Identifying Crops in the Lower Forty Eight

Michael Craig
MEC GeoStat, Inc.
MikeCraig42@live.com

Under Contract to: USDA/NASS
Overview of the USDA’s National Agricultural Statistics Service

Provider of timely, accurate, and useful statistics in service to U.S. agriculture
First time ever – “Major Crops” identified in the same growing season!
Cropland Data Layers
1997 - 2009
2009 Craighead County Arkansas

Land Cover Categories

**AGRICULTURE**
- Pasture/Grass
- Soybeans
- Rice
- Cotton
- Fallow/Idle Cropland
- Corn
- W. Wht./Soy. Dbl. Crop
- Winter Wheat
- Sorghum
- Aquaculture
- Other Crops/Vegetables & Fruits
- Other Tree Nuts

**NON-AGRICULTURE**
- Woodland
- Wetlands
- Urban/Developed
- Shrubland
- Water
- Barren
Cropland Data Layer (CDL) Objectives

- “Census by Satellite”
  - Annually cover major program crops and regions
  - Crops accurately geo-located

- Deliver in-season remote sensing acreage estimates
  - NASS Official Reports
  - Update planted area
  - Reduce respondent burden

- Provide timely, accurate, useful estimates
  - Measurable error
  - Unbiased/independent estimator
  - State, District, County

- Public domain crop specific crop classification
  - Hosted @ NRCS Geospatial Data Gateway or http://www.nass.usda.gov/research/Cropland/SARS1a.htm or
  - Google “Cropland Data Layer”
CDL Program

- **Inputs**
  - Resourcesat-1 AWiFS imagery
  - Farm Service Agency – Common Land Unit
  - NASS June Ag Survey
  - Ancillary data
    - NLCD & derivative products

- **Outputs**
  - Acreage Estimates
  - Cropland Data Layer

- **Process**
  - Commercial software suite
Commercial Software Suite

- Imagery Preparation
  - ERDAS Imagine

- Image classification
  - Decision tree software
    - See5.0 [www.rulequest.com](http://www.rulequest.com)

- Ground Truth Preparation
  - ESRI ArcGIS

- Acreage Estimation
  - SAS/IML workshop
IRS Resourcesat-1 AWiFS Imagery

740 km swath width

5-day revisit

4 spectral bands
- B2: 0.52 - 0.59
- B3: 0.62 - 0.68
- B4: 0.76 – 0.86
- B5: 1.55 – 1.7

56 m nadir/70 m field edges

Data provided through USDA Foreign Agricultural Service (FAS), Satellite Image Archive

13 Aug 2007
Crop Progress and Condition

AWiFS Imagery Time Series

- May 18
- June 21
- July 15
- Aug 27
July AWiFS Collection Drought

AWiFS Coverage for July (through July 22)
AWiFS Mid-Summer Acquisitions

AWiFS Coverage after July 29 - August 3
Landsat to the Rescue

Landsat Coverage
downloaded August 18, 2009
Agricultural Ground Truth
FSA Common Land Unit
Agricultural Ground Truth

- Common Land Unit (CLU)
- 578 attributed reporting data
Ground Truth – Land Cover

Agricultural Ground Truth
- Provided by FSA
- Id’s known fields and crops
- Divide known fields into 2 sets
  - ½ used for training software
  - ½ used for validating results

Non-Agricultural Ground Truth
- USGS National Land Cover Dataset
- Identifies urban infrastructure and non-agriculture land cover
  - Forest, grass, water, cities
Ancillary Data – USGS/NASA Products

- Elevation
- Imperviousness
- Forest Canopy
- NASA MODIS Terra (16-day NDVI composite)
CDL Processing Method

Satellite Imagery
Ancillary Data
Ground Truth

Sampling Done by
See5

Decision Tree

Classification

Iowa 2008 Cropland Data Layer

Land Cover Categories (Ordered by Decreasing Acreage)

Agriculture
- Corn
- Soybeans
- Pasture/Grass
- Alfalfa
- Oats
- Winter Wheat
- Spring Wheat
- Grassland
- Barley
- Clover/Weeds
- Other Crops
- Fallow/Cropland
- Drought/Yes
- Sorghum
- Pinto
- Dried Beans
- Viola/Field Crops
- Non-Agriculture
- Urban/Developed
- Woodland
- Wetlands
- Water
- Barren
- Shrubland
Data Partnerships

- Foreign Agricultural Service
  - Resourcesat-1 AWiFS

- Farm Service Agency
  - Common Land Unit “ground truth”

- US Geological Survey
  - National Land Cover Dataset

- US Geological Survey/ NASA
  - Landsat TM 5 & 7
  - MODIS
Mapping and the National Atlas of Ecosystem Services (NAtl-ES)

Office of Research and Development
US EPA

Through Interagency Agreement:

