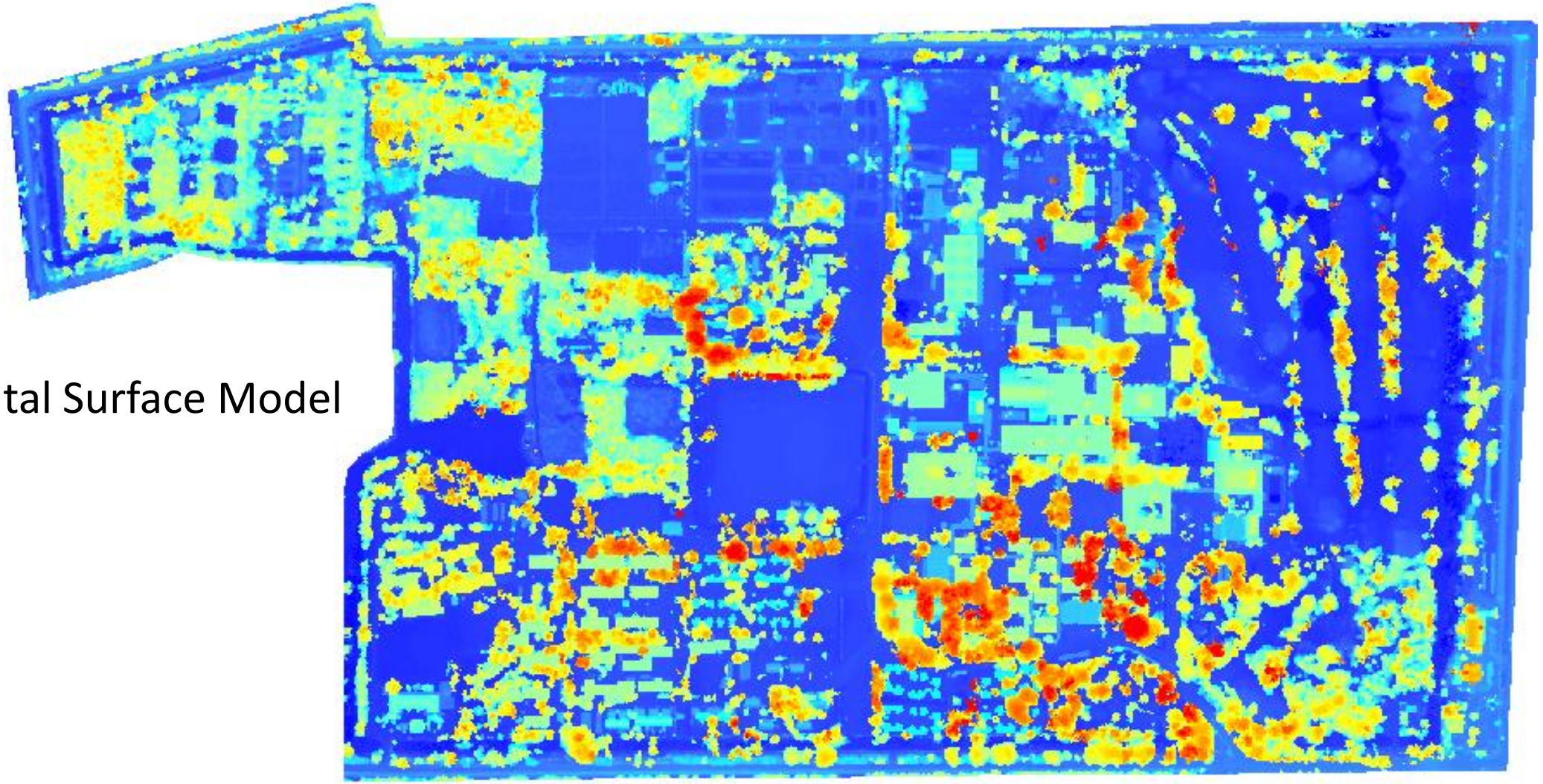
Applications of UAV at GIC

1. Mapping AIT

Orthomosaic

Applications of UAV at GIC

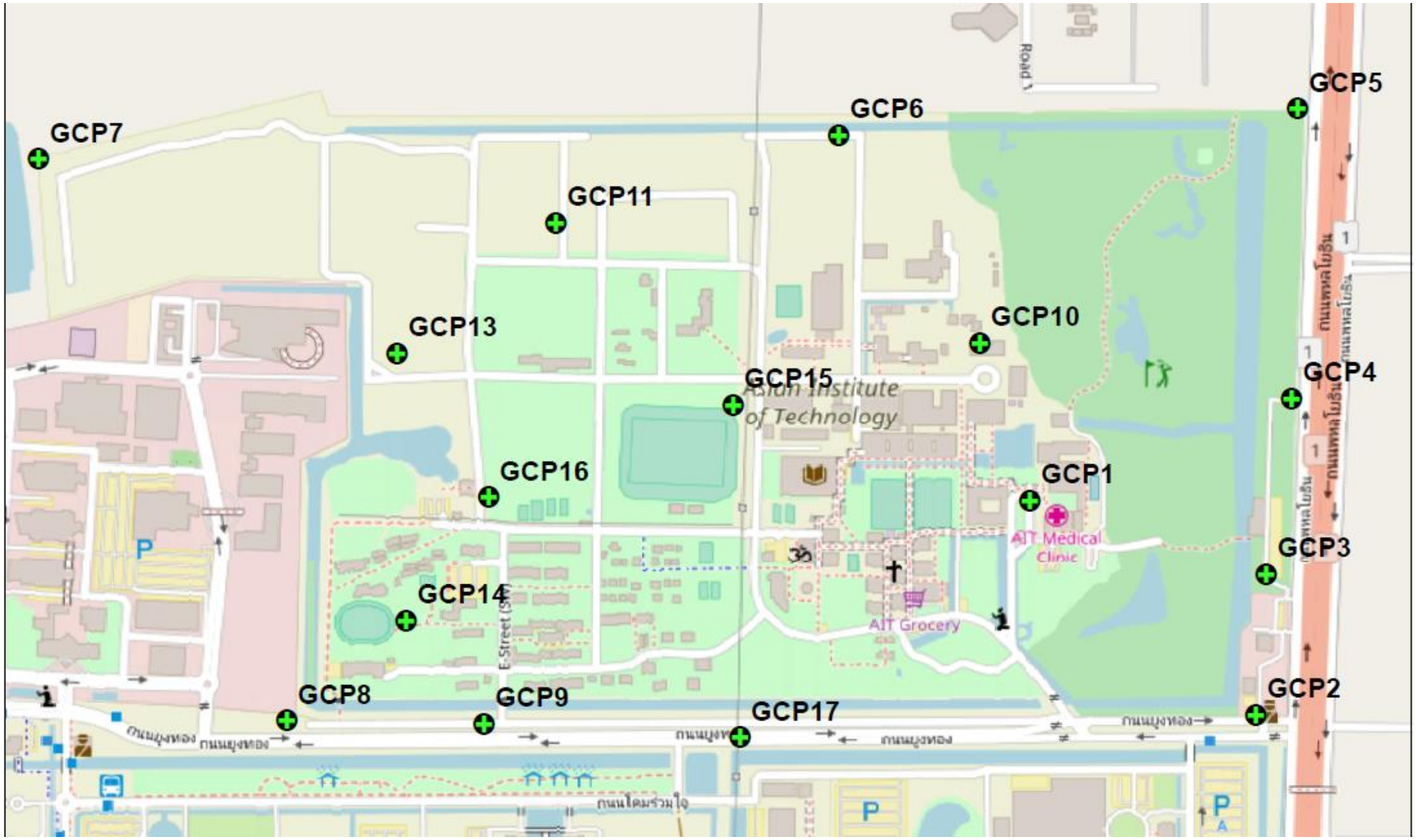
1. Mapping AIT



Digital Surface Model

Applications of UAV at GIC

1. Mapping AIT



Ground Control Points

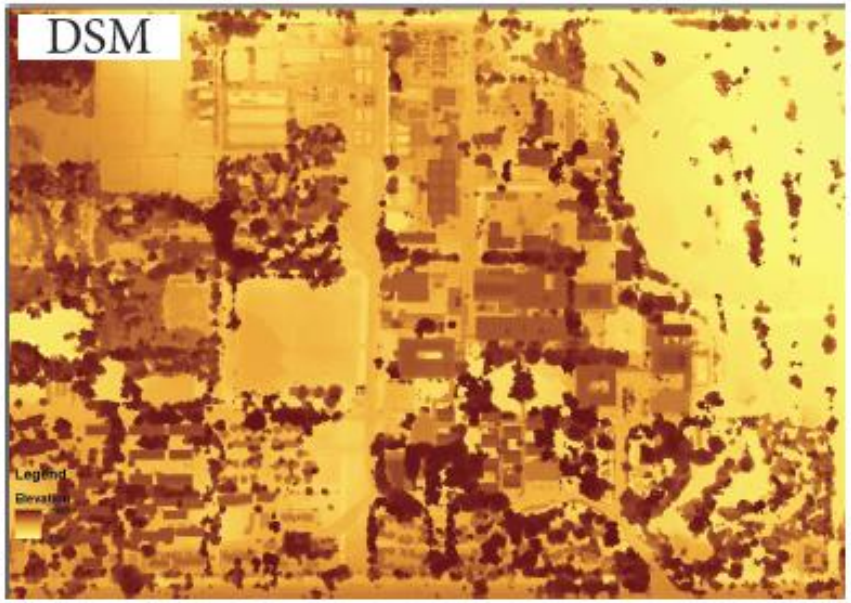
Applications of UAV at GIC

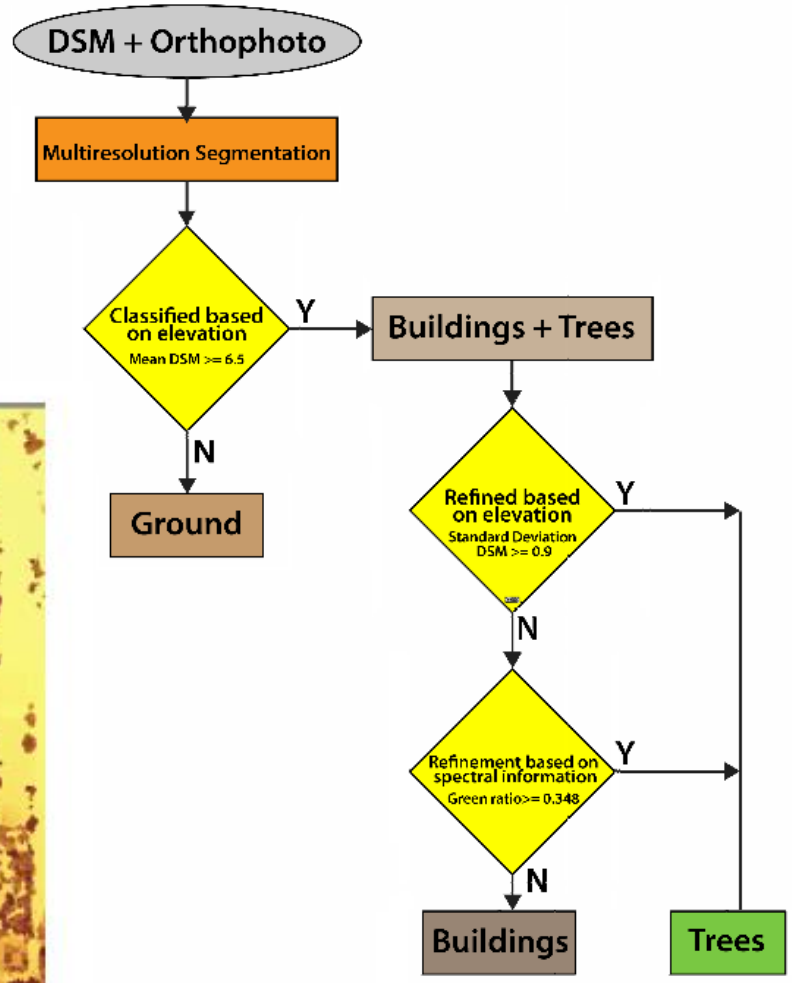
2. Tree Canopy Extraction using DSM and Orthophoto at AIT

