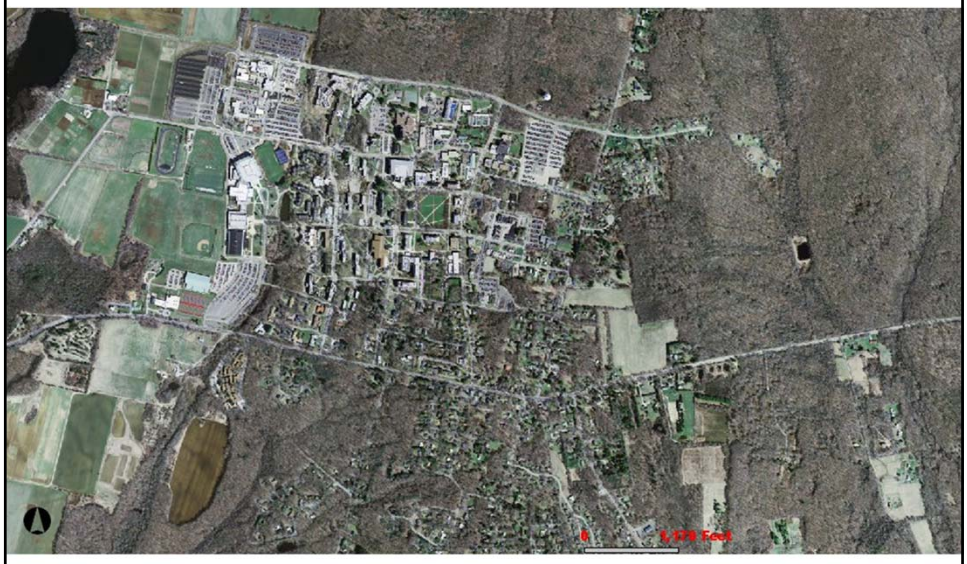
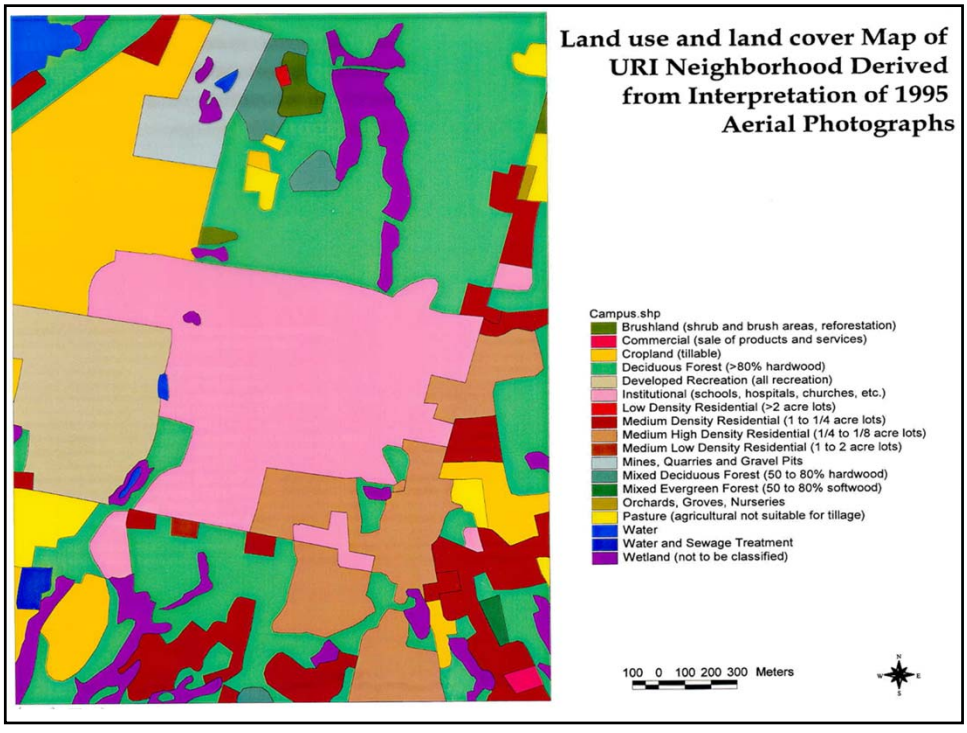
Principals and Elements of Image Interpretation





Fundamentals of Photographic Interpretation

- Observation and inference depend on interpreter's training, experience, bias, natural visual and analytical abilities.
- Human visual or manual interpretation is still a dominant approach to day-to-day applications of remote sensing.
- Observation and understanding of the basic elements of photo interpretation are critical.

Why photo/image interpretation?

- Aerial/Regional Perspective:
  - Examination of the Earth from an aerial perspective allows us to identify objects, patterns, and man-land interrelationships.
  - Remotely sensed image provides "spatial terrain" information.

Why photo/image interpretation?

- The ability to obtain a historical image record to document change:
  - The photographs or images are valuable historical records of the spatial distribution of natural and man-made phenomena.
  - The study of change increases our understanding about the natural and human-induced processes in the landscape.

Why photo/image interpretation?

