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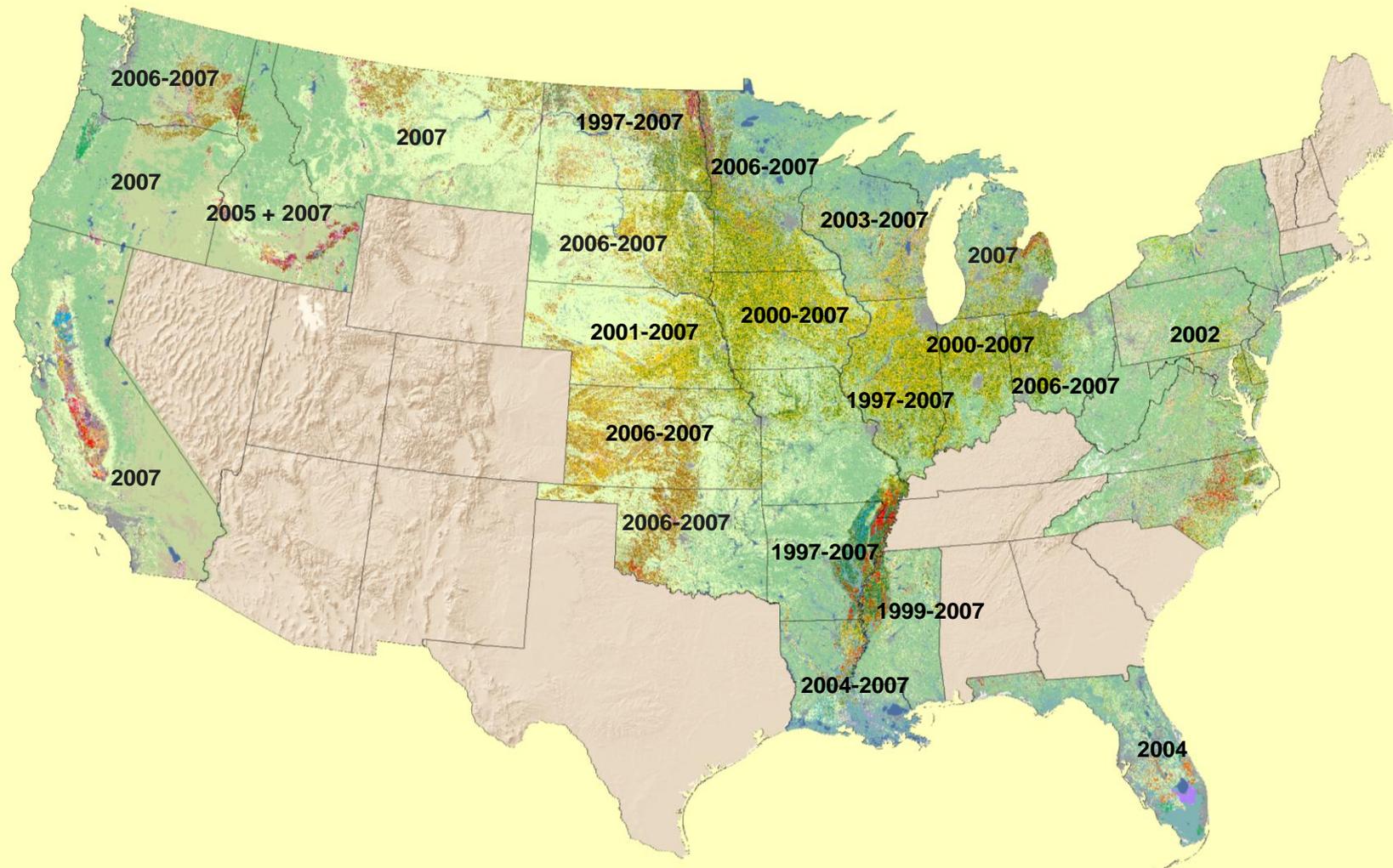
United States Department of Agriculture (USDA)
National Agricultural Statistics Service (NASS)
Research and Development Division (RDD)
Spatial Analysis Research Section (SARS)

