CHAPTER 5: Elements of Visual Image Interpretation

Reasons why photo/image interpretation are powerful scientific tools:

- scale: aerial/regional perspective;
- three-dimensional depth perception;
- ability to obtain knowledge beyond our human visual perception;
- ability to obtain a historical image record to document change.
CHANGING OUR PERSPECTIVE
LA PARGUERA FROM A PLANE

LA PARGUERA FROM SPACE

Thematic Mapper
EVERYTHING IS ABOUT SCALES

PUERTO RICO FROM THE SHUTTLE

EARTH FROM SPACE
Three-dimensional Depth Perception

Obtaining Knowledge Beyond our Human Visual Perception
### Elements of Image Interpretation

#### Table 5-1: Elements of Image Interpretation

<table>
<thead>
<tr>
<th>Element</th>
<th>Common Adjectives (quantitative and qualitative)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location</strong></td>
<td>x/y coordinates; column (x) and row (y) coordinates in an aerial image; x/y coordinates in a geographic coordinate system</td>
</tr>
<tr>
<td><strong>Texture</strong></td>
<td>gray tone; light (lightest), medium (medium), dark (darker)</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>length, width, perimeter, area (a)</td>
</tr>
<tr>
<td><strong>Shape</strong></td>
<td>various types of geometric characteristics: square, rectangle, triangle, oval, circle, ellipse, parallelogram, pentagon, hexagon, octagon, etc.</td>
</tr>
<tr>
<td><strong>Pattern</strong></td>
<td>spatial arrangement of objects, such as the overall layout; location, orientation, rectangular, circular, elliptical, parallel, perpendicular, organized, scattered, random, clustered, etc.</td>
</tr>
<tr>
<td><strong>Scale</strong></td>
<td>a silhouette used by atlas illustrator to illustrate scale</td>
</tr>
</tbody>
</table>

#### Elements of Image Interpretation

- **Remote Sensing Imagery as a Historical Record:** Informal City Demolition in Harare, Zimbabwe in 2005

(a) Quickbird 1-arc image obtained on April 18, 2003
(b) Quickbird 1-arc image obtained on June 4, 2005
Elements of Image Interpretation - Tone and Color
Elements of Image Interpretation - Tone and Color

Color composite
RGB = green, red, near-infrared
**Elements of Image Interpretation - Size**

![Size Examples](image1.png)

**Elements of Image Interpretation - Shape**

![Shape Examples](image2.png)
Elements of Image Interpretation - Texture

Elements of Image Interpretation - Pattern
Elements of Image Interpretation - Shadow

Elements of Image Interpretation - Height and Depth
Elements of Image Interpretation - Site, Situation and Association

Methods of Search

- Use of Collateral Information
- Convergence of Evidence
- Use of the Multi-concept
<table>
<thead>
<tr>
<th>Collateral Information</th>
</tr>
</thead>
</table>

Table 9-2: Collateral information of various frequencies and other commonly sourced data in the United States.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Collateral Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Government/City of the States (\times) (\times) USGS</td>
</tr>
<tr>
<td></td>
<td>National Geospatial Intelligence Agency (NGA) (\times) (\times) USGS</td>
</tr>
<tr>
<td></td>
<td>USGS 1:50,000 (\times) USGS</td>
</tr>
<tr>
<td></td>
<td>USGS 1:100,000 (\times) USGS</td>
</tr>
<tr>
<td></td>
<td>USGS 1:250,000 (\times) USGS</td>
</tr>
<tr>
<td></td>
<td>USGS 1:500,000 (\times) USGS</td>
</tr>
<tr>
<td></td>
<td>Geographic data systems: GAIA, Geospatial, National Geographic Information System (NGIS)</td>
</tr>
<tr>
<td>Federal</td>
<td>City and county tax maps</td>
</tr>
<tr>
<td></td>
<td>Geospatial control (\times)</td>
</tr>
<tr>
<td></td>
<td>Demography (\times)</td>
</tr>
<tr>
<td></td>
<td>Hydrology (\times)</td>
</tr>
<tr>
<td></td>
<td>Soils (\times)</td>
</tr>
<tr>
<td></td>
<td>Vegetation (\times)</td>
</tr>
<tr>
<td></td>
<td>Transportation (\times)</td>
</tr>
<tr>
<td></td>
<td>Weather (\times)</td>
</tr>
<tr>
<td></td>
<td>Climate (\times)</td>
</tr>
<tr>
<td></td>
<td>Water (\times)</td>
</tr>
<tr>
<td></td>
<td>Geospatial data systems: GAIA, Geospatial, National Geographic Information System (NGIS)</td>
</tr>
</tbody>
</table>

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Hagamos Un Ejercicio
Ejercicio #1: Explorando La Parguera

Ejercicio 2:
Identificar las diferencias entre la imagen visible y la imagen infrarroja de La Parguera.
Ejercicio 3: Principios de escala

➢ Examine el mapa topográfico del 1966 de La Parguera y determine su escala
➢ Interprete la escala en la parte inferior de la página.