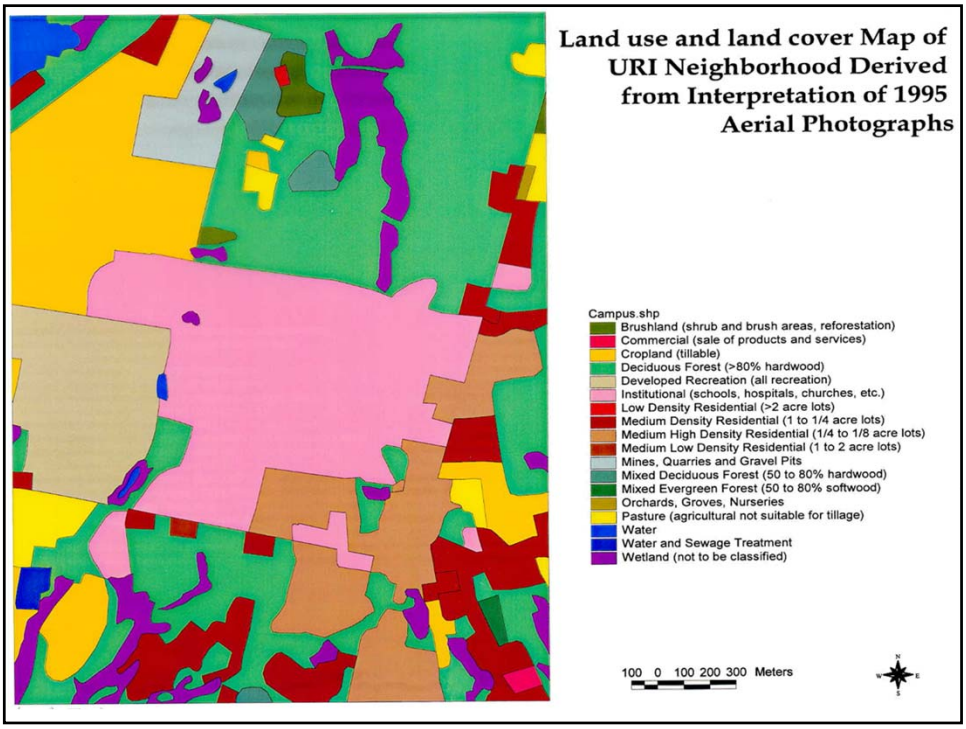
- Three-Dimensional Depth Perception:
  - We can obtain a 3-dimensional view of the terrain by viewing the two images of the terrain from two slightly different vantage points at the same time.
  - Stereoscopic analysis process provides us the information of object's height, depth, and volume.

Deriving Information from Data

Heads-up digitizing

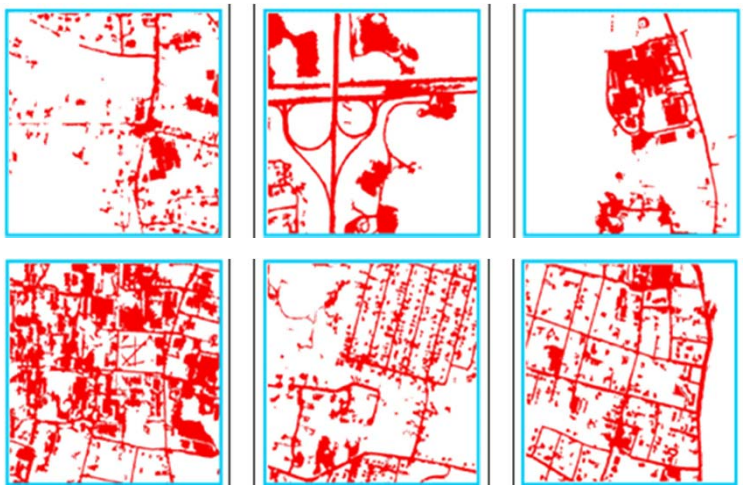
Digital image classifications

- Unsupervised
- Supervised



Digital Image Classification?

Information Extraction from Pixels



Principals and Elements of Visual Image Interpretation

Fundamentals of Photographic Interpretation

Photo Interpretation:

The examination of aerial photographs/images for the purpose of identifying objects and judging their significance.

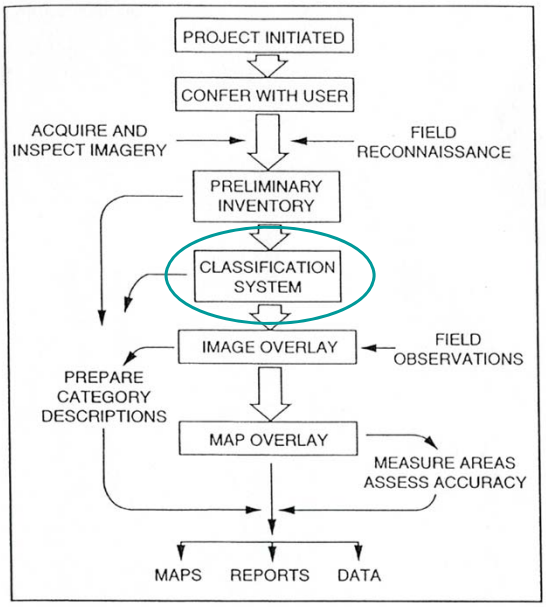
Observation & Inference:

Observation provides the raw data for interpretation. Inference is the logical process by which observation and interpretation are made.

Photo interpretation – Observation - Inference

Where to draw the line?