Agricultural Land-Use Classification for California Using AWiFS and MODIS Data





Cropland Data Layers 1997 - 2007



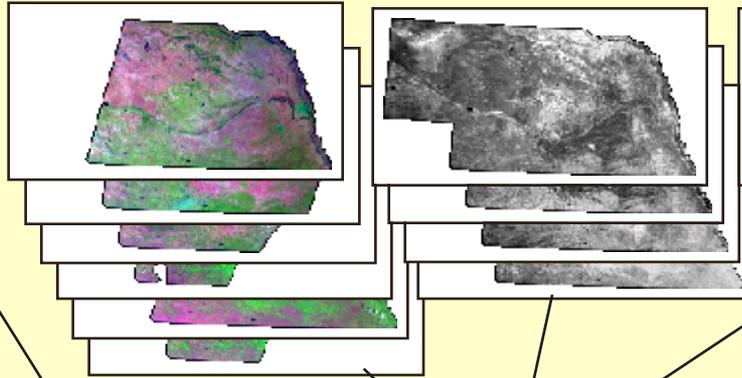
Cropland Data Layer and Acreage Estimation Processing Flow

Input Vector Data

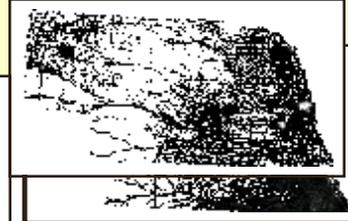
NASS JAS segments FSA CLU USGS NLCD



IRS Resourcesat-1 raw AWiFS summer time series NASA Terra MODIS 16-day NDVI prior fall and summer time series



USGS NLCD 2001 Impervious & Canopy



USGS NED Elevation

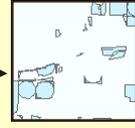


Tabular Data

JAS eData FSA 578

| STATE | FSA | CLU | AREA |
|-------|-----|-----|------|
| 01 | 001 | 1 | 2072 |
| 01 | 001 | 2 | 1000 |
| 01 | 001 | 3 | 3953 |
| 01 | 001 | 4 | 4000 |
| 01 | 001 | 5 | 4000 |
| 01 | 001 | 6 | 4000 |
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| 01 | 001 | 8 | 4000 |
| 01 | 001 | 9 | 4000 |
| 01 | 001 | 10 | 4000 |
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| 01 | 001 | 94 | 4000 |
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| 01 | 001 | 96 | 4000 |
| 01 | 001 | 97 | 4000 |
| 01 | 001 | 98 | 4000 |
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| 01 | 001 | 100 | 4000 |

Non-agricultural Ground truth



Agricultural Ground truth



Derives decision tree-based classification rules



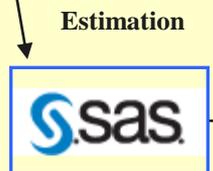
Generated rule set



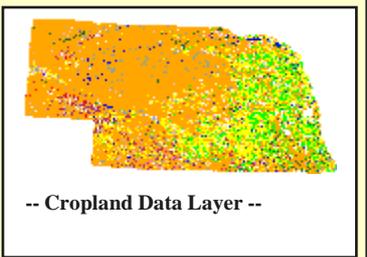
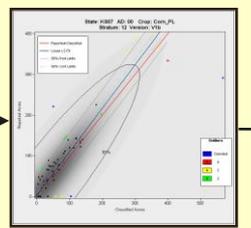
Link and assess data sets