Supported NASS Creation of Cropland Data Layers
For the 21 Non-Operational States
Validating CDLs

Measures CDL Accuracy

- **Compare**
  - Classified pixels from CDL
  - Known pixels, not used for classifying imagery, from FSA

- **Track**
  - Producer Accuracy & Errors of Omission - % of pixels from CDL that match groundtruth
  - User Accuracy & Errors of Commission - % of pixels from CDL that don’t match groundtruth
# Accuracy Assessments

<table>
<thead>
<tr>
<th>Cover Type</th>
<th>Attribute Code</th>
<th>*Correct Pixels</th>
<th>Producer's Accuracy</th>
<th>Omission Error</th>
<th>Kappa</th>
<th>User's Accuracy</th>
<th>Commission Error</th>
<th>Cond'I Kappa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>1</td>
<td>2197719</td>
<td>96.58%</td>
<td>3.42%</td>
<td>0.9226</td>
<td>97.86%</td>
<td>2.14%</td>
<td>0.9509</td>
</tr>
<tr>
<td>Soybeans</td>
<td>5</td>
<td>1471094</td>
<td>96.24%</td>
<td>3.76%</td>
<td>0.9392</td>
<td>95.78%</td>
<td>4.22%</td>
<td>0.9320</td>
</tr>
<tr>
<td>Corn</td>
<td>1</td>
<td>2258219</td>
<td>98.06%</td>
<td>1.94%</td>
<td>0.9527</td>
<td>98.58%</td>
<td>1.42%</td>
<td>0.9650</td>
</tr>
<tr>
<td>Soybeans</td>
<td>5</td>
<td>1339089</td>
<td>96.36%</td>
<td>3.64%</td>
<td>0.9438</td>
<td>97.96%</td>
<td>2.04%</td>
<td>0.9681</td>
</tr>
<tr>
<td>Corn</td>
<td>1</td>
<td>1856422</td>
<td>97.29%</td>
<td>2.71%</td>
<td>0.9605</td>
<td>97.32%</td>
<td>2.68%</td>
<td>0.9608</td>
</tr>
<tr>
<td>Soybeans</td>
<td>5</td>
<td>849249</td>
<td>95.83%</td>
<td>4.17%</td>
<td>0.9513</td>
<td>96.95%</td>
<td>3.05%</td>
<td>0.9643</td>
</tr>
<tr>
<td>Corn</td>
<td>1</td>
<td>803251</td>
<td>94.29%</td>
<td>5.71%</td>
<td>0.9342</td>
<td>95.78%</td>
<td>4.22%</td>
<td>0.9513</td>
</tr>
<tr>
<td>Soybeans</td>
<td>5</td>
<td>707383</td>
<td>95.03%</td>
<td>4.97%</td>
<td>0.9439</td>
<td>97.72%</td>
<td>2.28%</td>
<td>0.9741</td>
</tr>
</tbody>
</table>

State level accuracies are very high.
Regression-based Acreage Estimator

Simple Linear Regression

Regression used to relate categorized pixel counts to the ground reference data

- \((X)\) – Cropland Data Layer (CDL) classified acres
- \((Y)\) – June Agricultural Survey (JAS) reported acres

Outlier segment detection - removal from regression analysis

Using regression results in estimates reduces error rates over using JAS alone

Acreage not just about counting pixels
CDL Satellite Future

- Aging satellite fleet
  - Landsat 5 (1984)
  - Landsat 7 SLC-off (1999)

- Future
  - Resourcesat-2 (operational ~late 2010)
  - Landsat Data Continuity Mission (LDCM) ~2013
  - French Spot 4/5
Current Coverage – SPOT 4 and 5

USGS SPOT Databuy Coverage

Legend
- SPOT-5
- SPOT-4

06/24/2018
CDL Future

- National CDL crop year 2009
  - Funded in part by EPA released Jan 2010
- Fund Geospatial CDL portal
  - George Mason U/Center for Spatial Information Science and Systems
- National Commodity Crop Productivity Index
  - NRCS dynamic soils layer
CDL Distribution & Information

  - All CDL’s and Metadata
  - Download by State (all years for that State)
- [http://www.nass.usda.gov/research/Cropland/SARS1a.htm](http://www.nass.usda.gov/research/Cropland/SARS1a.htm)
  - Most current year only

- Rick Mueller, Head, Spatial Analysis Research Section, USDA/NASS, (703)877-8000 ext:111
  - [Rick_Mueller@nass.usda.gov](mailto:Rick_Mueller@nass.usda.gov)
- Mike Craig, Remote Sensing Analyst, MEC GeoStat Inc
  - [MikeCraig42@live.com](mailto:MikeCraig42@live.com), (703)798-0073
*NASS uses Geospatial Decision Support Systems to provide updated information to the Ag Statistics Board and data users.