Image interpretation for Land Use Mapping



USGS Land Use and Land Cover Classification System

Anderson, J. R., E. E. Hardy, and J. T. Roach, 1976. *A Land Use and Land Cover Classification System for Use with Remote Sensor Data*, Washington, DC: U.S. Geological Survey Profession Paper 964, 28 pp.

USGS Land Use and Land Cover Classification System

Level I	Level II
1 Urban or built-up land	11 Residential
	12 Commercial and Services
	13 Industrial
	14 Transportation, Communications, and Utilities
	15 Industrial and Commercial Complexes
	16 Mixed urban or Built-up land
	17 Other Urban or Built-up Land

USGS Land Use and Land Cover Classification System

Level I	Level II
2 Agricultural land	21 Cropland and pasture
	22 Orchards, groves, vineyards, nurseries, and ornamental horticultural areas
	23 Confined feeding operations
	24 Other agricultural land

USGS Land Use and Land Cover Classification System

Level I	Level II
3 Rangeland	31 Herbaceous rangeland
	32 Shrub and brush rangeland
	33 Mixed rangeland
4 Forest land	41 Deciduous forest land
	42 Evergreen forest land
	43 Mixed forest land

USGS Land Use and Land Cover Classification System

Level I	Level II
5 Water	51 Streams and canals
	52 Lakes
	53 Reservoirs
	54 Bays and estuaries
6 Wetland	61 Forested wetland
	62 Nonforested wetland

USGS Land Use and Land Cover Classification System

Level I	Level II
7 Barren land	71 Dry salt flats
	72 Beaches
	73 Sandy areas other than beaches
	74 Bare exposed rock
	75 Strip mines, Quarries, and gravel pits
	76 Transitional areas
	77 Mixed barren land

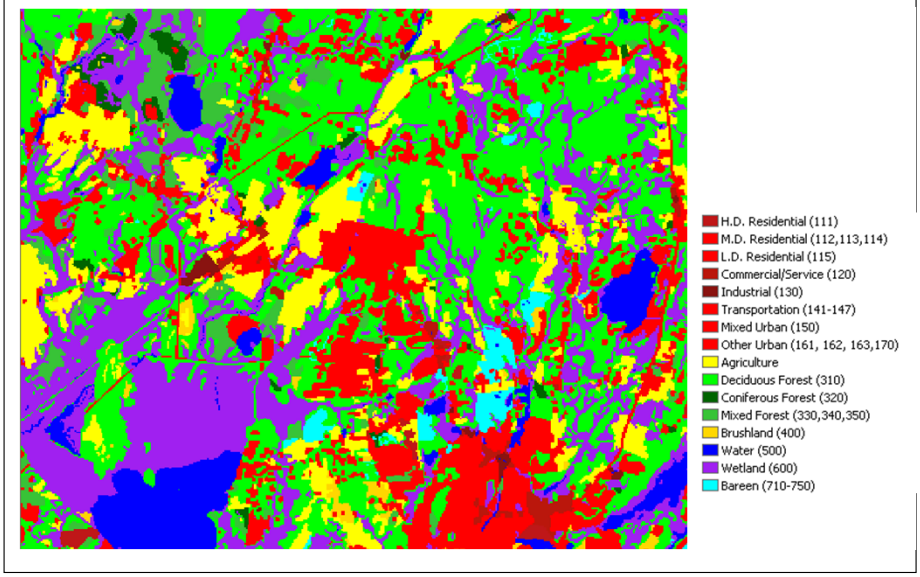
Example of Sub-categorization of Residential Land (Level III)

Level I	Level II	Level III
1. Urban or Built-up	1.1. Residential	1.1.1. Single-family Units 1.1.2. Multi-family Units 1.1.3. Group Quarters 1.1.4. Residential Hotels 1.1.5. Mobile Home Parks 1.1.6. Transient Lodgings 1.1.7. Other

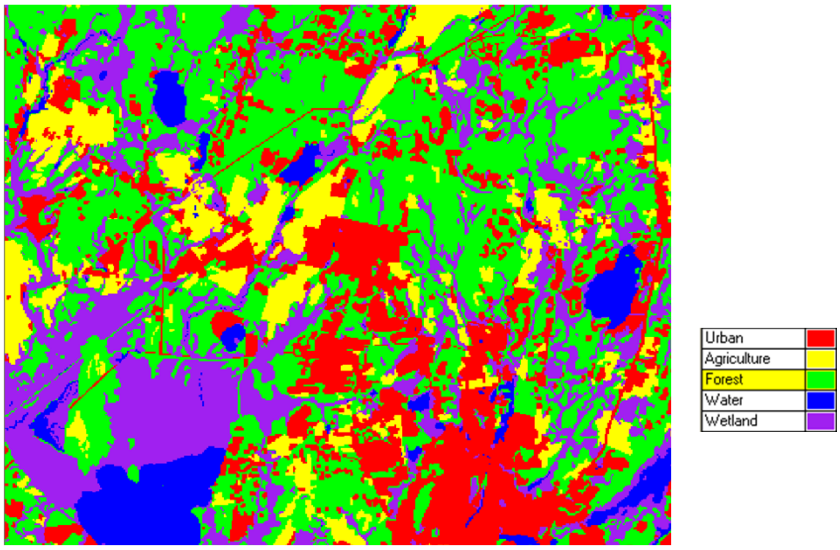
Representative Image Interpretation Formats for Various Land Use/Land Cover Classification Levels