Extract JAS intersecting pixels

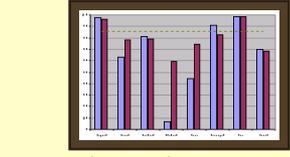


Customized for acreage estimation



State and county crop acreage statistics
NASS Internal Only

Output



Diagnostics

Cropland Data Layer and Acreage Estimation Processing Flow

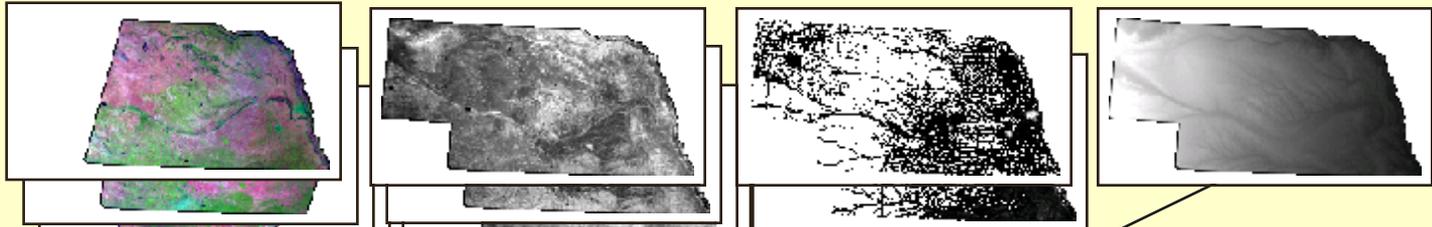
Input Vector Data

NASS JAS segments FSA CLU USGS NLCD



Input Raster Data

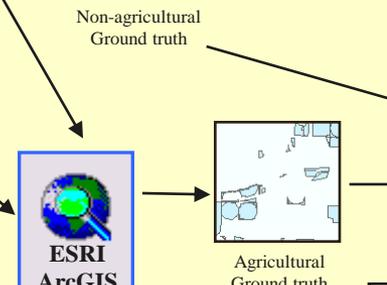
IRS Resourcesat-1 raw AWiFS summer time series NASA Terra MODIS 16-day NDVI prior fall and summer time series USGS NLCD 2001 Impervious & Canopy USGS NED Elevation



Tabular Data

JAS eData FSA 578

| STATE | FSA | CLU | AREA |
|-------|-----|-----|------|
| 01 | 001 | 1 | 2072 |
| 01 | 001 | 2 | 1468 |
| 01 | 001 | 3 | 3953 |
| 01 | 001 | 4 | 4051 |
| 01 | 001 | 5 | 4051 |
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| 01 | 001 | 7 | 4051 |
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| 01 | 001 | 96 | 4051 |
| 01 | 001 | 97 | 4051 |
| 01 | 001 | 98 | 4051 |
| 01 | 001 | 99 | 4051 |
| 01 | 001 | 100 | 4051 |