Camera Intrinsic and Extrinsic Parameters by Feature Matching (Sparse Cloud)

Dense Surface Reconstruction with Texture

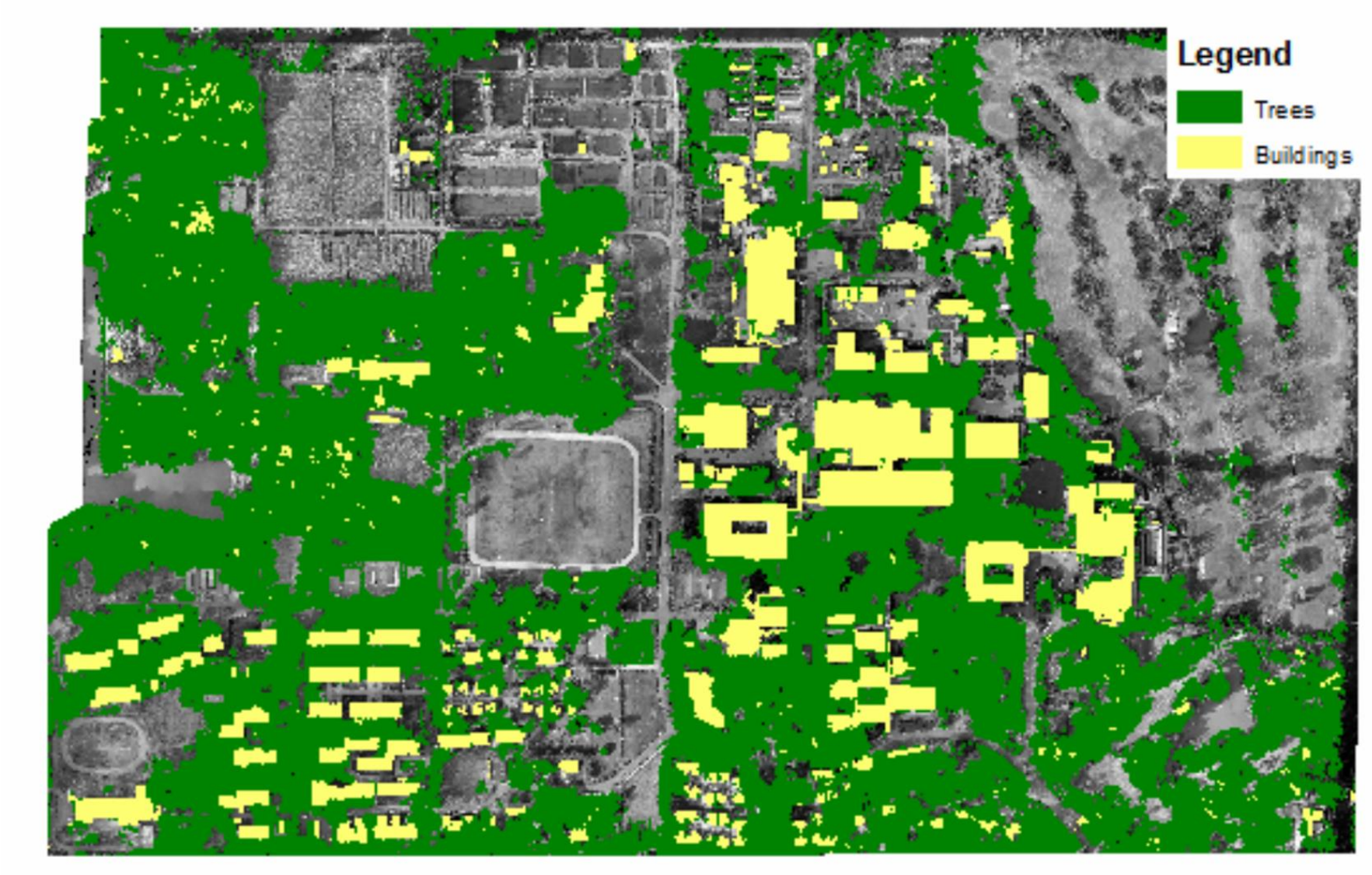
Orthophoto & DSM





Applications of UAV at GIC

2. Tree Canopy Extraction using DSM and Orthophoto at AIT – Classification Results



3. Construction Progress Monitoring

Background

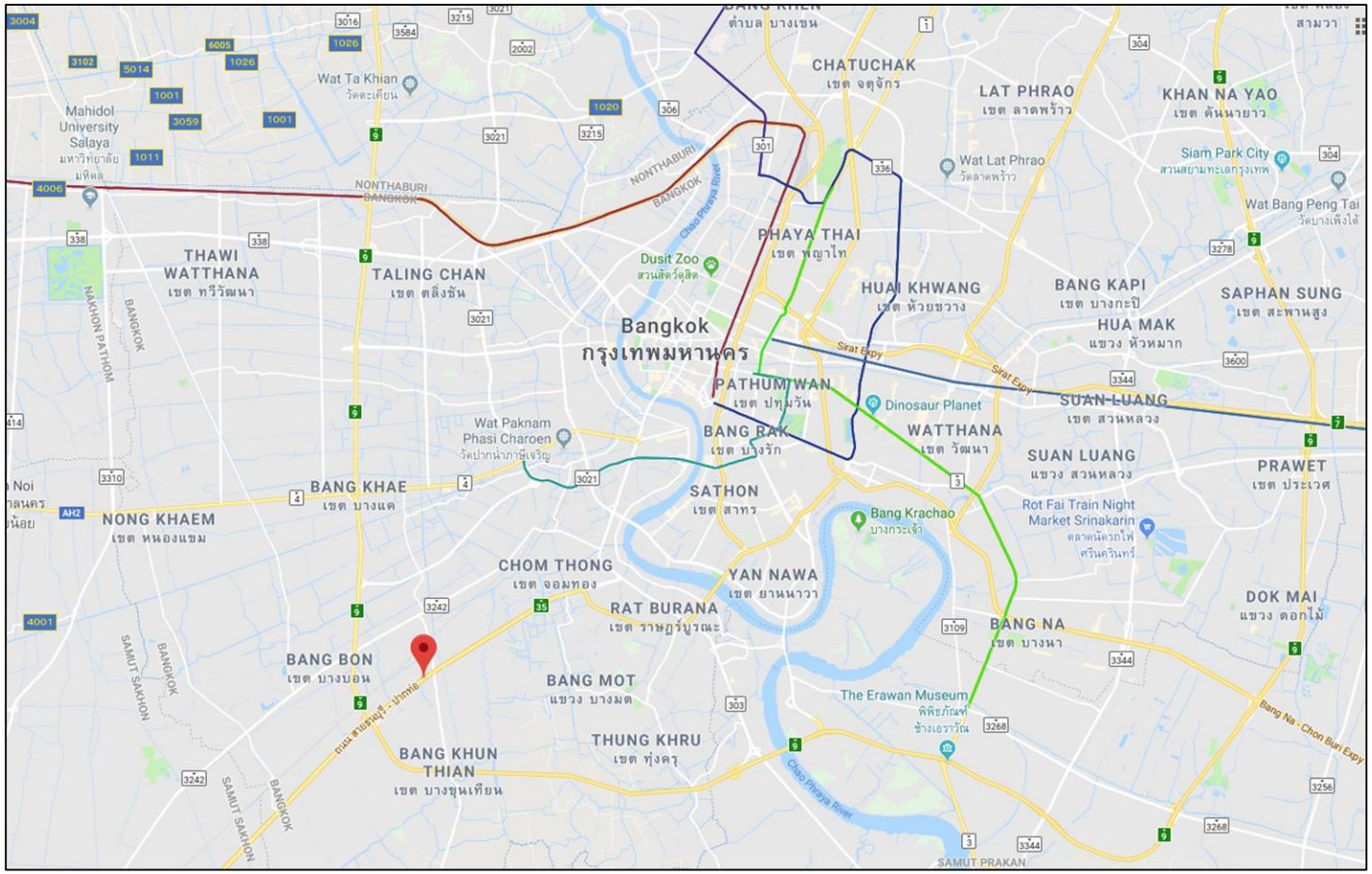
Prarama 2

road expansion project from km 9 - km 21 of the road

Construction period – 1 year (May 2018)

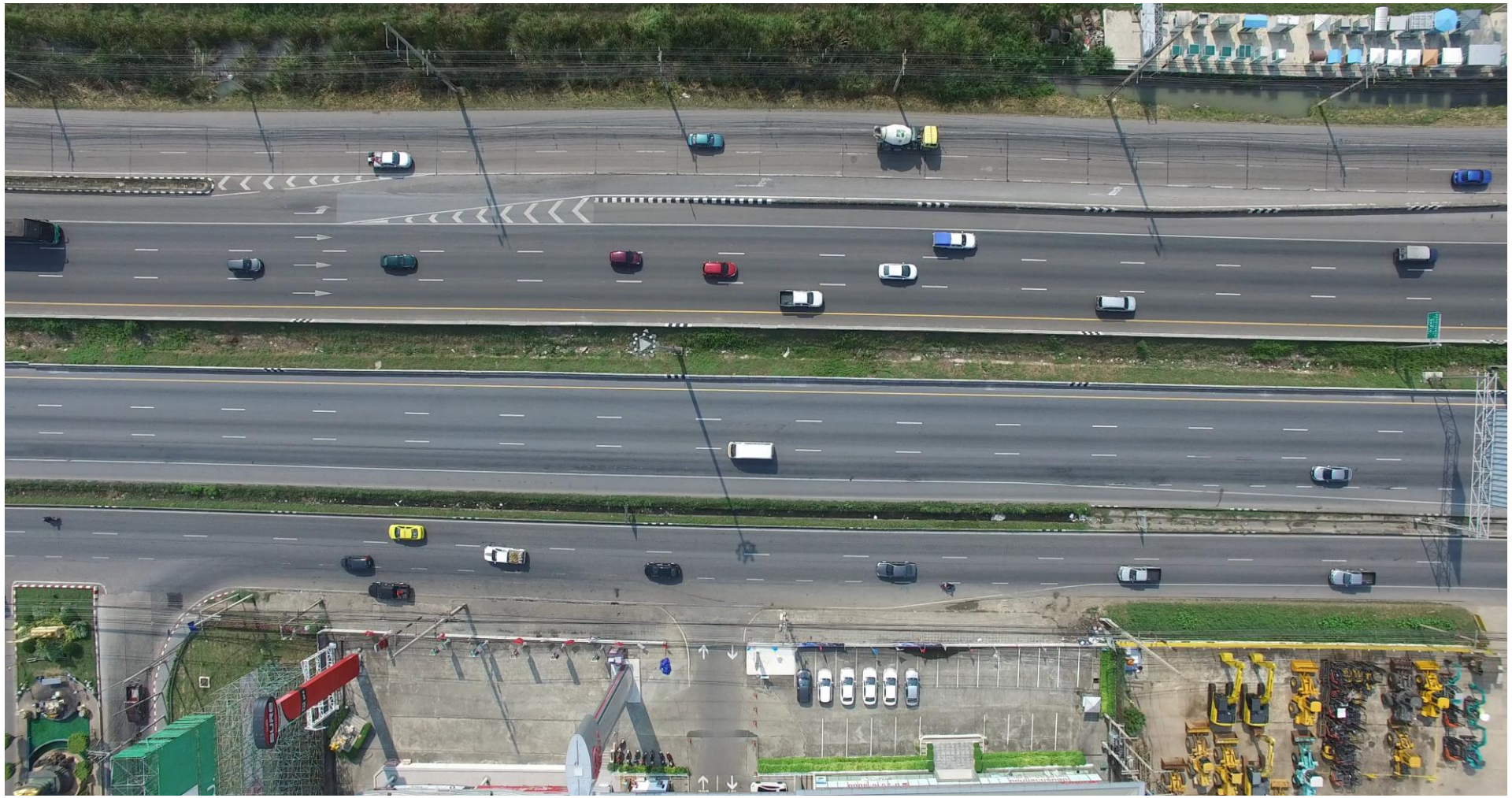
Construction plan – conducted in 3 sections by 3 companies simultaneously