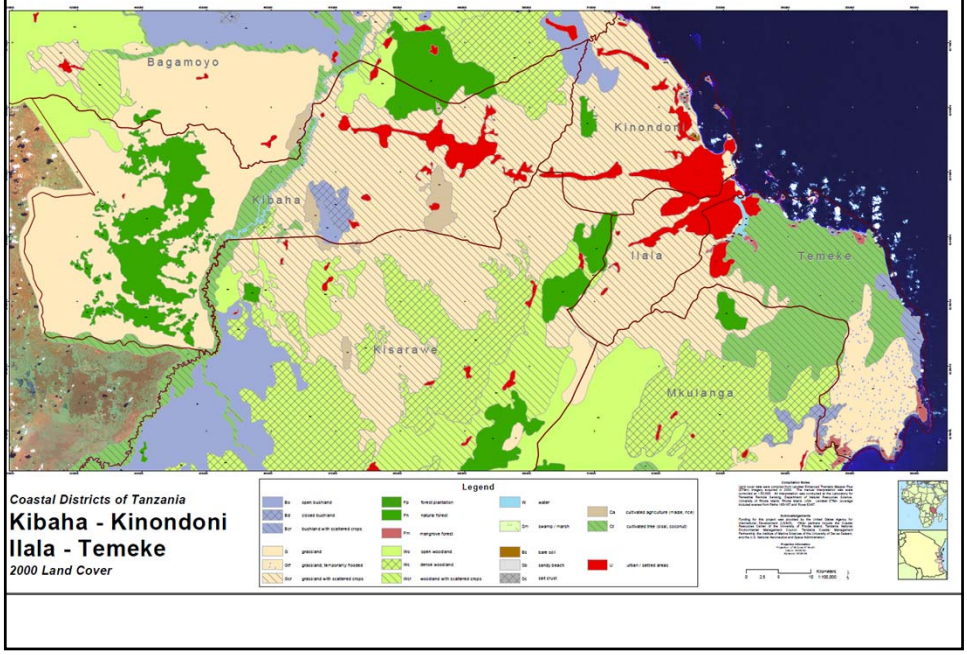
Land Use/Land Cover Classification Level	Representative Format for Image Interpretation
I	Low to moderate resolution satellite data (e.g., Landsat MSS)
II	Small-scale aerial photographs; moderate resolution satellite data (e.g., Landsat TM)
III	Medium-scale aerial photographs; high resolution satellite data (e.g., IKONOS)
IV	Large-scale aerial photographs

(USGS Level II)



(USGS Level I)


Urban
Agriculture
Forest
Water
Wetland


Bagamoyo
Kinondoni
Kibaha
Ilala
Temeke
Kisarawe
Mkuranga
Legend
Coastal Districts of Tanzania
Kibaha - Kinondoni
Ilala - Temeke
2000 Land Cover

Elements of Image Interpretation

- *x,y* Location
- Size
- Shape
- Shadow
- Tone/Color
- Texture
- Pattern
- Height/Depth
- Site (elevation, slope, aspect)
- Situation
- Association

Elements of Image Interpretation

Element	Common Adjectives (Quantitative and qualitative)
x,y location	*x,y* coordinate: longitude and latitude or meters easting and northing in a UTM map grid
Size	Length, width, perimeter, area (m^2) small, medium (intermediate), large
Shape	An object's geometric characteristics: linear, curvilinear, circular, elliptical, radial, square, rectangular, triangular, hexagonal, pentagonal, star, amorphous, etc.

Elements of Image Interpretation

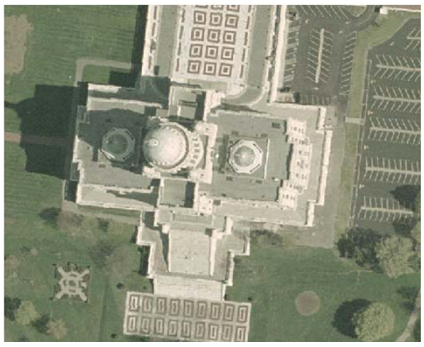
Element	Common Adjectives (Quantitative and qualitative)
Shadow	Caused by solar illumination from the side
Tone/color	Gray tone: light (bright), intermediate (gray), dark (black) Color: HIS = intensity, hue (color), saturation; RGB = red, green, blue; Munsel
Texture	Characteristic placement of objects on the ground: systematic, random, linear, curvilinear, rectangular, circular, etc.
Pattern	Spatial arrangement of objects on the ground: systematic, random, linear, curvilinear, rectangular, circular, etc.

Elements of Image Interpretation

Element	Common Adjectives (Quantitative and qualitative)
Height/depth Volume/ slope/aspect	z-elevation (height), depth (bathymetry), volume (m^3), slope ^{o}, aspect ^{o}
Site/ situation/ association	Site: elevation, slope, aspect, exposure, adjacency to water, transportation, utilities Situation: objects are placed in a particular order or orientation relative to one another Association: related phenomena are usually present

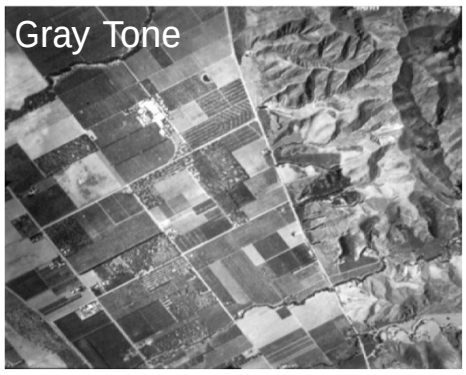
The **size** of an object is one of the most distinguishing characteristics and one of the most important elements of image interpretation.

