An Evaluation of Resourcesat-1 LISS-III vs AWiFS Imagery for Mapping Croplands

Monitoring Agriculture from Space with Commercial Imagery
NASS Background

Provider of timely, accurate, and useful statistics in service to U.S. agriculture
Developing methodologies and tools to improve NASS’ ability to collect, manage, and disseminate statistics on US agriculture utilizing remotely sensed, GIS, and GPS data.

- Agriculture Atlas of the USA
- Land Cover Classification
- Mobile GIS
- Crop Condition
- Tree Inventorying
- Yield Modeling
- Change Detection
- Crop Progress
- County Level Crop Maps
- Imagery Exploitation
Cropland Data Layer (CDL) Program

- State specific land cover classifications emphasizing row crop agriculture
  - Some regions done annually
    - Corn Belt, The Delta
  - Others “one-and-done”
    - Mid-Atlantic, Idaho, Florida
- Within NASS, CDL used to
  - Tighten confidence intervals on survey derived acreage estimates
  - Improve county level acreage estimates
Example CDL

Cropland Data Layer
Oklahoma 2006

Spatial Analysis Research Section

United States Department of Agriculture
National Agricultural Statistics Service
Research and Development Division
Spatial Analysis Research Section
History of NASS AWiFS Use

- **2004**
  - Obtained AWiFS August imagery
  - Used to augment TM images collected during entire summer
- **2005**
  - Obtained AWiFS June and August imagery
  - Used to augment or replace TM
  - Assessed quantitative differences
- **2006**
  - Switched from Landsat to Resourcesat at a USDA-wide level
  - Obtained AWiFS during entire summer growing season
- **2007**
  - Proceeding forward primarily with AWiFS
Why NASS Likes AWiFS

- Large swath width
- Inclusion of red, NIR, SWIR spectral bands
- Tolerable spatial resolution at 56 m sq
- Cost effectiveness
- Operational nature
- Fast data delivery by vendor
- Healthy satellite
AWiFS versus TM Study

Compared classification accuracy over three study sites using same date coincident TM and AWiFS data from 2005 growing season
Results of TM versus AWiFS

Overall Accuracy

<table>
<thead>
<tr>
<th>State</th>
<th>TM</th>
<th>AWiFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arkansas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iowa</td>
<td></td>
<td></td>
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<tr>
<td>Illinois</td>
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</tbody>
</table>
Hypothetical Question Raised

“Would classification accuracy improve if one had access to AWiFS swath width sized imagery but with LISS-III’s 23.5 m pixel resolution?”

- Better?
- Worse?
- No difference?
Testing of the question

- Can it be tested?
  - Yes!

- Conveniently, AWiFS and LISS-III
  - Ride in tandem on the same platform
  - Collect data in parallel
  - Are very similar instruments
### Sensor Specifications

<table>
<thead>
<tr>
<th></th>
<th>AWiFS</th>
<th>LISS-III</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IGFOV</strong></td>
<td>56m (nadir)</td>
<td>23.5 m</td>
</tr>
<tr>
<td></td>
<td>70m (field edge)</td>
<td></td>
</tr>
<tr>
<td><strong>Spectral bands</strong></td>
<td>B2: 0.52-0.59</td>
<td>B2: 0.52-0.59</td>
</tr>
<tr>
<td></td>
<td>B3: 0.62-0.68</td>
<td>B3: 0.62-0.68</td>
</tr>
<tr>
<td></td>
<td>B4: 0.77-0.86</td>
<td>B4: 0.77-0.86</td>
</tr>
<tr>
<td></td>
<td>B5: 1.55-1.70</td>
<td>B5: 1.55-1.70</td>
</tr>
<tr>
<td><strong>Swath</strong></td>
<td>370 km each head</td>
<td>141 km</td>
</tr>
<tr>
<td></td>
<td>740 km (combined)</td>
<td></td>
</tr>
<tr>
<td><strong>Integration time</strong></td>
<td>9.96 msec</td>
<td>3.32 msec</td>
</tr>
<tr>
<td><strong>Quantization</strong></td>
<td>10 bits</td>
<td>7 bits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(SWIR band has 10-bit quantization, selected 7 bits out of 10 bits will be transmitted by the data handling system)</td>
</tr>
<tr>
<td><strong>Number of gains</strong></td>
<td>1</td>
<td>4 for B2, B3 and B4. For B5 dynamic range obtained by sliding 7 bits out of 10 bits</td>
</tr>
</tbody>
</table>

“The CCDs used in AWiFS are identical to those of LISS-III.”
North Dakota Test Case

22 August 2006
North Dakota Raw Data

AWiFS
Red=Red, Green=NIR, Blue=SWIR

LISS-III
Red=Red, Green=NIR, Blue=SWIR
Ground truth – two sources

- NASS - June Agricultural Survey (JAS)
- Farm Service Agency (FSA) - Common Land Unit (CLU) / 578 data
Methodology

- Reprojected/mosaicked to common projection
- Clipped AWiFS to LISS-III’s extent
  - Only comparing the region of overlap
- Ran Supervised classification
  - Boosted Classification Tree (BCT) Analysis (implemented in See5.0)
    - Random half of FSA CLU/578 utilized for training
- Accuracy assessed
  - Against other half of ground truth.
North Dakota - Results

AWiFS
50.1% pixels correct

LISS-III
52.4% pixels correct
Post Classification Polishing

Method A. Applying a 20 acre minimum mapping unit

Raw Scene

Initial BCT Classification

20 acre MMU
Post Classification Polishing

Method B. Definiens (eCognition) segment fill

Raw Segmented Scene  Initial BCT Classification  Majority Fill Segments
## North Dakota Summary

<table>
<thead>
<tr>
<th>Category</th>
<th>AWiFS</th>
<th>LISS-III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Classification</td>
<td>50.1%</td>
<td>52.4%</td>
</tr>
<tr>
<td>20 Acre MMU Applied</td>
<td>54.6%</td>
<td>57.6%</td>
</tr>
<tr>
<td>Segment Majority Filled</td>
<td>53.9%</td>
<td>55.5%</td>
</tr>
</tbody>
</table>
Wisconsin Raw Data

AWiFS
Red=Red, Green=NIR, Blue=SWIR

LISS-III
Red=Red, Green=NIR, Blue=SWIR
Wisconsin - Results

AWiFS
50.4% pixels correct

LISS-III
55.9% pixels correct
### Wisconsin Summary

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<tr>
<td>Standard Classification</td>
<td>50.4%</td>
<td>55.9%</td>
</tr>
<tr>
<td>10 Acre MMU Applied</td>
<td>53.0%</td>
<td>60.0%</td>
</tr>
<tr>
<td>Segment Majority Filled</td>
<td>51.7%</td>
<td>59.6%</td>
</tr>
</tbody>
</table>
Conclusions

- A LISS-III resolution sensor with an AWiFS swath would improve NASS’ ability to map croplands!
- A 5-10% gain in map accuracy is suggested
- Accuracy gains are greater in areas with smaller field sizes
- Optimal resolution for mapping croplands is still not know but it is likely closer to 23 m than 56 m
- LISS-III is impractical today for NASS regional scale classification efforts due to limiting 141 km swath width, 26 day revisit rate, and cost
Thank You

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