Monitoring Weed Growth in Forest Stands using QuickBird Imagery

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Outline

- Introduction
- Aim and Objectives
- Methodology
- Results
- Conclusions
Introduction

- Impact of weed competition in forest stands

- Effects on stand management
  - Random assessments can miss problem areas
  - Visual assessments subjective
  - Identification of problem areas can improve management focus
  - Principle behind „Precision Forestry“

- Opportunities provided by remote sensing
  - Vegetation discrimination using Multispectral bands
  - Limitations of multispectral bands
  - Role of textural analyses
  - Medium vs High Resolution Imagery
Aim and Objectives

Aim
- status of vegetation cover
- stands less than two years
- application of classification and textural analysis techniques
- level of discrimination is between crop and weed.

Objectives
- Undertake unsupervised classification of multispectral imagery
- Undertake textural analysis of panchromatic imagery
- Differentiate Crop from Weed
- Undertake Accuracy assessment of classifications
- Quantify Weed and Crop Areas within forest stands
Study Site
Methodology

1. Subset Stands: High Res. Image
   - Pan: Edge-Enhancement
     - Reclassify to 2 Classes
       - Vectorise
         - Union MSS and Pan
           - Derive Classification Matrix
             - Tabulate Area; Calculate GC%
   - Multi-spectral: Unsuper. Classification- 4 Classes
     - Vectorise
Process Details

- **Image sub-setting**
  - Reverse-buffer compartments – *ArcToolbox*
  - Used as Areas of Interest (AOIs) – *Erdas Imagine 8.7*

- **Edge Enhancement**
  - Subset compartments converted to point vectors, clipped – *Spatial Analyst*
  - Semivariograms run to determine optimal convolution window – *Geostat.Analyst*
    - Ordinary kriging, lag distance = 0.6m; kernel size = Range/lag distance.
  - Edge enhancement routine using kernel – *Imagine 8.7*
  - Output reclassified into 2 classes (Rows/NoRows); Vectorised – *Spatial Analyst*

- **Unsupervised Classification**
  - 4 Class unsupervised classification of multispectral image – *Imagine 8.7*
  - Output vectorised – *Spatial Analyst*
  - Unioned with 2 Class Panchromatic data - *ArcToolbox*
  - Weed areas calculated – *ArcMap (Field Calculator)*
### Methodology: Classification Matrix

<table>
<thead>
<tr>
<th>Class</th>
<th>1-No</th>
<th>2-Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1: Shadow/Soil</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Class 2: Soil/Slash</td>
<td>21</td>
<td>22</td>
</tr>
<tr>
<td>Class 3: Light Vegetation</td>
<td>31</td>
<td>32</td>
</tr>
<tr>
<td>Class 4: Heavy Vegetation</td>
<td>41</td>
<td>42</td>
</tr>
</tbody>
</table>
Example of 4 Class Unsupervised Classification
Example of Panchromatic Edge Enhanced Image
Example of Classified Row Image highlighting Crop Rows
Classification Results

- Can separate crop from weed; but stand age has an effect

- 3 distinct phases noted
  - Function of degree of crop row delineation
  - Phase 1: 1-3 Months after Planting
  - Phase 2: 3-12 Months after Planting
  - Phase 3: 12-16 Months after Planting

- Canopy closure occurs – Weed no longer problematic
Detail of Phase 1
Classes 12; 21;22 & 31,<3 Months
Detail of Phase 2
Classes 21 & 22, 3-12 Months

Class 1: Shadow/Soil
Class 2: Soil/Slash
Class 3: Light Vegetation
Class 4: Heavy Vegetation

Rows

<table>
<thead>
<tr>
<th></th>
<th>1-No</th>
<th>2-Yes</th>
</tr>
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<tbody>
<tr>
<td>11</td>
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<td>32</td>
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<td>41</td>
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<td>42</td>
</tr>
</tbody>
</table>

Fig. b Details of Class 21 and 22
Detail of Phase 3
Classes 21;22;31 & 32, 12-16 Months
Detail of Phase 3
Classes 41 & 42, 12-16 Months
### Accuracy Assessment: 3-14 Month Data

#### Results Report - Chi Square Table of Observed and Reference

<table>
<thead>
<tr>
<th>Observed</th>
<th>Crop</th>
<th>Heavy Weed</th>
<th>Light Weed</th>
<th>Shadow/Soil</th>
<th>Soil/Slash</th>
<th>Row Total</th>
<th>Incremental Chi Square</th>
<th>User Accuracy</th>
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<td></td>
<td></td>
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<td>90.2%</td>
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<tr>
<td>expected</td>
<td>46</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>51</td>
<td>60.967</td>
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<td></td>
<td>19.125</td>
<td>5.419</td>
<td>7.650</td>
<td>3.506</td>
<td>15.300</td>
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<td></td>
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<tr>
<td><strong>Heavy Weed</strong></td>
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<td>78.9%</td>
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<tr>
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<td>3.150</td>
<td>1.444</td>
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<tr>
<td><strong>Soil/Slash</strong></td>
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<td></td>
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<td>88.9%</td>
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<tr>
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<td>0</td>
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<td>17</td>
<td>24</td>
<td>11</td>
<td>48</td>
<td>160</td>
<td>386.428</td>
<td>82.5%</td>
</tr>
</tbody>
</table>

**Grand Total** 386.428  Overall Accuracy 82.5%

**Producer Accuracy** 76.7% 88.2% 83.3% 100.0% 83.3%
Example of Stand Ground Cover Percentage

% Ground Cover by Age

- Soil/Slash
- Crop/Soil
- Crop
- Crop/Weed
- Light Weed
- Heavy Weed

Age (Months)

- 1
- 3
- 10
- 14

Percent

0 20 40 60 80 100 120
Conclusions

- Possible to
  - identify potential weed problem areas within *A. mearnsii* stands – between three and twelve/fourteen months after planting
  - monitor change in weed potential over time
  - quantify crop and weed areas and degree of change
Acknowledgements:

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Dr. Jan van Aardt

Thank You