Many natural and man-made features on the ground have very unique **shapes** that can be referenced in photo and image interpretation.



The electromagnetic radiation (EMR) recorded by remote sensing system can be displayed in shades of gray ranging from black to white – ***tone***.

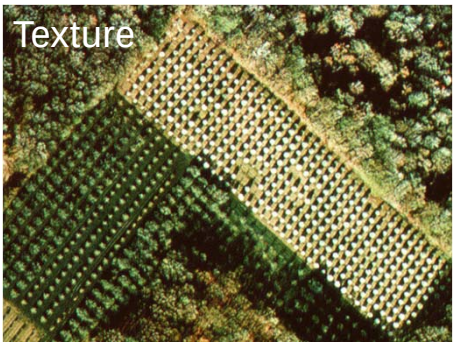
We may use additive color-combining techniques to create ***color*** composite images.

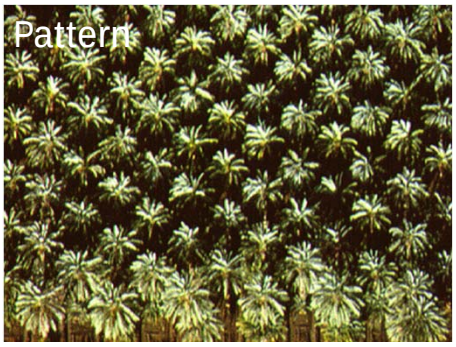


Texture is the characteristic placement and arrangement of repetitions of tones or color in an image.

Pattern is the spatial arrangement of objects in the landscape.

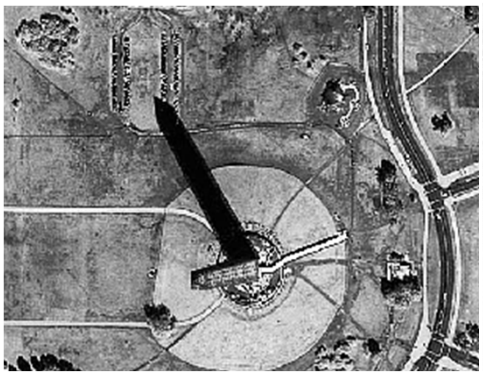
Both texture and pattern are scale independent.

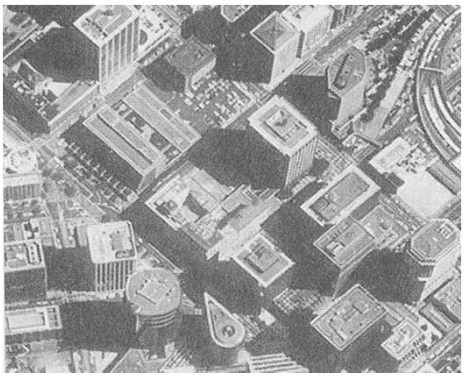




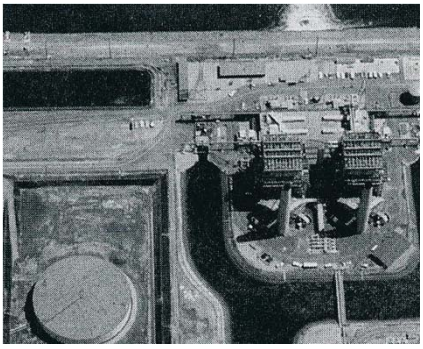
The **shadow** in the image provides real clue to an object's identification, e.g., height.

The ability to visually appreciate or measure the **height** (elevation) or **depth** (bathymetry) of an object or landform is one of the most diagnostic elements of image interpretation.





Site, situation, and **association** characteristics are very important when trying to identify an object or activity. They are always used together.



Site:
- physical (elevation, slope, aspect, type of surface cover)
- socioeconomic (value of the land, adjacency to water)

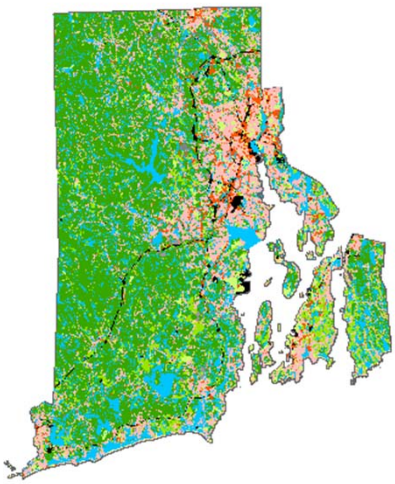
Situation:
How objects are organized and oriented relative to one another.

Association:
When you find a certain activity or phenomena, you almost invariably encounter related or associated features or activities.