(each section is 4 km)



3. Construction Progress Monitoring

Video captured by UAV



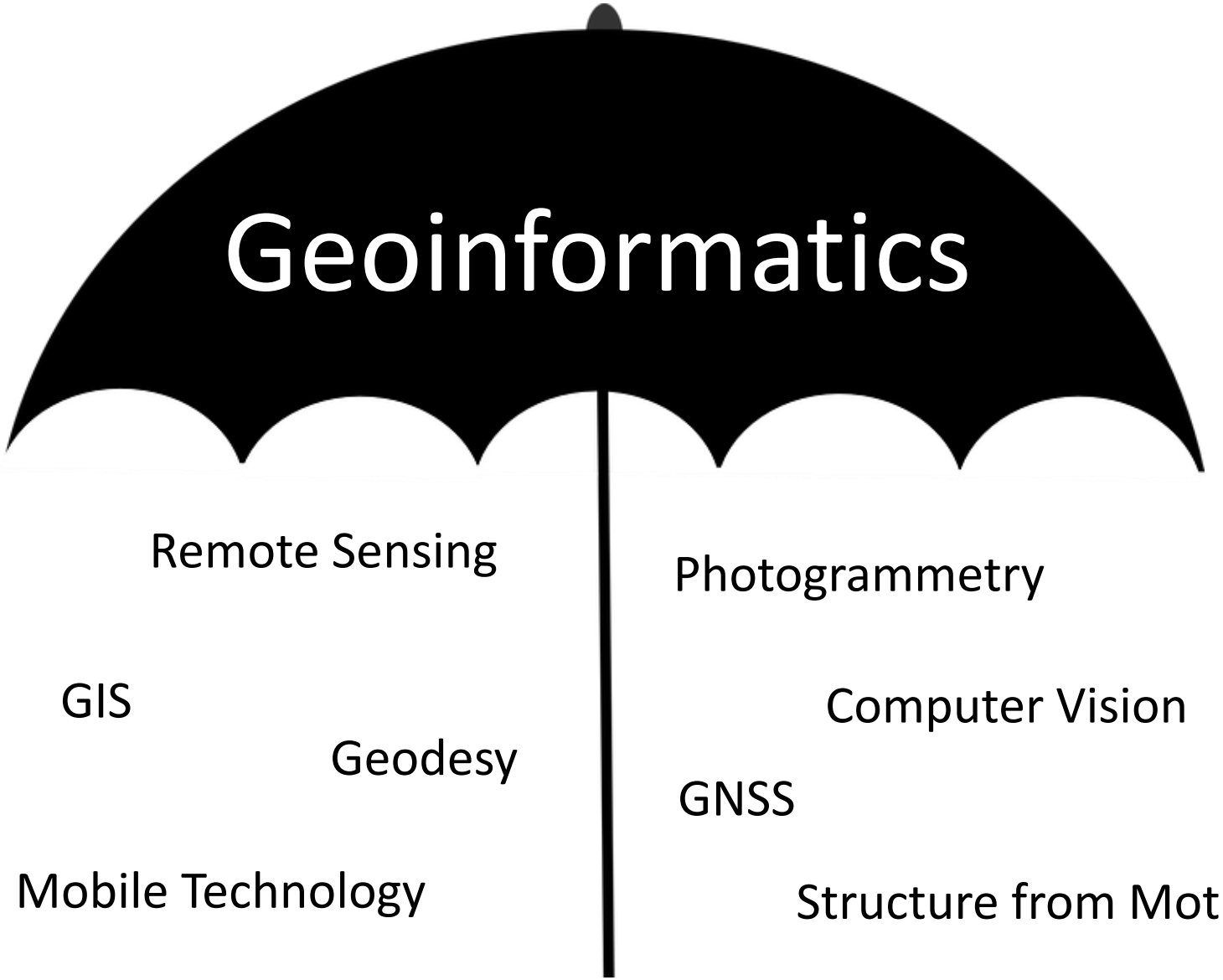
3. Construction Progress Monitoring

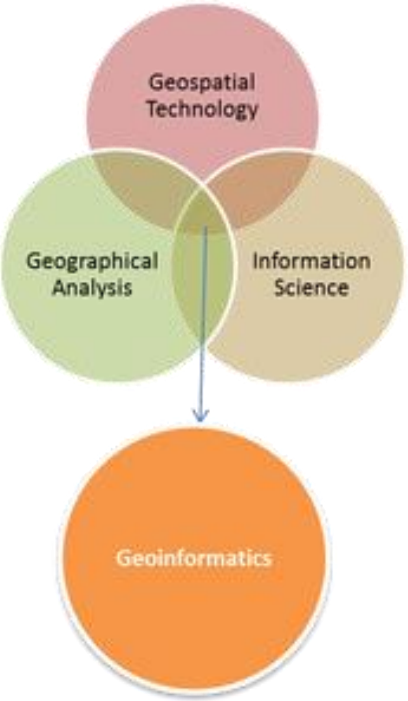
Time Series Analysis

3. Construction Progress Monitoring

Stitching lengths of highway

Geoinformatics





Remote Sensing

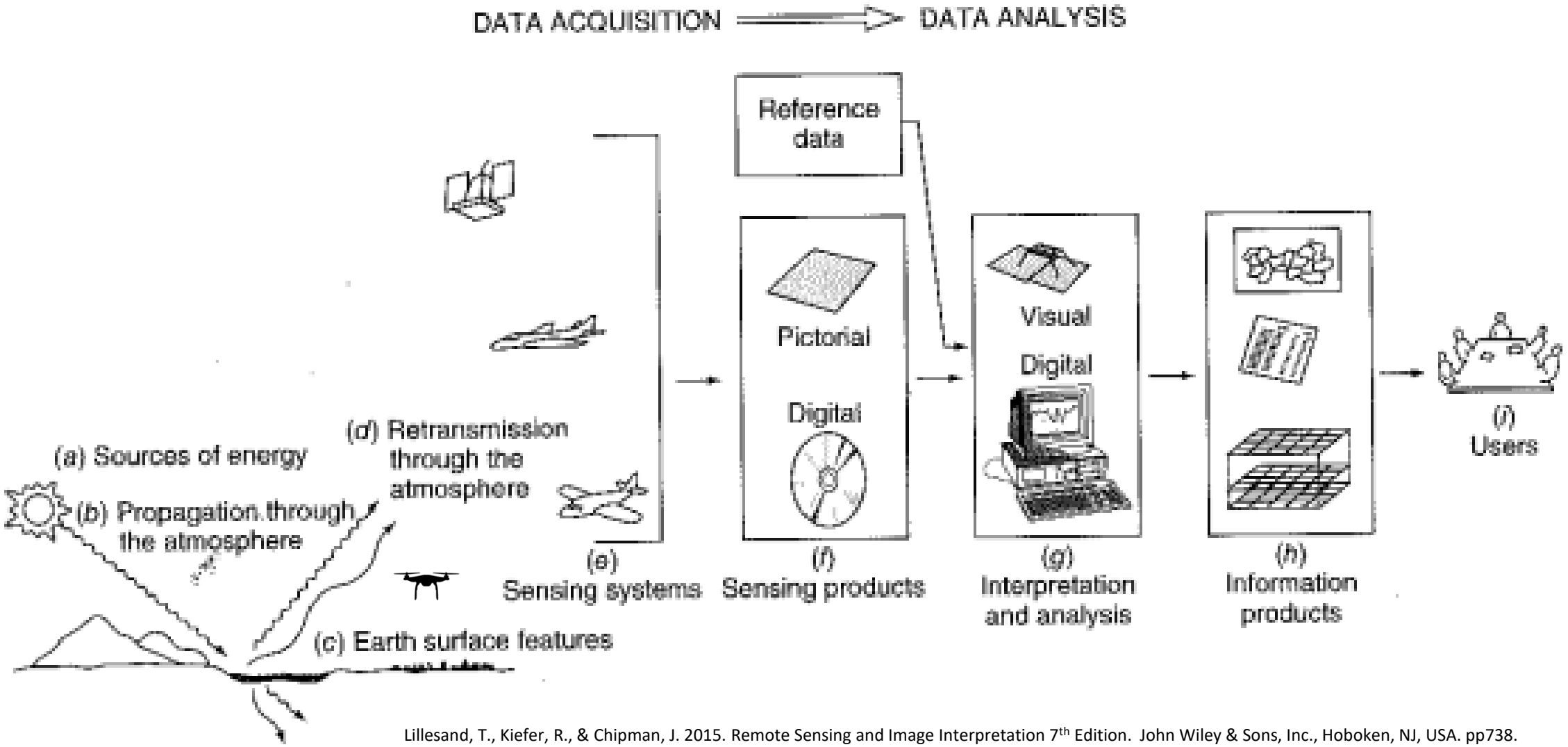
Definition

The science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area, or phenomenon under investigation.

Lillesand, T., Kiefer, R., & Chipman, J. 2015. Remote Sensing and Image Interpretation 7th Edition. John Wiley & Sons, Inc., Hoboken, NJ, USA. pp738.

