ESTIMATING CHARACTERISTICS OF FORESTS IN THE APALACHICOLA REGION USING REMOTELY SENSED IMAGERY AND FIELD SAMPLES

John Hogland, Nathaniel Anderson, Jason Drake, Paul Medley, David Affleck, and Joseph St. Peter
Classical Approach

<table>
<thead>
<tr>
<th>Region</th>
<th>Pine BAA</th>
<th>All BAA</th>
<th>Longleaf Dominant (Acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARSA</td>
<td>29.2</td>
<td>62.6</td>
<td>352,913</td>
</tr>
<tr>
<td>GCPEP</td>
<td>27.5</td>
<td>58.6</td>
<td>714,115</td>
</tr>
<tr>
<td>OCLIT</td>
<td>15.9</td>
<td>53.6</td>
<td>343,112</td>
</tr>
<tr>
<td>OOL</td>
<td>33.6</td>
<td>64.6</td>
<td>70,065</td>
</tr>
</tbody>
</table>
Classical Estimates (Stratified by NLCD)

<table>
<thead>
<tr>
<th>NLCD</th>
<th>Pine BAA (ft² / Acre)</th>
<th>All BAA (ft² / Acre)</th>
<th>Longleaf Dominant (Acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evergreen</td>
<td>53.9</td>
<td>73.5</td>
<td>26,158</td>
</tr>
<tr>
<td>Woody Wet</td>
<td>27.1</td>
<td>92.9</td>
<td>8,847</td>
</tr>
</tbody>
</table>
Alternative Approach

22,400,000 acres

Preprocessing

Texture
First Order STD

Contact
Extrema

Second Order GLCM
Determination
Statistics

Spatial Outputs

Mapping Forest Characteristics at Fine Resolution across Large Landscapes of the Southeastern United States Using NAIP Imagery and FIA Field Plot Data

John Hughes, John Friedel, and Nicholas Lefcheck

International Journal of Geographical Information Science

Abstract

This paper investigates the effectiveness of using National Agriculture Imagery Program (NAIP) imagery for forest characteristic mapping at the field plot level within the Forest Inventory and Analysis (FIA) program. Specifically, the study focuses on estimating biomass using a machine learning approach and examines the role of ancillary information to improve mapping accuracy.

Results

The study demonstrates that NAIP imagery can be effectively used for forest characteristic mapping at the field plot level within the FIA program. The estimated biomass values were found to be highly correlated with the actual values, indicating the potential of NAIP imagery for improved forest management and planning.

Conclusions

The findings suggest that NAIP imagery can be a valuable tool for forest managers and planners, providing accurate estimates of biomass and other forest characteristics at the field plot level.

References


Papers

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Sustainability

- Efficient use of resources
- Minimization of waste
- Promoting awareness of environmental issues

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Proudly sponsoring research on the efficiency of spatial data from remote sensing.
How It Works

ADF 2008
Improved Spatial Modeling Tools

```java
IRasterInfo2 rInfo2 = (IRasterInfo2)rSet.RasterInfo;
IRasterStatistics rsStats = new RasterStatisticsClass();
rsStats.Mean = 0.5;
rsStats.Maximum = 1;
rstats.Minitim = 0;
rsStats.StandardDeviation = 0.25;
rStats.SkipFactorX = 1;
rStats.SkipFactorY = 1;
rStats.Isvalid = true;
if (r.Regression) {
    double pmin = r.computeNew(r.minValues)();
    double pmax = r.computeNew(r.maxValues)();
    double pmean = (pmax - pmin)/2;
    rsStats.Mean = r.minValues()
    rsStats.StandardDeviation = pmean * 0.5;
}
```
Modeled Estimates

<table>
<thead>
<tr>
<th>Longleaf Dominant (Acres)</th>
<th>Lower 95% CL</th>
<th>Upper 95% CL</th>
</tr>
</thead>
<tbody>
<tr>
<td>52,737</td>
<td>45,271</td>
<td>60,202</td>
</tr>
</tbody>
</table>
Comparison (30 miles$^2$)