On-line review
RIGIS land use/land cover map data

http://www.edc.uri.edu/rigis/

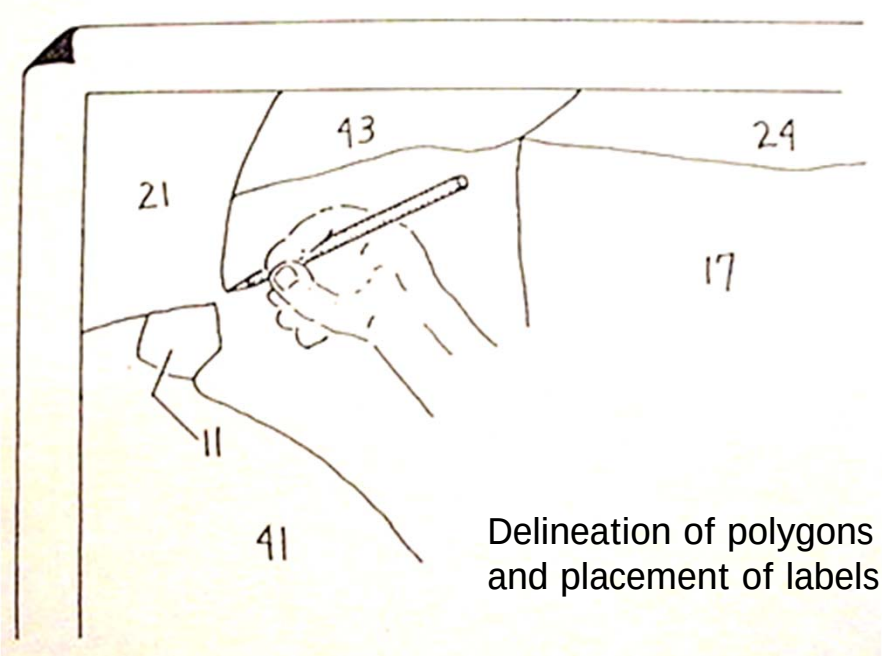
RIGIS Land Use Land Cover Map Data



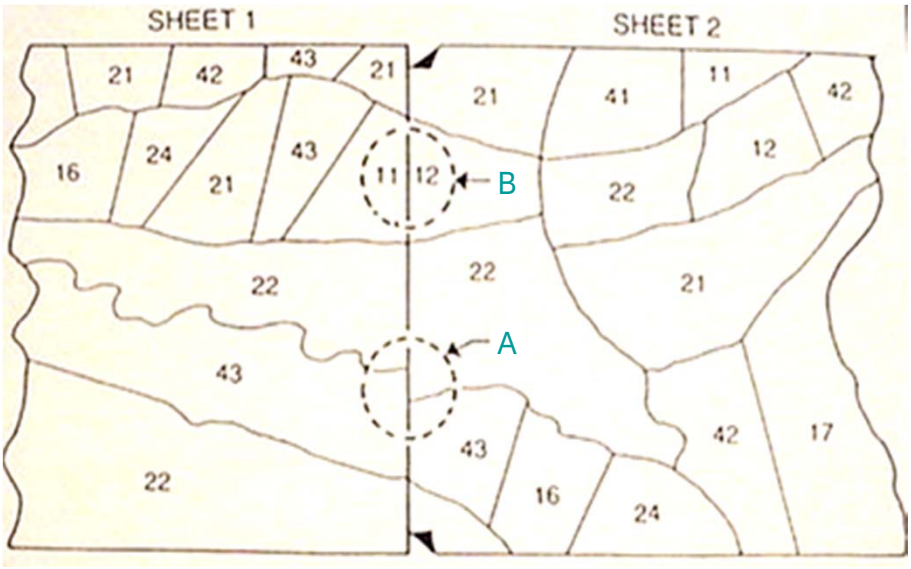
Land use/land cover from 1987 aerial photography coded to Anderson modified level 3 with ½ acre minimum polygon resolution.

1995 Land use/land cover updated using 1987 land use as a base.

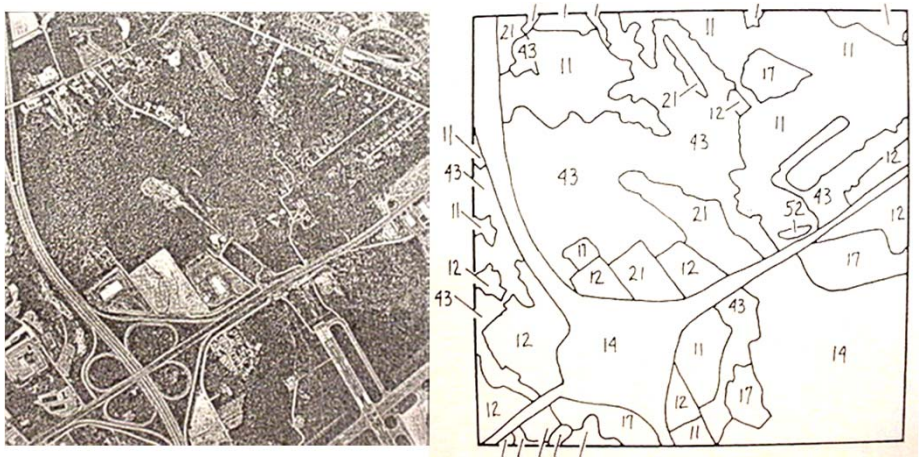
Where to draw the line?