Ejercicio 3: Principios de escala

➢ Use una regla y mida la distancia a través del área de estudio de oeste a este.
  ¿Cuántas pulgadas mide la distancia de oeste a este?
➢ Coloque la regla sobre la barra de escala que representa Kilómetros y determine:
  \[ X \text{ Kilómetros} = X \text{ pulgadas} \]
  ¿Cuántos Kilómetros mide a través del área de estudio de oeste a este?
Ejercicio 3: Principios de escala

- Repita las medidas a través del área de estudio de norte a sur y determine:
  - ¿Cuántas pulgadas mide la distancia de norte a sur?
  - ¿Cuántos kilómetros mide la distancia a través del área de estudio de norte a sur?

Ejercicio 4: Medidas de Área

- Utilice las medidas de distancia de norte a sur y de oeste a este y determine:
  - ¿Cuál es el Área, del área de estudio, en pulgadas cuadradas?
  - ¿Cuál es el Área, del área de estudio, en Kilómetros cuadrados?

Información: Área es la medida que se obtiene cuando se multiplica el largo por el ancho.
Ejercicio 5: Medidas de Distancia

- Seleccione los dos mismos puntos en las imágenes y determine la distancia en millas.

REFERENCE: Introduction to Remote Sensing, Chapter 4
James B. Campbell (2007)
The Guilford Press
**Processes Affecting the Remote Signal**

- Inherent Optical Properties of the Water
- Bottom Reflectance

**Measuring the Radiance**

- What we Measure
- What we Want

*From NEMO Overview*

Nemo.nrl.navy.gov
Acquisition and reproduction of remotely sensed images

Pixel coordinates

Where?

What?

Grey shades or colour

How much?

Element of an image

grey

(x, y, value)

Direction of motion

Satellite

Transmission to ground station

Sensor

Scanning

Scene

Resolution cell

DIGITAL IMAGING

Picture Elements

PIXELS
PIXEL

MULTISPECTRAL PIXELS
ANALOG TO DIGITAL CONVERSION

SENSITIVITY OF THE SENSOR
SIGNAL TO NOISE RATIO (S/N)

HIGH S/N RATIO
SENSOR RESPONSE
NOISE
SIGNAL
SCENE

LOW S/N RATIO

SPECTRAL SENSITIVITY

Sampling Interval
Maximum
FWHM
50% of Maximum

RELATIVE SIGNAL
WAVELENGTH
DIGITAL VALUES

- Each digital value is recorded as a series of binary values known as bits.

- A bit (a contraction of binary digit) is the basic unit of information in computing and telecommunications; it is the amount of information stored by a digital device or other physical system that exists in one of two possible distinct states.

- Each bit records an exponent of a power of 2, with the value of the exponent determined by the position of the bit in the sequence.

- Example: A system designed to record 7 bits for each digital value. This means that seven binary places are available to record the brightness sensed for each band of the sensor.
A 7 BITS SYSTEM

<table>
<thead>
<tr>
<th>Bit</th>
<th>A binary digit (0 or 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte</td>
<td>8 bits, 1 character</td>
</tr>
<tr>
<td>Kilobyte (K or KB)</td>
<td>1,024 bytes</td>
</tr>
<tr>
<td>Megabyte (MB)</td>
<td>1,048,576 bytes</td>
</tr>
<tr>
<td>Gigabyte (GB)</td>
<td>1,073,741,824 bytes</td>
</tr>
<tr>
<td>Terabyte (TB)</td>
<td>1,099,511,627,776 bytes</td>
</tr>
</tbody>
</table>

MAXIMUM DIGITAL VALUES

<table>
<thead>
<tr>
<th># Bits</th>
<th>MDV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>32</td>
</tr>
<tr>
<td>6</td>
<td>64</td>
</tr>
<tr>
<td>7</td>
<td>128</td>
</tr>
<tr>
<td>8</td>
<td>256</td>
</tr>
<tr>
<td>9</td>
<td>512</td>
</tr>
<tr>
<td>10</td>
<td>1024</td>
</tr>
<tr>
<td>11</td>
<td>2048</td>
</tr>
</tbody>
</table>

11 bits = 2048
From 0 to 2047
A KEY CONCEPT OF REMOTE SENSING

RADIOMETRIC DIFFERENTIATION - Examination of any image acquired by remote sensing ultimately depends upon detection of differences in the brightness of objects and the features.

Radiometric Resolution: This is the sensitivity to small differences in the radiation of an observed object.

- MSS = 6 bits
- Landsat TM = 8 bits
- IKONOS = 11 bits
- ERS SAR = 16 bits

DATA FORMATS

RASTER  VECTOR
DATA FORMATS
Band Interleaved by Pixel (BIP)

DATA FORMATS
Band Interleaved by Line (BIL)
DATA FORMATS
Band Sequential (BSQ)

DIGITAL ANALYSIS