<table>
<thead>
<tr>
<th>NLCD Class</th>
<th>Pine BAA</th>
<th>All BAA</th>
<th>Longleaf Dominant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evergreen</td>
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</tbody>
</table>
Restoration Prioritization
Utility

Biomass

Tons/Acre

High    Low

Cost Zones

$/Ton

High    Low

Papers & Tutorials

IMAGE BASED CLASSIFICATION USING THE RMRS RASTER UTILITY TOOLBAR: FOCUS ON WORKFLOW

Prioritization of Open Pine Red Cocksade Woodpecker Habitat

1. Introduction

2. Methods

3. Results

4. Discussion

5. Conclusion

Keywords: Biomass, logistics, optimization, decision support, remote sensing
Challenges

• Imagery
  • Dates\Resolution\Preprocessing

• Plot Protocol
  • Layout
  • Size
  • Sampling intensity
  • Small trees

• Co-registration errors
  • GPS
  • Imagery
Improving Base Information

• Imagery Normalization
  • Improve radiometric normalization

• Co-registration error
  • Quantify impact
  • Correct for bias

• Plot Protocol
  • Design layout to related to imagery
  • Types of information

• Sample Design
Image Normalization

Before

Aggregation size

After
Image Normalization NAIP

Spatial Resolution 30m² vs 1m²

Aggregation size

[Diagrams and images showing comparison of spatial resolution and aggregation size]
Plot Protocol & Co-registration Errors:

NAIP Shift GPS & Image (8m, 6m)
Simulations

- 6 real images and 19 virtual images
- 200 locations
- 2 random shifts
  - GPS (7 m)
  - Image (NAIP: 6 cells, Landsat: 2 cells)
- Extract spectral values
- Regress against one another
- Record intercept, slope, RMSE and $R^2$
- Repeated (1-100 cells)

\[ Y_i = \beta_0 + \beta_i X_i \]

Record
Results: Co-registration

\[
\ln \left( \frac{R^2}{1 - R^2} \right) = \ln(\text{overlap}) + GMI + \ln(\text{overlap}) \times GMI
\]
Plot Protocol & Co-registration errors

- Given extent, what sampling intensity and spatial layout

- Layouts
  - 1 big plot
  - 4 subplots one in each corner
  - 4 subplots randomly placed
  - 4 subplots based on FIA protocol
  - 5 subplots one in the center one in each corner
  - 9 subplots equally spaced out within the extent

- Intensity
  - 5-100% area inventoried
Results: Plot/Subplot Layout

- **Plot data**
  - GPS location Subplot1
    - 20 positions (Averaging)
    - HDOP < 5
    - 3D mode
    - DGPS if possible
  
- **Subplot data**
  - Last Burn
  - % CWD
  - % Herb
  - % Saw
  - % Broad
  - % Bare
  - % Pine
    - Tree
      - DBH > 2"
      - Species
      - Status
      - Count
Sample Design

• Modeled sampled design

  • Partition population
    • Inexpensive and costly locations

  • Describe the distribution of predictor variables for the population

  • Select sample units that minimize the number of expensive samples while matching the population's predictor variables distribution
Develop a methodology to determine if the values of a sample match the natural population distribution

- Multivariate Kolmogorov-Smirnov (K-S) test

Partition predictor variables into cluster space

Randomly select locations within predefined inexpensive areas to match frequency distribution of the population clusters

Test the distribution of predictors variables

\[
d = \max_x |f_{n1}(x) - f_{n2}(x)|
\]

\[
f_n(x) = \frac{1}{n} \sum_{i=1}^{n} I(x_i \leq x)
\]

\[
\overline{wKS} = \sum_{i=1}^{k} KS_{statistic_i} \ast \lambda_i
\]
Results: Sample Design

Before

After
Results: Field Plots

Random Locations

Modeled Locations

Natural Distribution

Practical
Next Steps

• Normalize NAIP imagery

• Build predictive surfaces

• Summarize plot data

• Build models and outputs

• Compare predictions
Questions

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RMRS Raster Utility Website:  http://www.fs.fed.us/rm/raster-utility/