GOING BEYOND THE BASE MAP

Understanding Elements of Remote Sensing

Importance of Mapping Standards

AARON SCHEPERS, GISP
LINCOLN, NE
WWW.CORNERSTONE_MAPPING.COM
Talking Points

Talk about current technology

Review remote sensing principles

Discuss importance of mapping standards
Technology Trends

In the Past: **Two flights for two products**

- **Film Cameras**
  - RGB
- **Digital Cameras**
  - CIR

*Enables one flight for RGBN*
Technology Trends

Moving into era of higher spatial resolution
  - 5-cm engineering design
  - 3-inch high value mapping
  - 6-inch urban
  - 1-foot rural

Higher image overlap
  - Ultra dense surface models
  - Less building lean
Technology Trends

- Color + LiDAR
- 4-band + Thermal
- LiDAR + Color, Thermal, Oblique
- Thermal + Hyperspectral

3D Modeling & Obliques

Sensor Fusion

4-Band

oblique
# Types of Image Resolution

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial</td>
<td><strong>Pixel Size</strong></td>
</tr>
<tr>
<td></td>
<td>3-inch, 6-inch, 1-meter</td>
</tr>
<tr>
<td>Spectral</td>
<td><strong>“Bands”</strong></td>
</tr>
<tr>
<td></td>
<td>blue, green, red, NIR, thermal</td>
</tr>
<tr>
<td>Radiometric</td>
<td><strong>Shades of Gray</strong></td>
</tr>
<tr>
<td></td>
<td>8-bit, 12-bit</td>
</tr>
<tr>
<td>Temporal</td>
<td><strong>Image Frequency</strong></td>
</tr>
<tr>
<td></td>
<td>monthly, annually, every few years</td>
</tr>
</tbody>
</table>
Types of Data Accuracy

In context of remote sensing

Accuracy

Lines up in the right area, but not with good repeatability

Precision

Seamless, but with a horizontal-vertical bias

Consistency

Uniform accuracy and precision throughout dataset
What is Infrared Aerial Photography?

**Color Image**

![Color Image Diagram]

**Color Infrared Image**

Infrared Imagery is **RED** in color
Band Combinations

Layer / Band

1
Red

2
Green

3
Blue

4
NIR

RGB = 1, 2, 3

CIR = 4, 1, 2

Displayed As

Color
Shift

Red car will ‘look’ green in CIR mode

Nebraska GIS Symposium - 2013
Features of Near-Infrared

Chlorophyll Absorption
Chlorophyll Absorption
Biomass Indicator

Affects the NIR reflectance
Thus creating a “signature”

Plant Tissue Structure

trees
grass
bare soil
Near-Infrared Detects Vegetation

Color

Color-Infrared (CIR)

Synthetic Turf “looks real”

Living Vegetation = Red
Applications for CIR

- Impervious Surface Area
- Land Cover – Land Use
- Wetland Delineation
- Crop Analyses (precision agriculture)
- Invasive Species (river management)
Color & CIR

Wetland Mapping

Color

CIR

Vegetation = Red

Water = different signature
Camera Sensitivity

End Product
Most people use 8-bit imagery
\[ 2^8 = 256 \text{ values} \quad (0-255 \text{ DN}) \]

Data Acquisition
Quality sensors acquire data at 12-bits or higher
\[ 2^{12} = 4096 \text{ values} \quad (0-4095 \text{ DN}) \]

It is common to optimize 12-bit data for 8-bit output
- Enhance detail in shadows
- Reduce effects of haze
- Atmospheric corrections
Histogram Assessment

Typical Bell Curve

Standard Deviations

NIR

Red

Green
Histogram Stretching

Original

Standard Deviation Stretch

Min-Max Stretch
Band Combinations

<table>
<thead>
<tr>
<th>Layer / Band</th>
<th>Band Combo</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Red, Red</td>
<td>Mix as Purple</td>
</tr>
<tr>
<td></td>
<td>Red, Blue</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Low vegetation vigor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Non-vegetation</td>
</tr>
<tr>
<td>2</td>
<td>Not Used</td>
<td>Vegetation as Green</td>
</tr>
<tr>
<td>3</td>
<td>Not Used</td>
<td>For Display Purposes Only</td>
</tr>
<tr>
<td>4</td>
<td>NIR, Green</td>
<td>- Does not affect pixel values -</td>
</tr>
</tbody>
</table>

CIR: 4, 1, 2
False Color: 1, 4, 1
Band Ratios

NDVI – Normalized Difference Vegetation Index

\[
NDVI = \frac{\text{Red} - \text{NIR}}{\text{Red} + \text{NIR}}
\]

Data Range

-1 -0.5 0 0.5 1

Indicates Non-Vegetative Features

Vegetation Vigor

Data Range

Indicates Non-Vegetative Features

Vegetation Vigor
**NDVI**

*Enhance crop vigor differences within a crop*
Mapping Standards

Why they are so Important!
Business Economics

“It's unwise to pay too much, but it's worse to pay too little.

When you pay too much, you lose a little money - that's all.

When you pay too little, you sometimes lose everything…”

- John Ruskin
Accuracy = Higher Cost

If project pricing is all over the board

--------------------------------------------

Look at the mapping accuracy being delivered

Unusually low cost often translates into below mapping standards
Understanding Accuracy Standards

- **NMAS**: Era of hard copy, fixed-scale mapping
- **ASPRS**: Adapted NMAS to account for the dynamic scaling of digital data
- **NSSDA**: Scale-independent statistical measure
### Understanding Accuracy Standards

**for 6-inch GSD orthophotography**

<table>
<thead>
<tr>
<th>Map Scale</th>
<th>RMSe X or Y (1.0-ft)</th>
<th>Class</th>
<th>Radial RMSe (1.4-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;=100’</td>
<td>1.0-ft</td>
<td>Class I</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>Class II</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>3.0</td>
<td>Class III</td>
<td>4.2</td>
</tr>
</tbody>
</table>
Controlling Error

Total Error Budget

- Systematic Error
  - Position (GPS)
  - Orientation (IMU)
  - Sensor Calibration
  - Data Processing
  - Interpretation

- Random Error

Error Budget:
- 0%
- 20%
- 40%
- 60%
- 80%
- 100%
Accuracy = Higher Cost

Aerial Photography

Has no coordinates
Simply, a pretty picture

Photogrammetry

• Ground Control
• Airborne GPS/IMU
• Aerial Triangulation
• Camera Calibration
• Expertise

Accurate map that always line up in your GIS

New data layers can be generated with confidence

Future data layers will also overlay with accuracy
Data Accuracy

Data fusion will only be successful if the spatial accuracy is consistent

Avoid having to say . . .

- Wish it was better
- Its always been that way

The “low cost approach” can cost more in the long run
Real Cost of Lower Quality Data

What are downstream costs of poor accuracy?

- Re-do a project from scratch?
- Extensive editing to cleanup data?
- Poor classification results?

Quality of your base map (and other layers) will directly affect your GIS applications.
How to procure imagery

Don’t “copy & paste” requirements from another proposal

- *Take the time to understand your needs*
- *Pretty picture vs. accuracy*

Identify your needs

Determine your budget

Gather information from vendors
**Bundling Services**

Bundling Services can be Counter Productive

Often a Better Value to use Multiple Vendors

- *Adds a middle-man for communications*
- *Sometimes more overhead and project cost*
- *Get to choose best vendor per deliverable*
Review Sample Products

Request Samples

Evaluate the Imagery

Highlights / Shadows

Color / Tone Balance

Undesirable Characteristics
Multispectral Technology has Numerous Applications

Don’t Forget about Mapping Standards!