Agenda

- Cropland Data Layer (CDL) Intro
- CDL Inputs
- Method
- Accuracy Assessment
- Acreage Estimation
- Summary
2010 Cropland Data Layers

Inputs:
- Landsat (8601 scenes)
- AWIFS (1194 scenes)

~9 billion pixels!

Released Jan. 10, 2011
National 30m Product
Harmonize ALL historical CDL products to standards: color scheme, categories, projection, metadata

http://nassdata.gmu.edu/CropScape
Cropland Data Layer (CDL) Objectives

- Annually cover major crops for conterminous United States
- Potential adjusted Ag Census @ .22 acre/pixel scale

- Deliver in-season remote sensing acreage estimates
  - For June, August, September, and October Official Reports
  - Update planted area/survey variance reduction
  - Reduce respondent burden
  - Basis for crop progress/condition/yield program monitoring

- Provide timely, accurate, useful estimates
  - Measurable error
  - Unbiased/independent estimator
  - State, District, County
14 states – winter wheat
14 – corn & soybeans
15 – rice, cotton & peanuts
17 – all small grains
24 – all crops
27 – operational

Cropland Data Layer 2010 in-season production @ 56m
48 states post season @ 30m
2010 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/Vege. & Fruits
- Other Tree Nuts

NON-AGRICULTURE
- Woodland
- Wetlands
- Urban/Developed
- Shrubland
- Water
- Barren
2010 Cropland Data Layer Inputs

Satellite Imagery - AWiFS & Landsat TM

USDA Farm Service Agency/Common Land Unit

NLCD & Derivative products

NASS June Agricultural Survey
Ground Truth – Land Cover

Agriculture Ground Truth
Provided by Farm Service Agency
Identifies known fields and crops

Divide known fields into 2 sets
70% used for training software
30% used for validating results

Non-Agriculture Ground Truth
U.S. Geological Survey
National Land Cover Dataset
Identifies urban infrastructure and non-agriculture land cover
Forest, grass, water, cities
Satellite Data with Farm Service Agency Common Land Unit (CLU) Polygons
Satellite Data with Farm Service Agency
CLUs Overlay

Corn -  Soybean -  Winter Wheat -  Alfalfa -
Kansas 2010 CDL Input Layers

Scenes of data actually used: 24 AWiFS, 13 Landsat TM, 2 MODIS NDVI, DEM, Canopy, and Impervious
Classification Methodology Overview

1) “Stack” Landsat, Landsat-like data, and ancillary data layers within a raster GIS

2) Sample spatially through stack from known ground truth from FSA (ag. categories) and NLCD (non-ag. categories)

3) “Data-mine” those samples using Boosted Classification Tree Analysis to derive best fitting decision rules

4) Apply derived decision rules back to entire input data stack to create full scene classification

Agricultural ground truth (via the USDA Farm Service Agency)

Non-agricultural ground truth (using the National Land Cover Dataset as a proxy)

Imagery stack (independent data)

ERDAS IMAGINE®

Manages and visualizes datasets

Rulequest See5.0

Derives decision tree-based classification rules

Generated rule set

Output “Cropland Data Layer”
CDL Accuracy Assessment

Each classification tested against independent set of ground truth data to determine overall and within class accuracies.