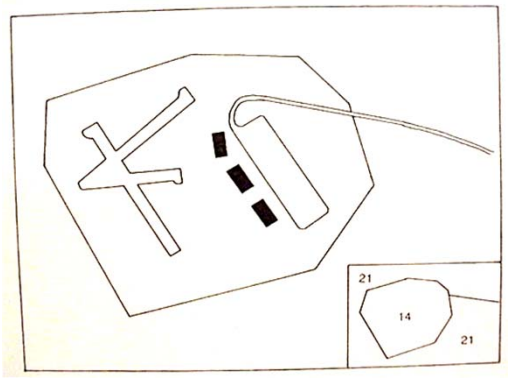
Delineation of polygons and placement of labels



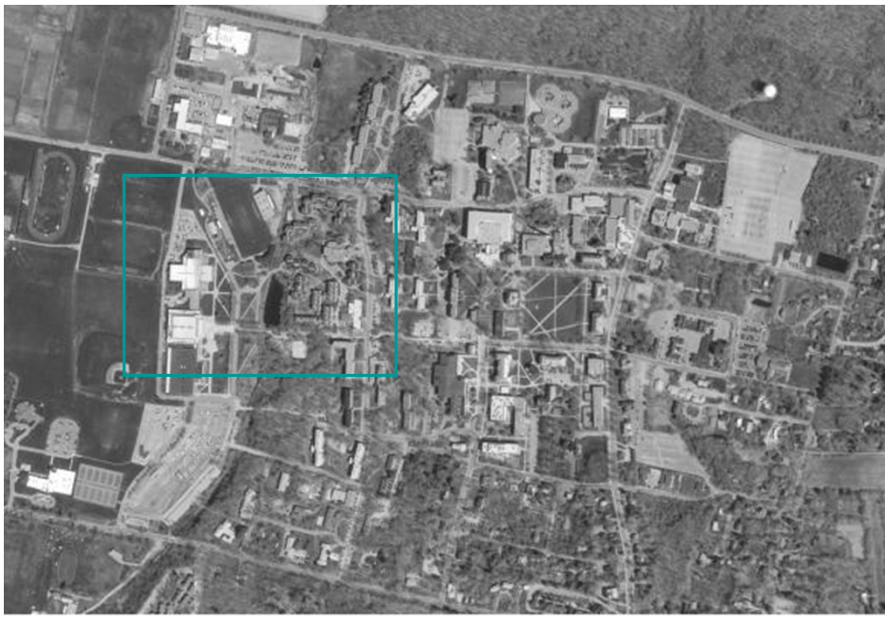
A: Error in matching boundaries
B: Error in labeling parcels



The Photo-Overlay
Left: aerial photograph
Right: land cover boundaries as interpreted from the photographs; numbers corresponded to Anderson Level II classification system.



The delineation of a land use polygon includes the entire area devoted to a particular use. In this example the entire area inside the boundaries of an airfield is represented on the land use map as a single polygon, even though it is composed of several recognizable components.



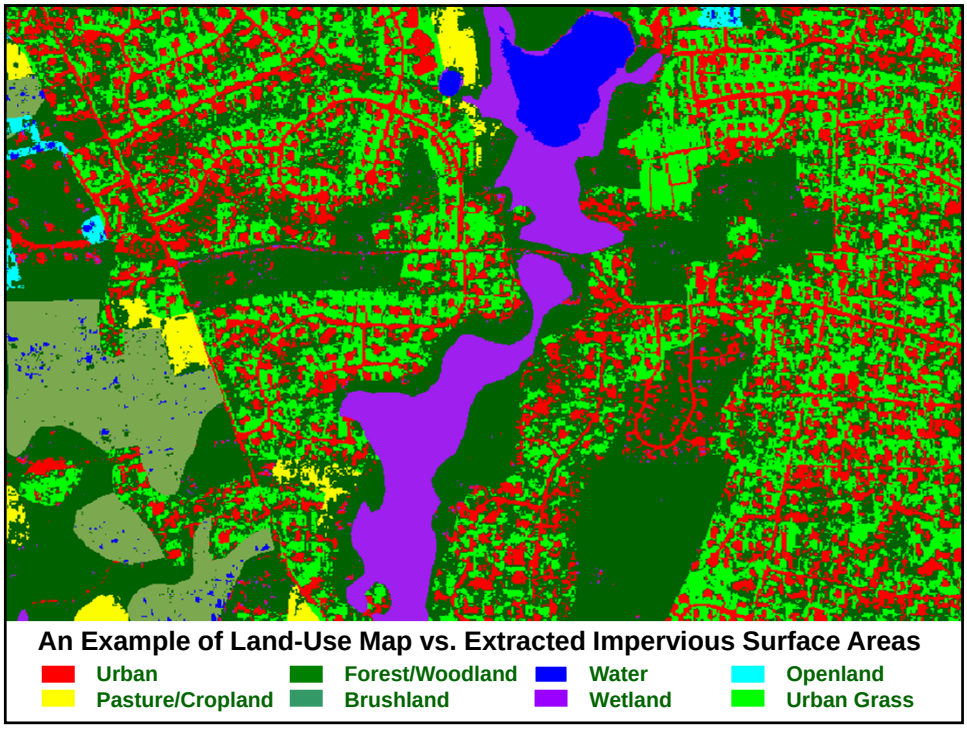
Land-Use Map

- The use of land by humans, usually with emphasis on the functional role of land in economic activities
- Land use forms an abstraction, not always directly observable even by a closest inspection
- ABSTRACT

