Principals and Elements of Image Interpretation

Land use and land cover Map of URI Neighborhood Derived from Interpretation of 1995 Aerial Photographs

Legend:
- Campus.shp
- Shrubland (shrub and brush areas, reforestation)
- Commercial (sale of products and services)
- Cropland (kind)
- Deciduous Forest (>80% hardwood)
- Developed Recreation (all recreation)
- Institutional (schools, hospitals, churches, etc.)
- Low Density Residential (>2 acre lots)
- Medium Density Residential (1 to 1/4 acre lots)
- Medium High Density Residential (1/4 to 1/10 acre lots)
- Medium Low Density Residential (1 to 2 acre lots)
- Mines, Quarries and Gravel Pits
- Mixed Deciduous Forest (50 to 80% hardwood)
- Mixed Evergreen Forest (50 to 80% softwood)
- Orchards, Groves, Nurseries
- Pasture (agriculture not suitable for tillage)
- Water
- Water and Sewage Treatment
- Wetland (not to be classified)
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.
Image interpretation for Land Use Mapping

USGS Land Use and Land Cover Classification System

# USGS Land Use and Land Cover Classification System

**Level I**

1 Urban or built-up land

**Level II**

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

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**Level I**

2 Agricultural land

**Level II**

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

<table>
<thead>
<tr>
<th>Level I</th>
<th>Level II</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Rangeland</td>
<td>31 Herbaceous rangeland</td>
</tr>
<tr>
<td></td>
<td>32 Shrub and brush rangeland</td>
</tr>
<tr>
<td></td>
<td>33 Mixed rangeland</td>
</tr>
<tr>
<td>4 Forest land</td>
<td>41 Deciduous forest land</td>
</tr>
<tr>
<td></td>
<td>42 Evergreen forest land</td>
</tr>
<tr>
<td></td>
<td>43 Mixed forest land</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level I</th>
<th>Level II</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Water</td>
<td>51 Streams and canals</td>
</tr>
<tr>
<td></td>
<td>52 Lakes</td>
</tr>
<tr>
<td></td>
<td>53 Reservoirs</td>
</tr>
<tr>
<td>6 Wetland</td>
<td>54 Bays and estuaries</td>
</tr>
<tr>
<td></td>
<td>61 Forested wetland</td>
</tr>
<tr>
<td></td>
<td>62 Nonforest wetland</td>
</tr>
</tbody>
</table>
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)

<table>
<thead>
<tr>
<th>Level I</th>
<th>Level II</th>
<th>Level III</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Urban or Built-up</td>
<td>1.1. Residential</td>
<td>1.1.1. Single-family Units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1.2. Multi-family Units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1.3. Group Quarters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1.4. Residential Hotels</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1.5. Mobile Home Parks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1.6. Transient Lodgings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1.7. Other</td>
</tr>
</tbody>
</table>
### Representative Image Interpretation Formats for Various Land Use/Land Cover Classification Levels

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

(USGS Level II)
Elements of Image Interpretation

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

<table>
<thead>
<tr>
<th>Element</th>
<th>Common Adjectives (Quantitative and qualitative)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x,y$ location</td>
<td>$x,y$ coordinate: longitude and latitude or meters easting and northing in a UTM map grid</td>
</tr>
<tr>
<td>Size</td>
<td>Length, width, perimeter, area ($m^2$) small, medium (intermediate), large</td>
</tr>
<tr>
<td>Shape</td>
<td>An object’s geometric characteristics: linear, curvilinear, circular, elliptical, radial, square, rectangular, triangular, hexagonal, pentagonal, star, amorphous, etc.</td>
</tr>
</tbody>
</table>
## Elements of Image Interpretation

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

## Elements of Image Interpretation

<table>
<thead>
<tr>
<th>Element</th>
<th>Common Adjectives (Quantitative and qualitative)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height/depth</td>
<td>z-elevation (height), depth (bathymetry), volume (m³), slope °, aspect °</td>
</tr>
<tr>
<td>Volume/ slope/aspect</td>
<td></td>
</tr>
<tr>
<td>Site/ situation/ association</td>
<td>Site: elevation, slope, aspect, exposure, adjacency to water, transportation, utilities</td>
</tr>
<tr>
<td></td>
<td>Situation: objects are placed in a particular order or orientation relative to one another</td>
</tr>
<tr>
<td></td>
<td>Association: related phenomena are usually present</td>
</tr>
</tbody>
</table>
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.

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On-line review

RIGIS land use/land cover map data

http://www.edc.uri.edu/rigis/
Land use/land cover from 1987 aerial photography coded to Anderson modified level 3 with ½ acre minimum polygon resolution.


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
- Water
- Wetland
- Openland
- Urban Grass

Quonset State Airport

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

<table>
<thead>
<tr>
<th>Category</th>
<th>Symbol</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban/Built-up Land</td>
<td>1</td>
<td>Red</td>
</tr>
<tr>
<td>Agricultural Land</td>
<td>2</td>
<td>Light Brown</td>
</tr>
<tr>
<td>Rangeland</td>
<td>3</td>
<td>Light Orange</td>
</tr>
<tr>
<td>Forest Land</td>
<td>4</td>
<td>Green</td>
</tr>
<tr>
<td>Water</td>
<td>5</td>
<td>Dark Blue</td>
</tr>
<tr>
<td>Wetland</td>
<td>6</td>
<td>Light Blue</td>
</tr>
<tr>
<td>Barren Land</td>
<td>7</td>
<td>Gray</td>
</tr>
<tr>
<td>Tundra</td>
<td>8</td>
<td>Green-Gray</td>
</tr>
<tr>
<td>Perennial Snow or Ice</td>
<td>9</td>
<td>White</td>
</tr>
</tbody>
</table>
From oblique aerial photograph to measurable information???