Example classification subset

Example validation subset
## Accuracy Statistics

<table>
<thead>
<tr>
<th>Cover Type</th>
<th>Attribute Code</th>
<th>*Correct Pixels</th>
<th>Producer's Accuracy</th>
<th>User's Accuracy</th>
<th>Kappa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>1</td>
<td>460221</td>
<td>93.78%</td>
<td>5.53%</td>
<td>0.9351</td>
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<tr>
<td>Sorghum</td>
<td>4</td>
<td>63253</td>
<td>57.82%</td>
<td>42.18%</td>
<td>22.63%</td>
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<tr>
<td>Soybeans</td>
<td>5</td>
<td>1870</td>
<td>48.85%</td>
<td>51.15%</td>
<td>5.98%</td>
</tr>
<tr>
<td>Sunflower</td>
<td>6</td>
<td>26389</td>
<td>61.28%</td>
<td>38.72%</td>
<td>25.91%</td>
</tr>
<tr>
<td>Sweet Corn</td>
<td>12</td>
<td>905</td>
<td>54.75%</td>
<td>45.25%</td>
<td>7.27%</td>
</tr>
<tr>
<td>Barley</td>
<td>21</td>
<td>7877</td>
<td>66.47%</td>
<td>33.53%</td>
<td>28.45%</td>
</tr>
<tr>
<td>Durum Wheat</td>
<td>22</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Spring Wheat</td>
<td>23</td>
<td>2236</td>
<td>48.46%</td>
<td>51.54%</td>
<td>50.98%</td>
</tr>
<tr>
<td>Winter Wheat</td>
<td>24</td>
<td>817165</td>
<td>92.79%</td>
<td>7.21%</td>
<td>4.50%</td>
</tr>
<tr>
<td>Rye</td>
<td>27</td>
<td>285</td>
<td>14.57%</td>
<td>85.43%</td>
<td>68.61%</td>
</tr>
<tr>
<td>Oats</td>
<td>28</td>
<td>4483</td>
<td>33.63%</td>
<td>66.37%</td>
<td>52.59%</td>
</tr>
<tr>
<td>Millet</td>
<td>29</td>
<td>70479</td>
<td>79.66%</td>
<td>20.34%</td>
<td>33.04%</td>
</tr>
<tr>
<td>Speltz</td>
<td>30</td>
<td>85</td>
<td>85.00%</td>
<td>15.00%</td>
<td>50.87%</td>
</tr>
<tr>
<td>Canola</td>
<td>31</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Flaxseed</td>
<td>32</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Safflower</td>
<td>33</td>
<td>577</td>
<td>31.26%</td>
<td>68.74%</td>
<td>80.03%</td>
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<tr>
<td>Alfalfa</td>
<td>36</td>
<td>174154</td>
<td>72.85%</td>
<td>27.15%</td>
<td>14.18%</td>
</tr>
<tr>
<td>Other Hay</td>
<td>37</td>
<td>54825</td>
<td>39.87%</td>
<td>60.13%</td>
<td>19.22%</td>
</tr>
<tr>
<td>Sugarbeets</td>
<td>41</td>
<td>4381</td>
<td>80.64%</td>
<td>19.36%</td>
<td>16.96%</td>
</tr>
<tr>
<td>Dry Beans</td>
<td>42</td>
<td>12029</td>
<td>68.64%</td>
<td>31.36%</td>
<td>45.17%</td>
</tr>
<tr>
<td>Potatoes</td>
<td>43</td>
<td>12742</td>
<td>85.17%</td>
<td>14.83%</td>
<td>91.00%</td>
</tr>
<tr>
<td>Other Crops</td>
<td>44</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Misc. Veggies &amp; Fruits</td>
<td>47</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Watermelons</td>
<td>48</td>
<td>25</td>
<td>6.35%</td>
<td>93.65%</td>
<td>39.68%</td>
</tr>
</tbody>
</table>

**Producer's Accuracy:** relates to the probability that a ground truth pixel will be correctly mapped and measures errors of omission.

**Errors of Omission:** occur when a pixel is excluded from the correct category.

**User's Accuracy:** indicates the probability that a pixel from the classification actually matches the ground truth data and measures errors of commission.

**Errors of Commission:** occur when a pixel is included in an incorrect category.
Regression-based Acreage Estimator

Acreage not just about counting pixels

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

Estimate 17 crops in 39 states
Reported = 1.32 + 0.86\times\text{Classified} \\
r^2 = 0.769

Washington - June 
Winter Wheat – Stratum 11

R^2 
Jun – 0.769
Reported = 6.76 + 0.96*Classified

\[ r^2 = 0.883 \]

Washington - September
Winter Wheat – Stratum 11

Reported = Classified
Linear LS Fit
95% Pred Limits
95% Conf Limits

Outliers
State: WA10   AD: 00    Crop: Wht_Wintr_PL
Stratum: 11  Version: v1a

R²
Jun – 0.769
Sep – 0.883
Reported = 5.94 + 0.95*Classified

$r^2 = 0.890$

State: WA10   AD: 00    Crop: Wht_Wintr_PL
Stratum: 11  Version: v1a

Washington - October
Winter Wheat – Stratum 11

$R^2$
Jun – 0.769
Sep – 0.883
Oct – 0.890

Outliers

Red – Deleted
Yellow – 4
Green – 3
Black – 2
Cropland Data Layer Summary

• **Operational Program**
  – Timely estimate delivery
  – Measureable statistical error
  – Set national/regional/county acreage estimates

• **Components**
  – AWiFS/Landsat imagery
  – Farm Service Agency/Common Land Unit
  – USGS NLCD/ancillary layers
  – June Agricultural Survey

• **Leverage**
  – CDL program paramount to other NASS geospatial activities
  – Partnerships with cooperating agencies critical for success
  – Heavy reliance on satellites and information technology

• **Distribution**
  – CropScape Portal
  – NRCS Data Gateway
Thank you!

Spatial Analysis Research Section
USDA/NASS R&D Division

nassgeodata.gmu.edu/CropScape