Process of Remote Sensing

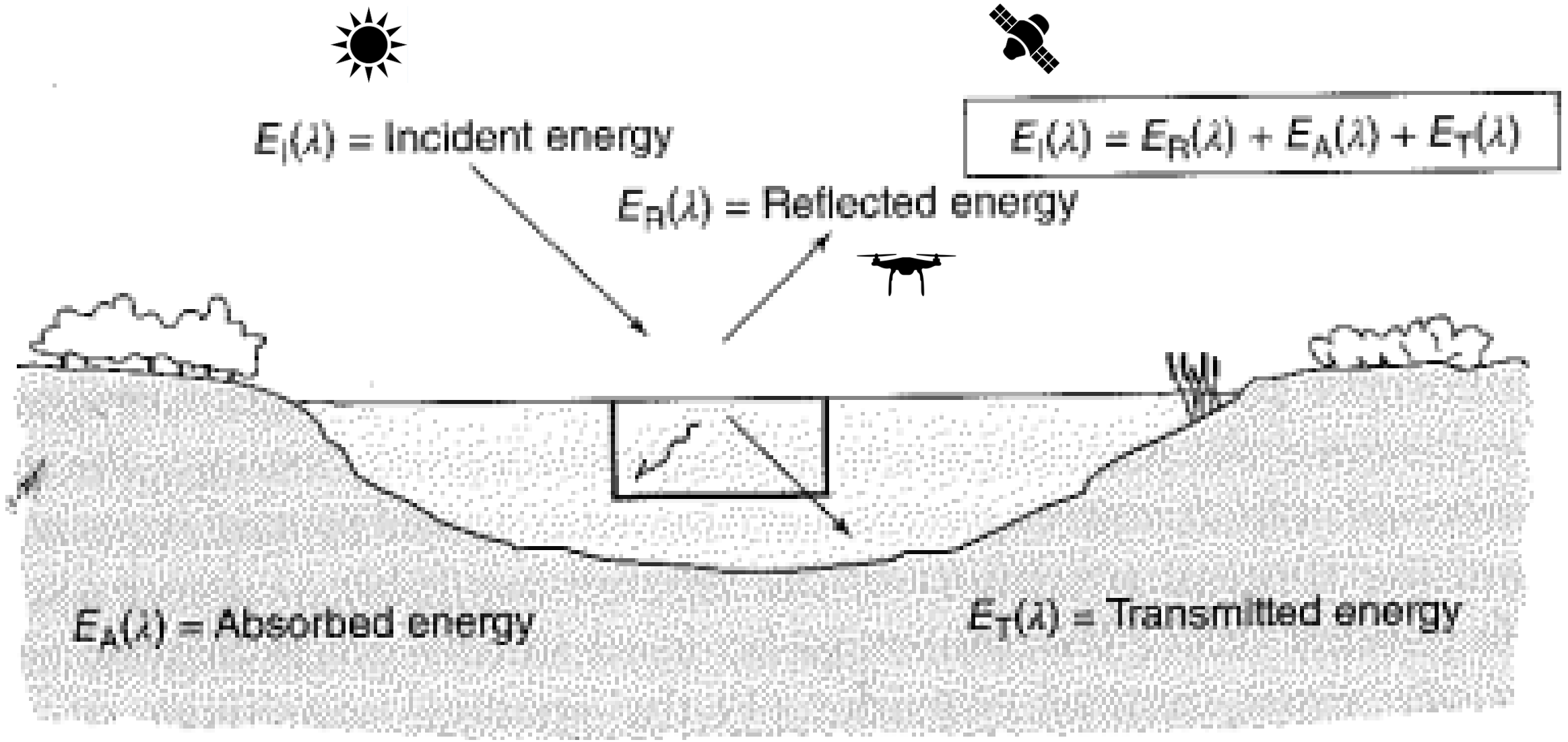
From data acquisition to analysis



Lillesand, T., Kiefer, R., & Chipman, J. 2015. Remote Sensing and Image Interpretation 7th Edition. John Wiley & Sons, Inc., Hoboken, NJ, USA. pp738.

Interaction of Electromagnetic Energy and Earth Surface Features

Path of incident energy



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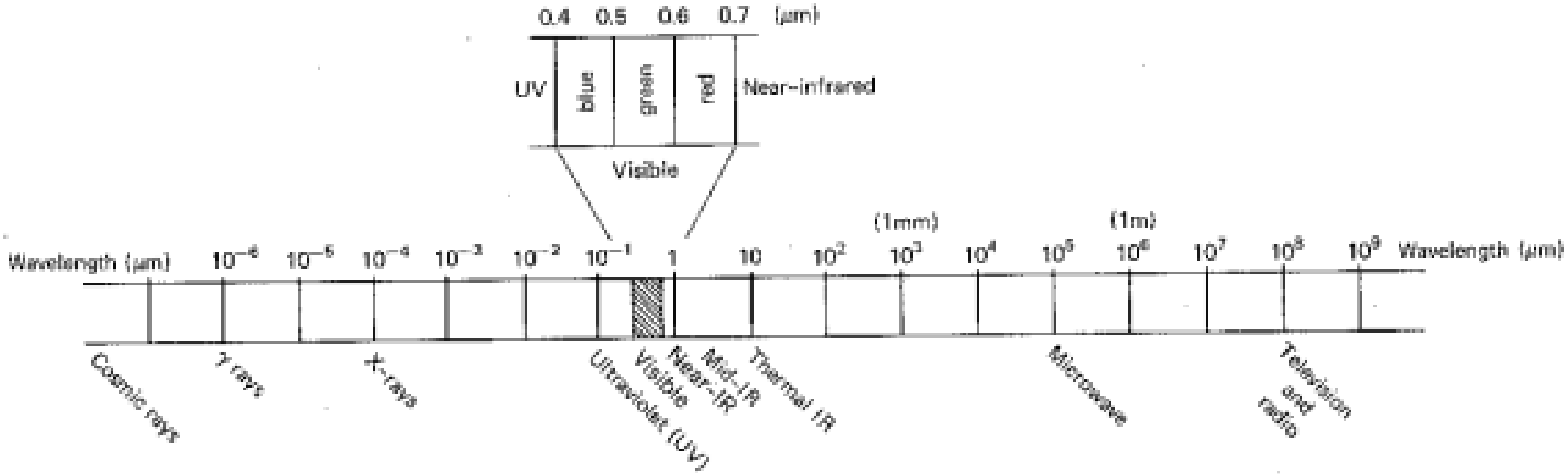
Electromagnetic Spectrum

Wide range of wavelengths



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Common Sources of Satellite Imagery

Free of charge

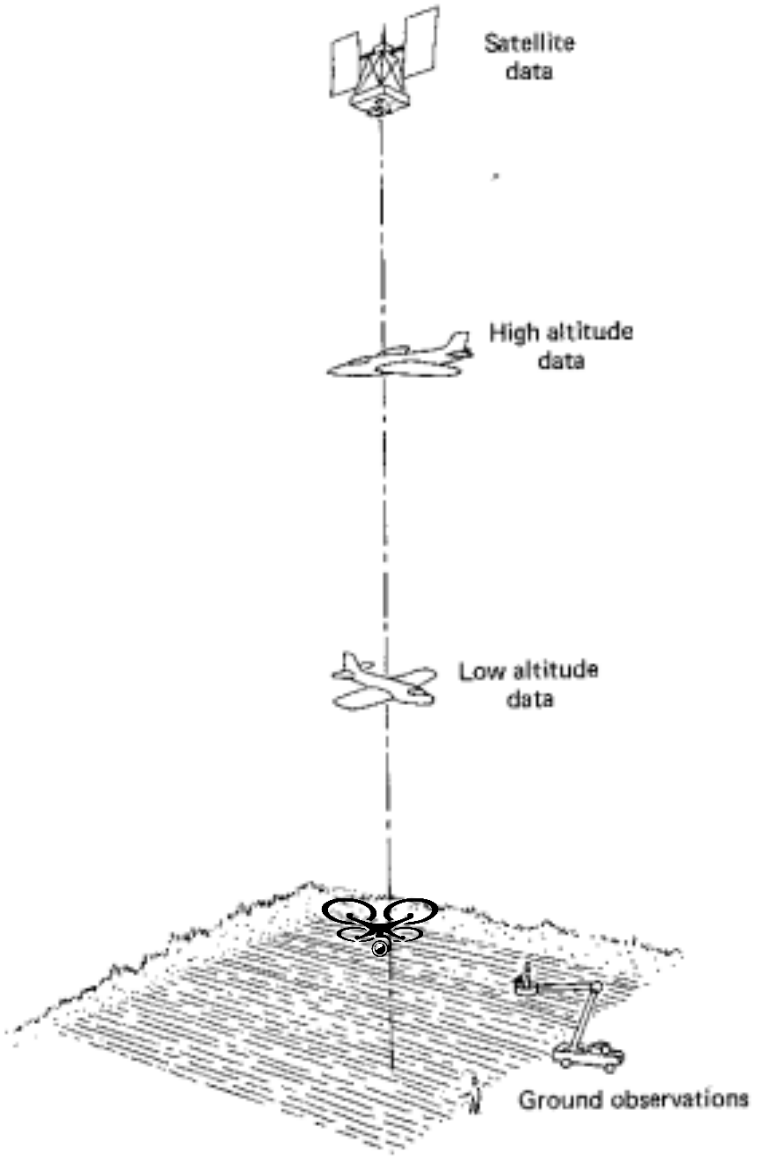
MODIS

Landsat

Sentinel

Comparison of Altitudes for Remote Sensing platforms

Wide range of altitudes



705 km

12 km

8 km

30+ m

Resolution for Remote Sensing

4 types

Radiometric Resolution

Spectral Resolution

Spatial Resolution

Temporal resolution

Resolution for Remote Sensing

Spatial Resolution

Spatial resolution – How well a sensor can record spatial detail

Landsat
(30m/pixel)

Quickbird-2
(2.5 m/pix)

Resolution for Remote Sensing

Spatial Resolution

Sentinel-2
10m/pix

UAV
4.4 cm/pix

AIT Campus

Resolution for Remote Sensing

Temporal Resolution

Temporal resolution – the revisit time of the image capturing medium

Ex satellite: orbital repeat cycle

Clouds

MODIS	Landsat 8	Sentinel-2	UAV
1-2 days	16 days	5 days	On demand

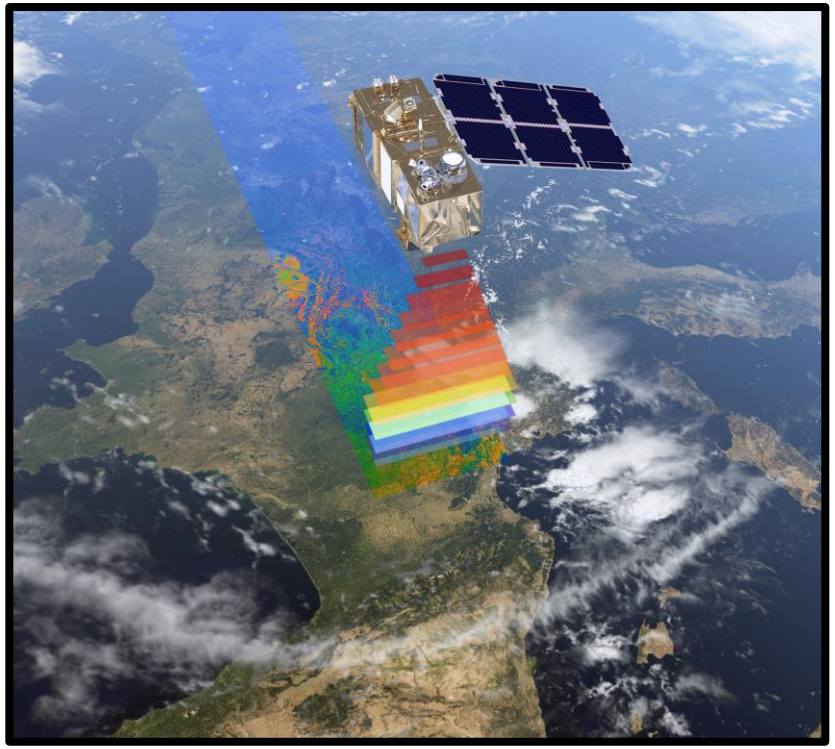


Image Classification

RS Image Analysis

Objective: Automatically categorize all pixels in an image to land cover classes or themes