Land-Cover Map

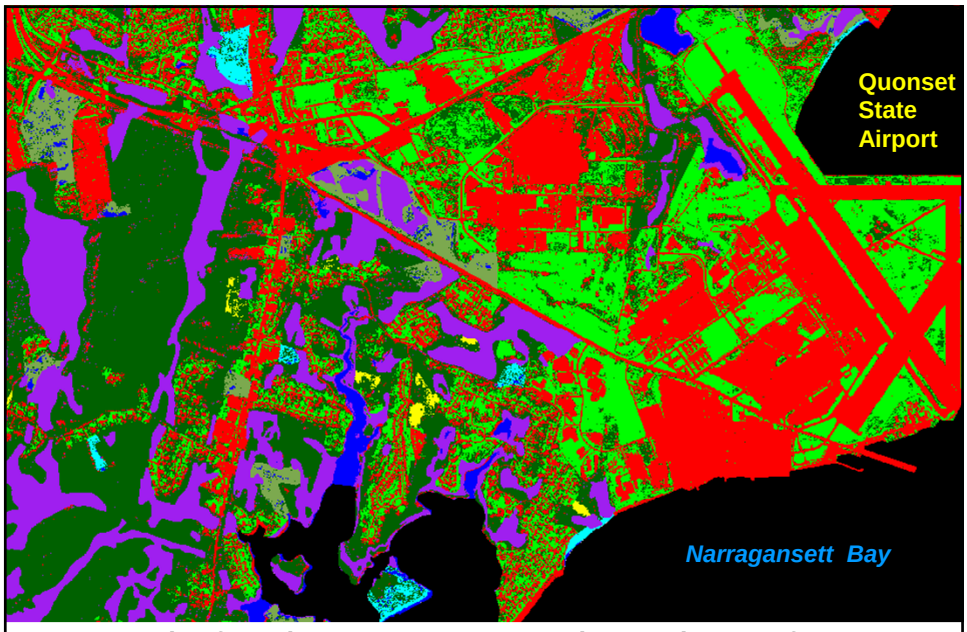
- Designates the visible evidence of land use features.
- Directly observable physical or biophysical cover on the earth's surface
- CONCRETE

The definition establishes a direct link between land cover and the actions of people in their environment.



An Example of Land-Use Map vs. Extracted Impervious Surface Areas

Urban
Pasture/Cropland
Forest/Woodland
Brushland
Water
Wetland
Openland
Urban Grass

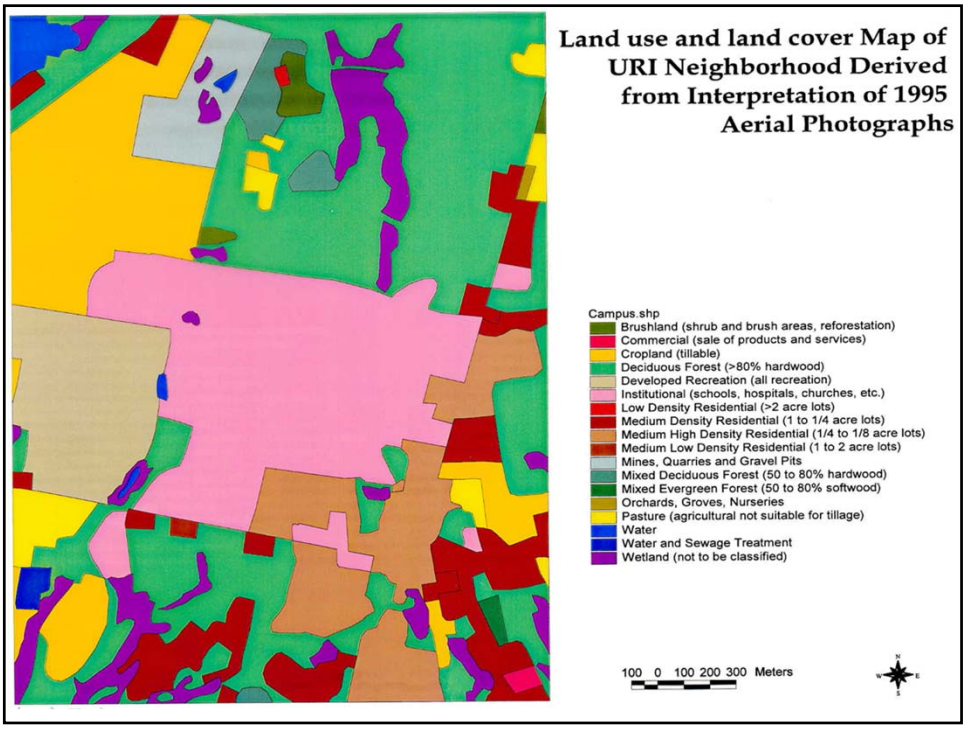


An Example of Land-Use Map vs. Extracted Impervious Surface Areas

Urban
Pasture/Cropland
Forest/Woodland
Brushland
Water
Wetland
Openland
Urban Grass

Use of color as symbols for land use classes by USGS system Level I

Category	Symbol	Color
Urban/Built-up Land	1	Red
Agricultural Land	2	Light Brown
Rangeland	3	Light Orange
Forest Land	4	Green
Water	5	Dark Blue
Wetland	6	Light Blue
Barren Land	7	Gray
Tundra	8	Green-Gray
Perennial Snow or Ice	9	White



From oblique aerial photograph to measurable information???