Based on spectral values – similar pixels join same group

Image Classification

Unsupervised Classification

Analyst selects a number of classes for the pixels to be classified into

Pixels are aggregated into natural spectral groupings

Analyst determines the land cover identity of the classes by comparing to the original image

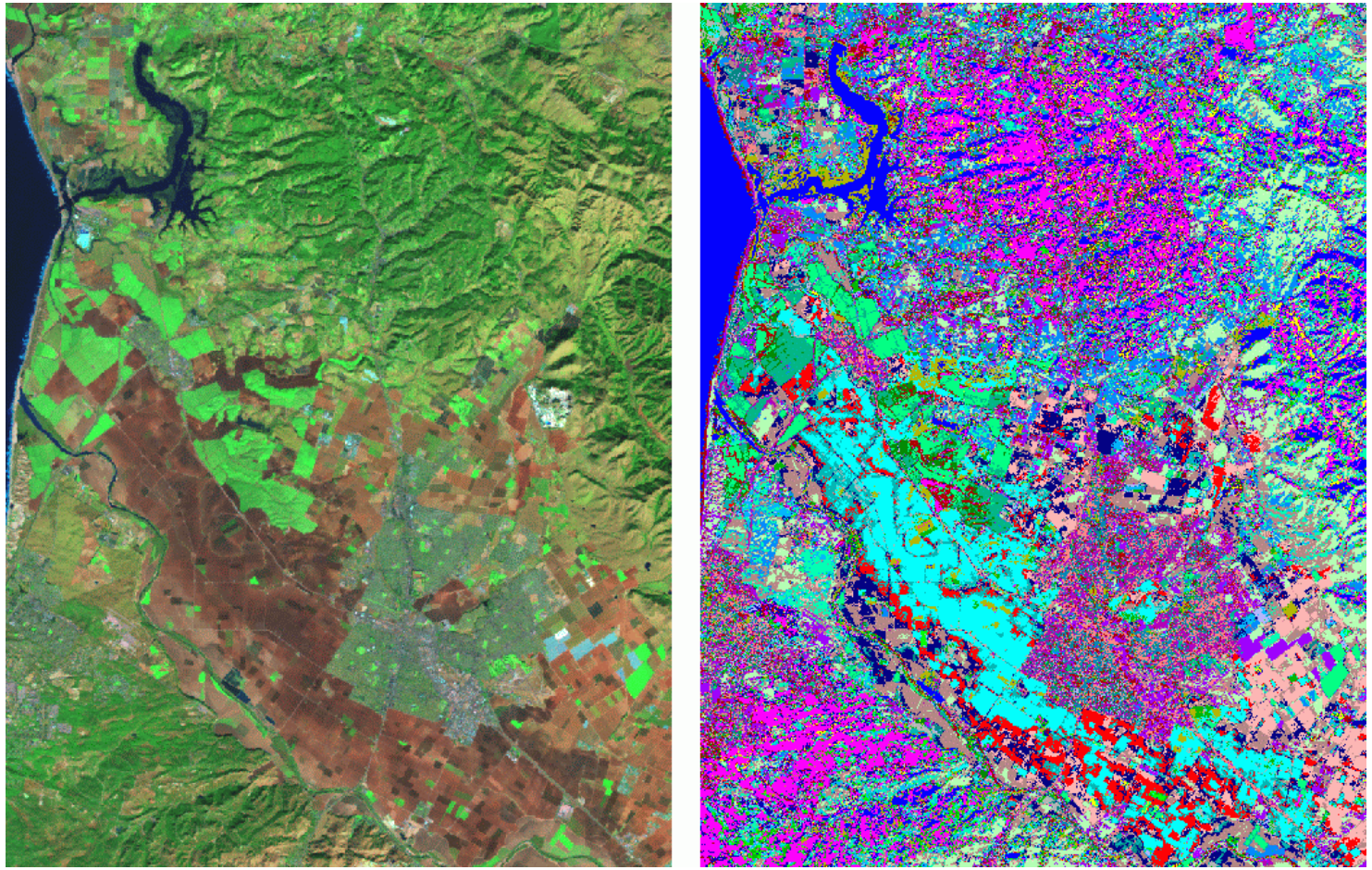
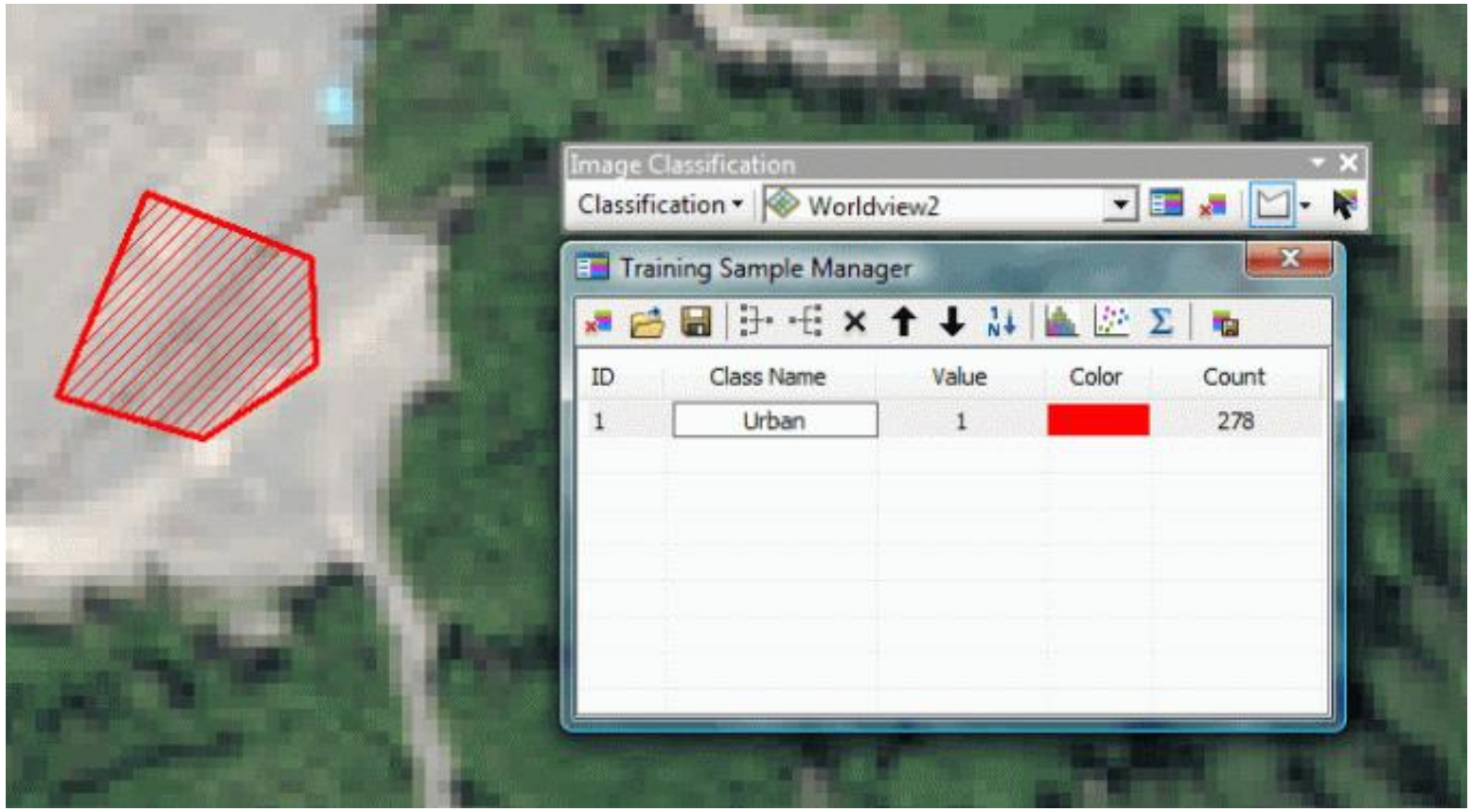


Image classification

Supervised Classification

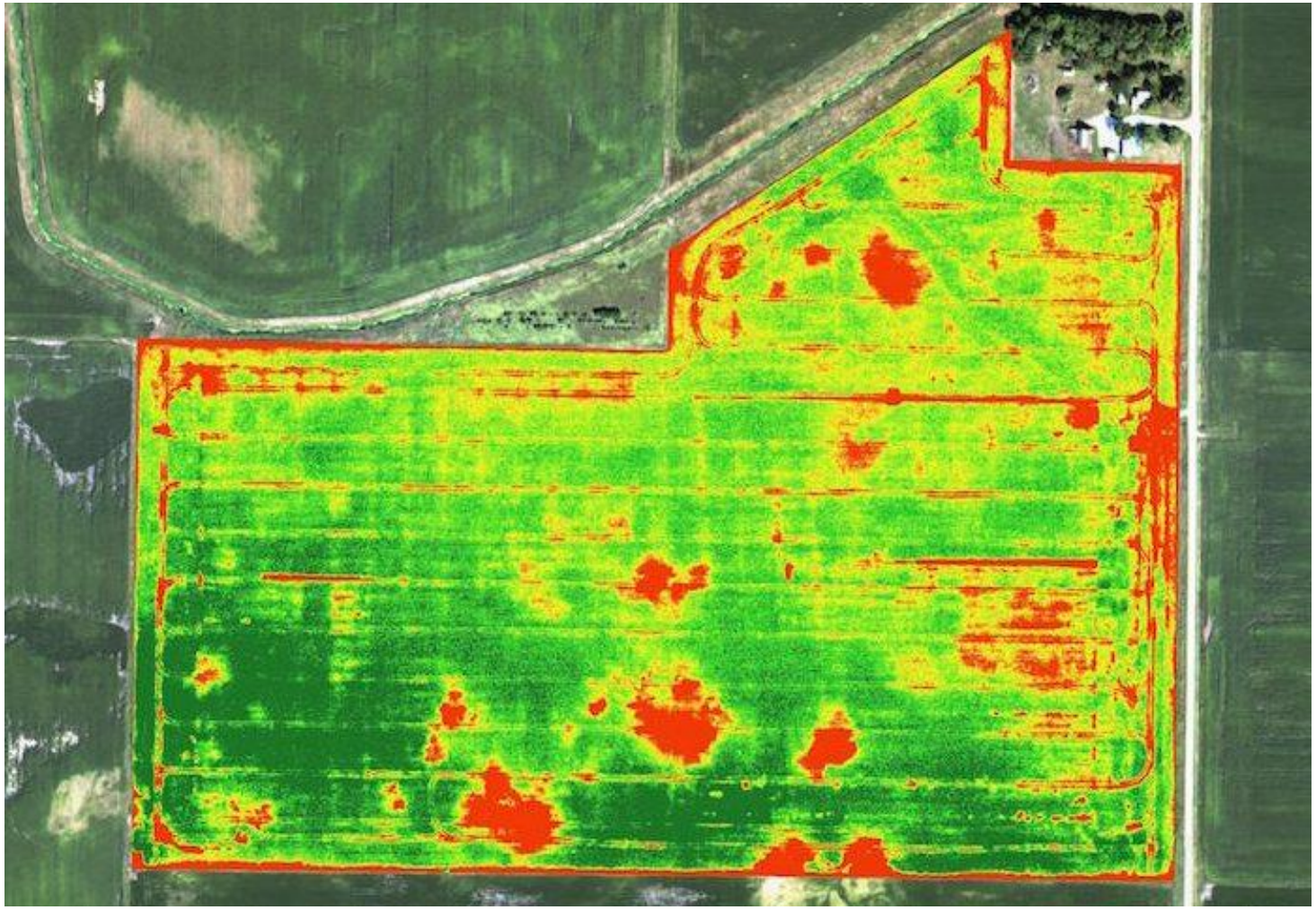
Analyst is the supervisor: select training samples of each cover type

Classification: Training samples are used to find other similar pixels from the rest of the image



Band Ratios and Indexes

Normalized Difference Vegetation Index



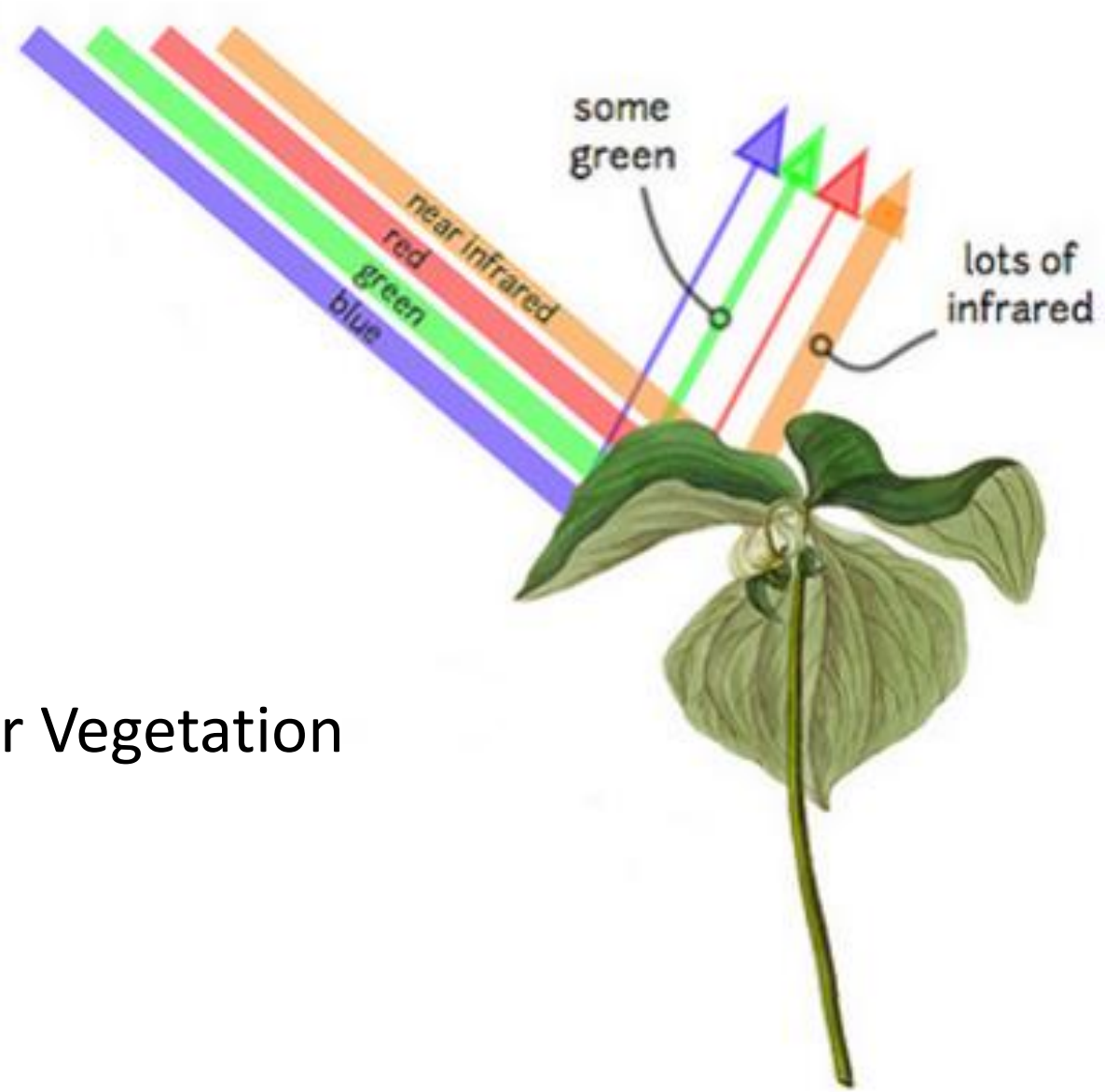
$$NDVI = \frac{NIR - Red}{NIR + Red}$$

Indicator of Cholrophyll

Crop health

Reflectance Characteristics

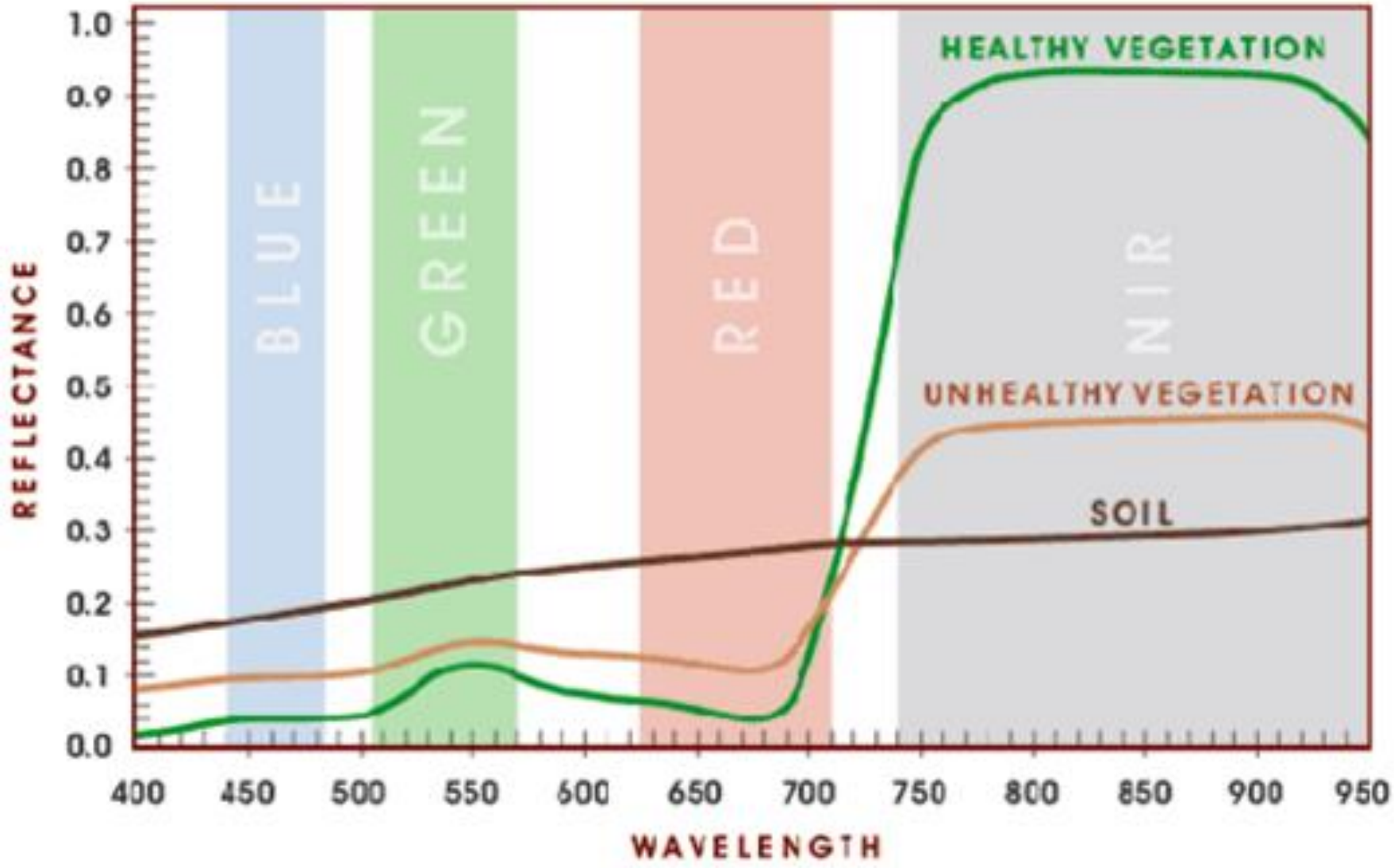
Ex: Vegetation



Reflectance for Vegetation

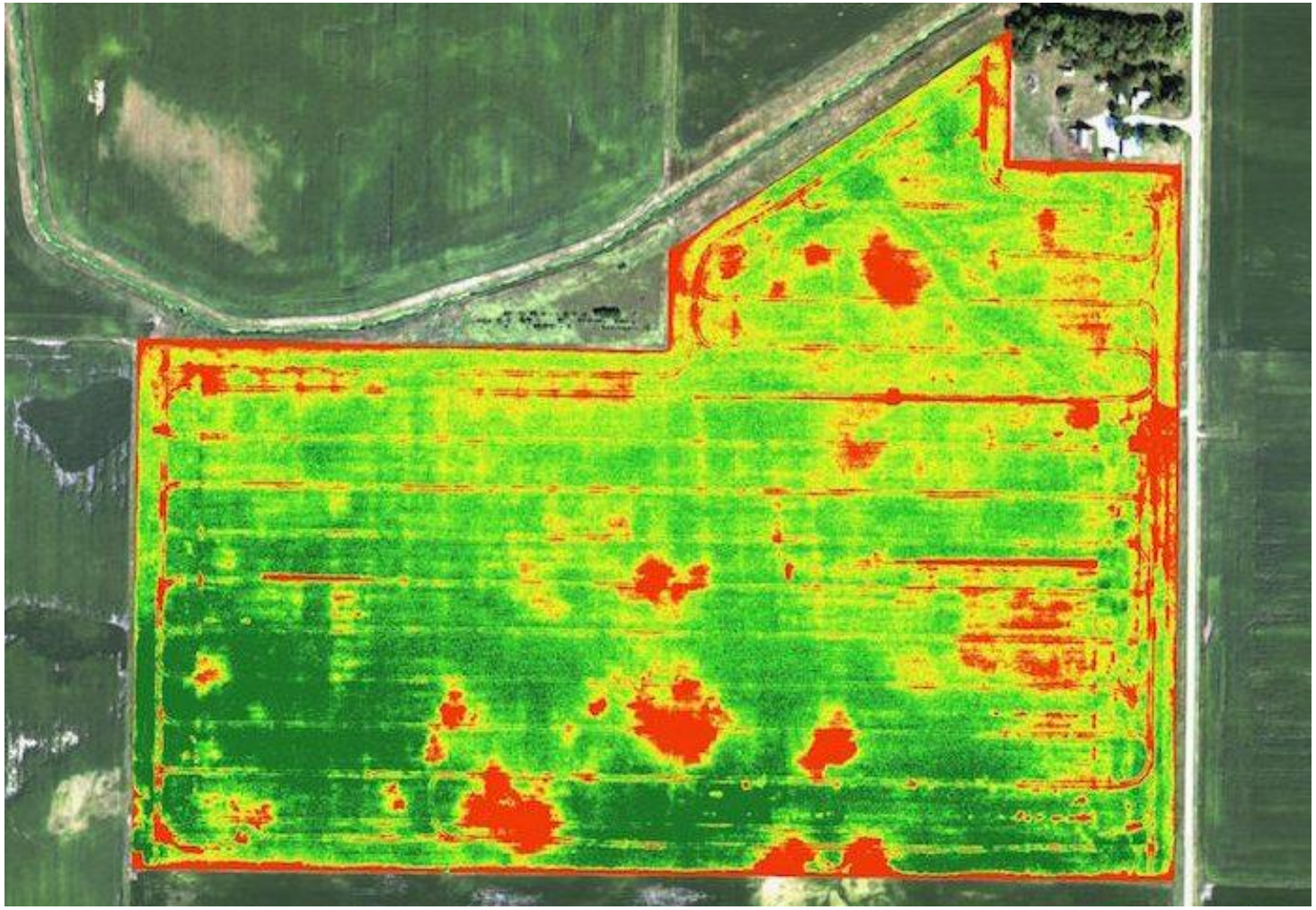
Reflectance Characteristics

Ex: Vegetation



Band Ratios and Indexes

Normalized Difference Vegetation Index



$$NDVI = \frac{NIR - Red}{NIR + Red}$$

Indicator of Cholrophyll

Crop health

GIS – Geographic Information Systems

Definition

(def) A geographic information system (GIS) captures, stores, analyzes, manages, and presents data that is linked to locations.

GIS is a set of tools that allow for the processing of spatial data into information.

A good GIS should answer the following questions:

Location – *Where is it?*

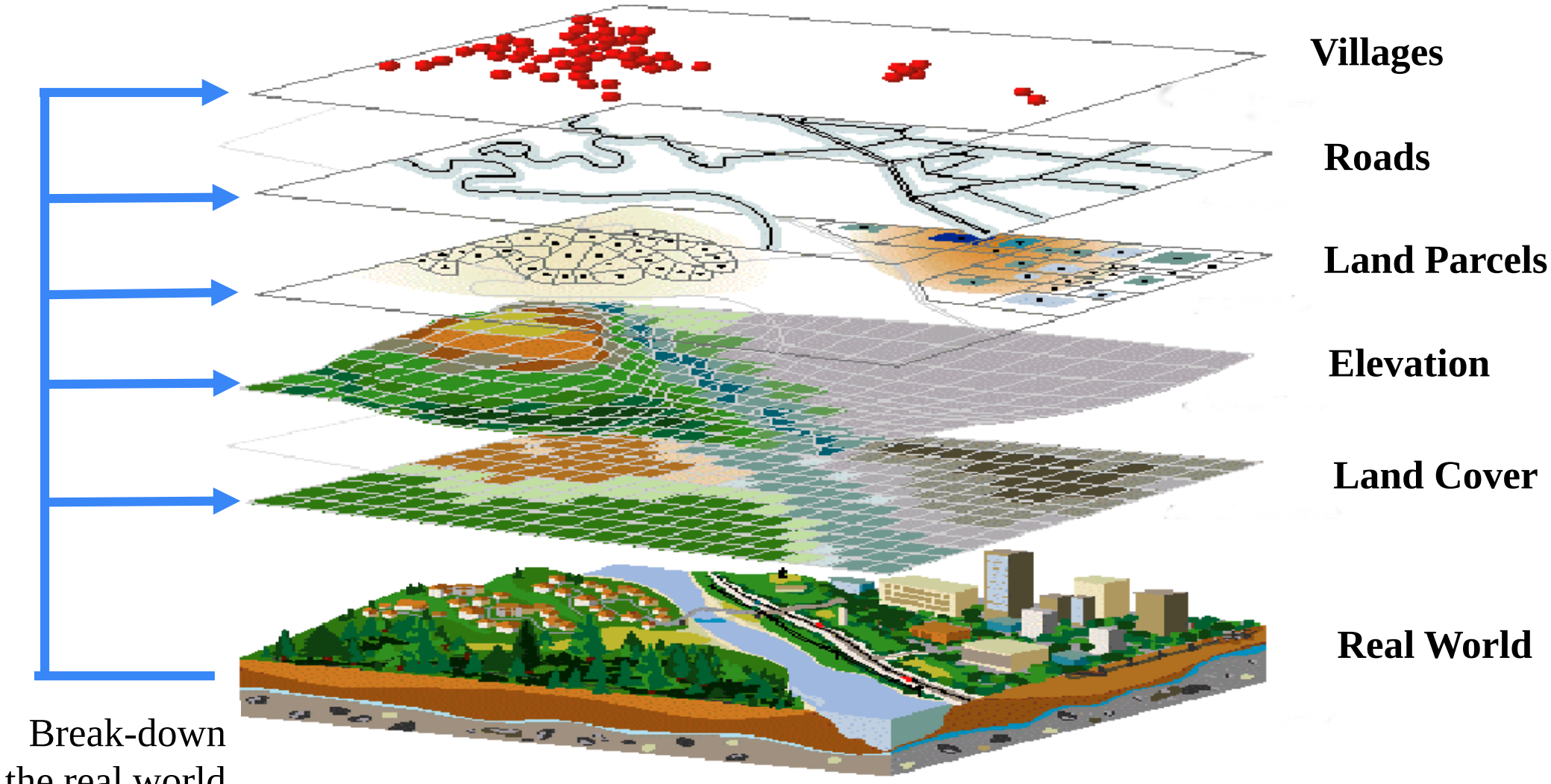
Condition – *What if?*

Trends – *What has changed since?*

Relations – *Which data are related?*

Interpretation of Real World in GIS Terms

Layers of information



Data used in a GIS

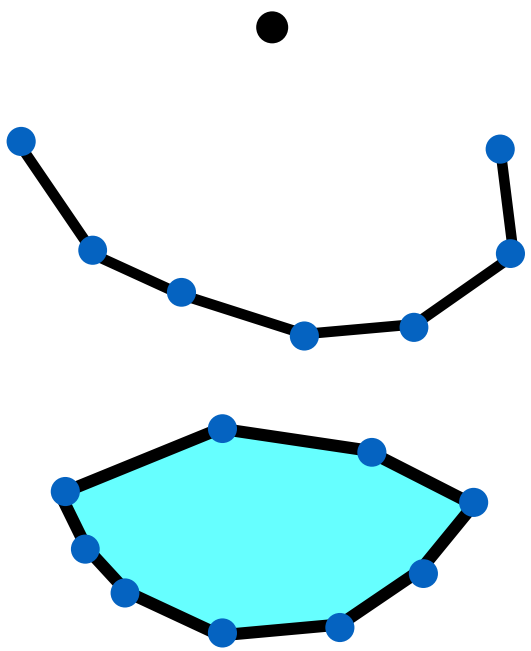
Interaction among data

Spatial Data	Features that have a known location on earth.
Attribute Data	The information linked to the geographic features (spatial data) describing them
Data Layers	Are the result of combining spatial and attribute data. Essentially adding the attribute database to the spatial location.
Layer Types	A layer type refers to the way spatial and attribute information are connected. There are two major layer types, vector and raster.
Topology	How geographic features are related to one another, and where they are in relation to one another.

Spatial Data Models

Vector – 3 types

We typically represent objects in space as three distinct spatial elements:



Points - simplest element

Lines (arcs) - set of connected points

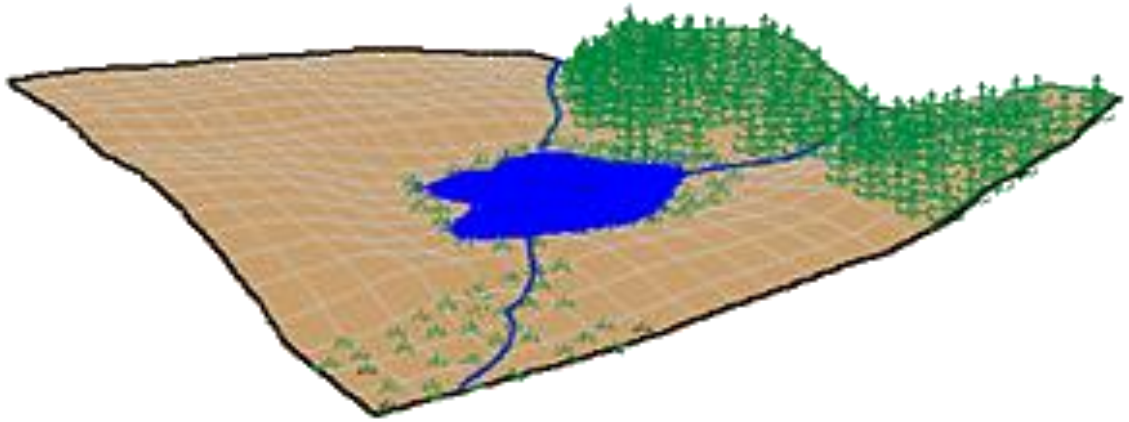
Polygons - set of connected lines

We use these three spatial elements to represent real world features and attach locational information to them.

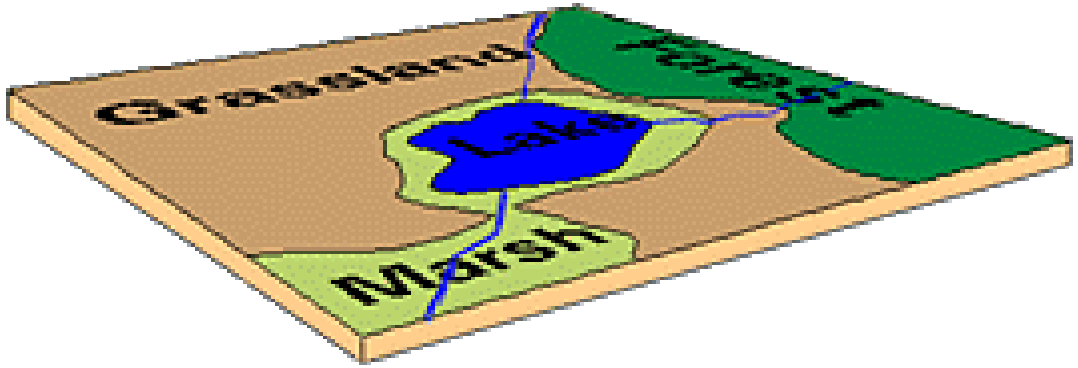
Vector

Polygons

Real World



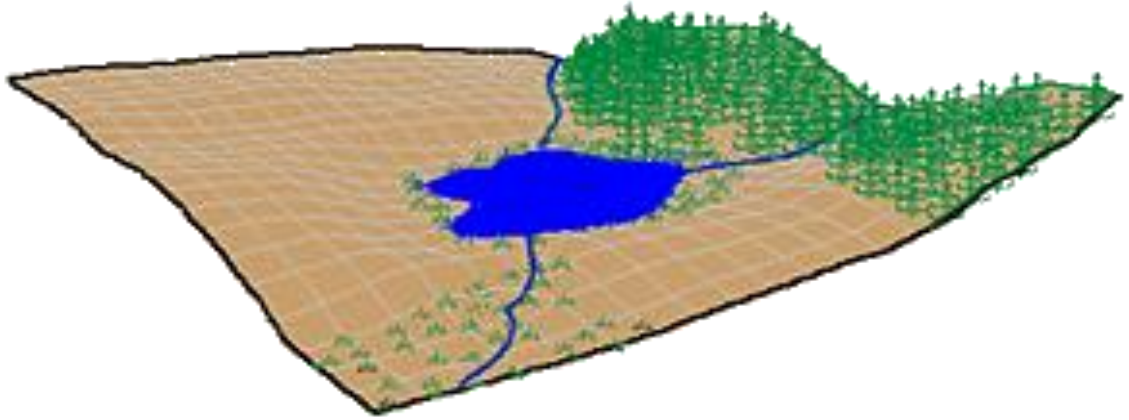
Vector



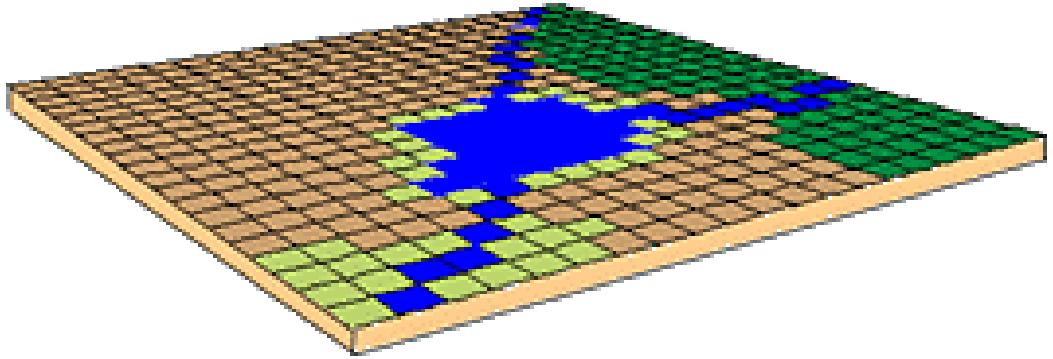
Raster

Polygons

Real World



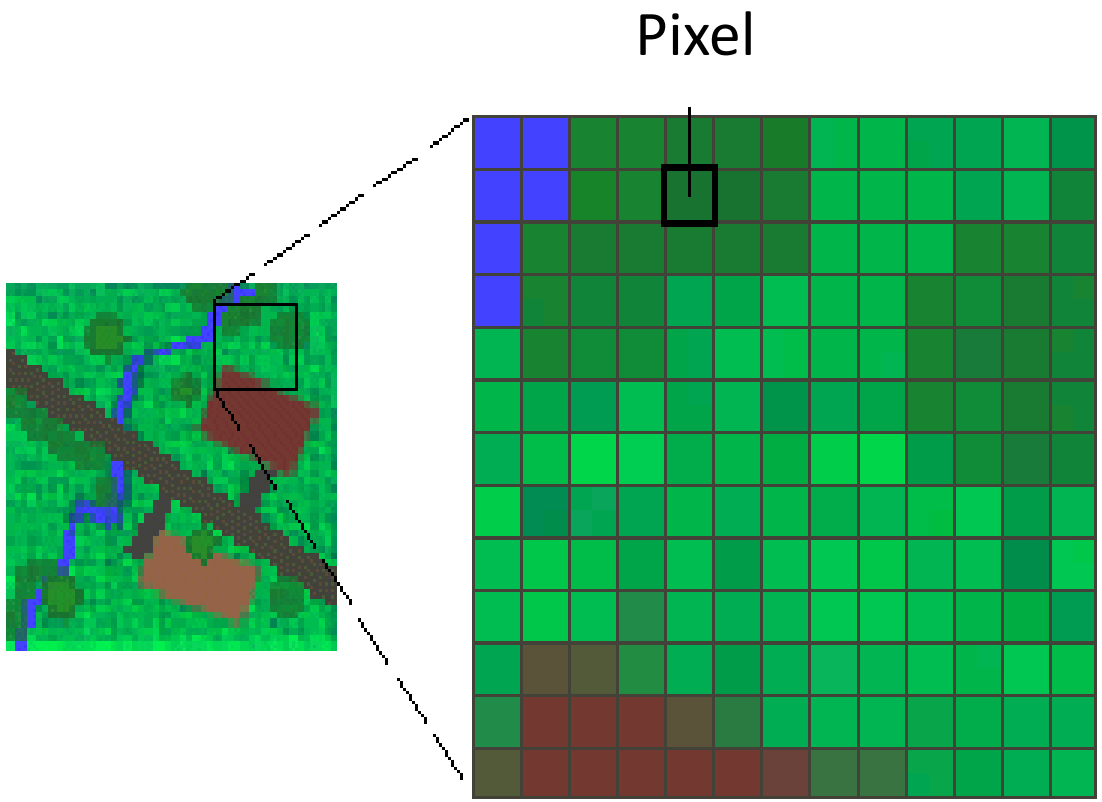
Raster



Raster Data

Composed of pixels

A GIS in which graphic data is stored in the form of grid cells or pixels.



PIXEL (picture element)

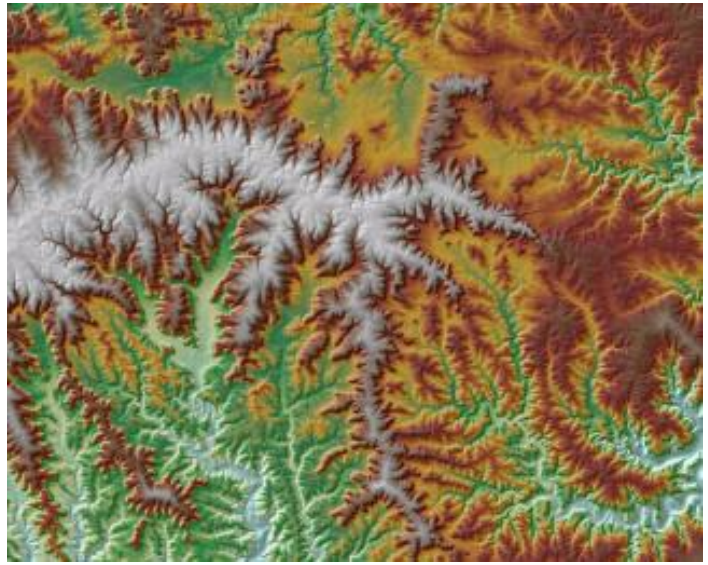
The smallest unit in an image.

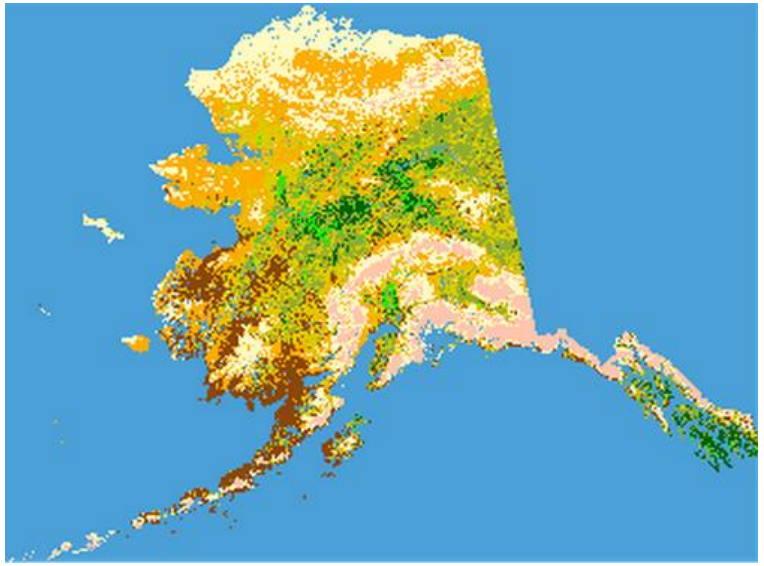
In raster based GIS systems, attribute information can be assigned to each pixel.

Examples of Raster Data

A variety of rasters

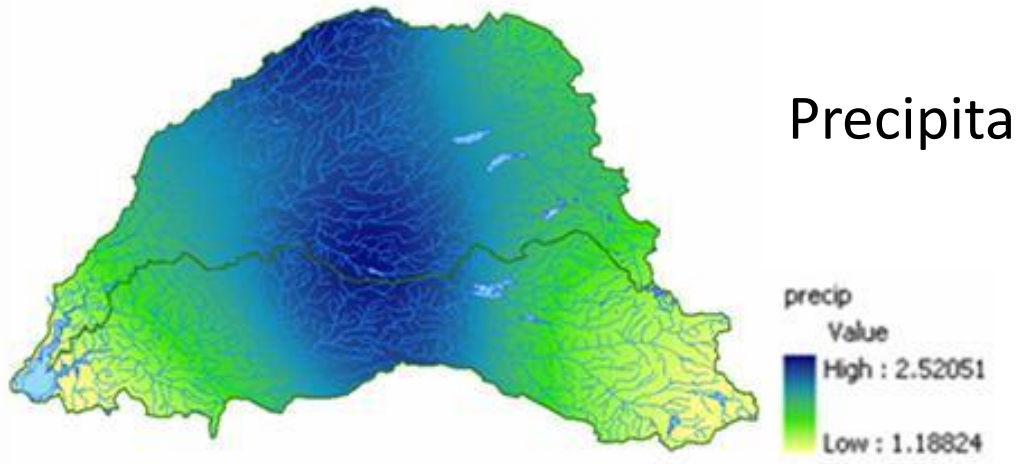
Elevation





Land Cover

Satellite imagery



Precipitation

Applications of GIS to Agriculture

Risk Management

Use info including slope, aspect, soil data, floodplain map, farm location, crop data, satellite imagery

Use all that info to create insurance rate zones (some areas have higher rates than others based on the criteria derived from the aforementioned data in the GIS).

-Use satellite data to determine if farmers are making fradulent claims on crop losses (compare imagery before / after flood event).

2. Map health of crops

End of Presentation

Thank You

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Please Download and Install

3 Programs

On your phone / tablet: 1. Pix4D Capture

On your computer: 2. Pix4D Free Trial

3. QGIS

https://qgis.org/en/site/forusers/download.html