Derives decision tree-based classification rules



Generated rule set

Manages and visualizes datasets



Extract JAS intersecting pixels

Estimation

Customized for acreage estimation

Pixel count vs. reported acreage

-- Cropland Data Layer --

State and county crop acreage statistics

NASS Internal Only

Output

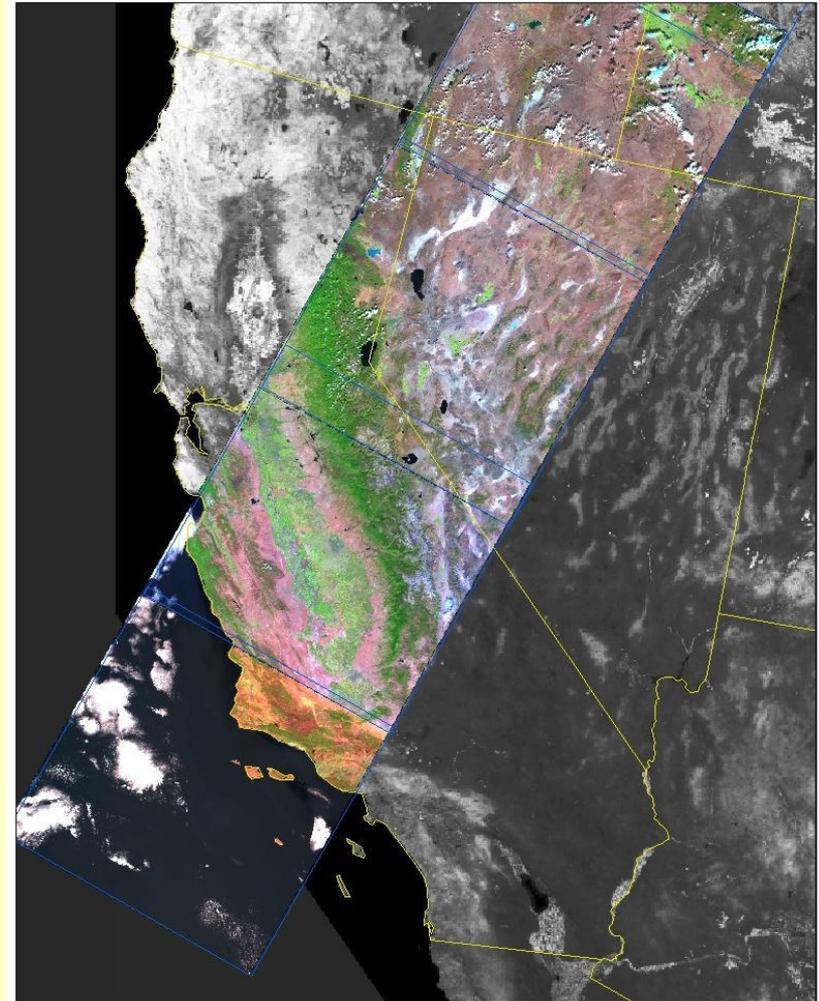
Confidence Layer

Accuracy Assessment

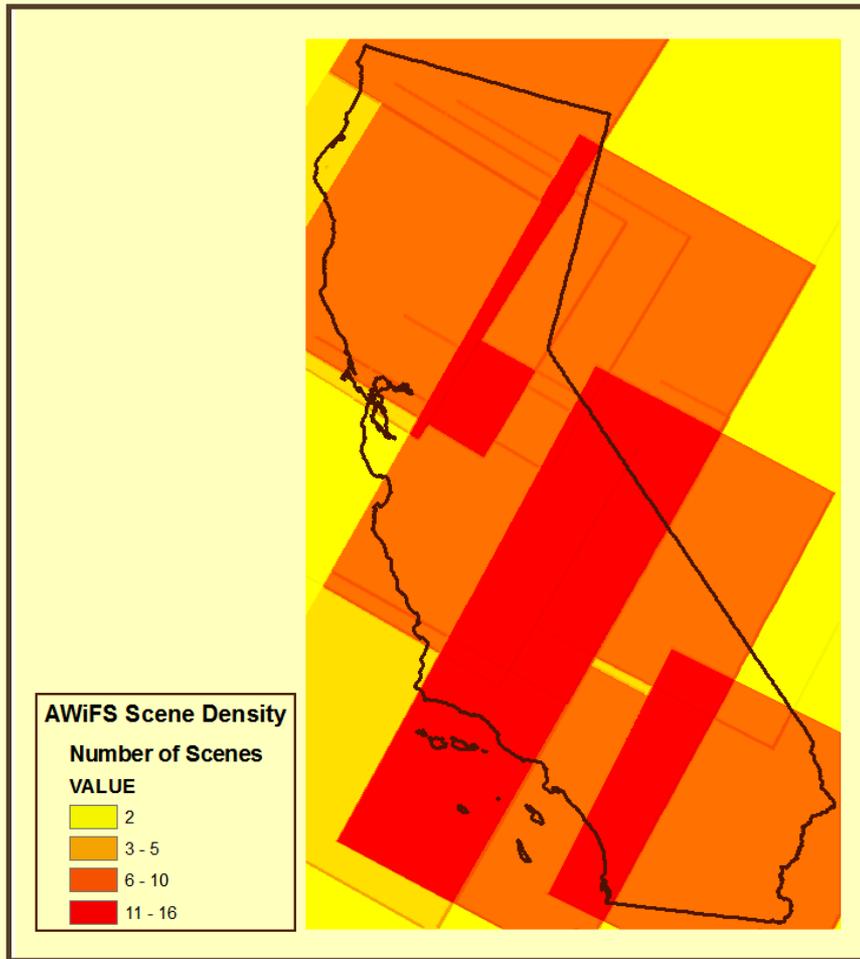
Diagnostics

Imagery - AWiFS Specifications

| Key Characteristics | |
|------------------------|---|
| Swath width | 737 km |
| Spectral bands | Green: 0.52 – 0.59 Red: 0.62 – 0.68 Near IR: 0.77 – 0.86 Mid IR: 1.55 – 1.70 |
| Repeat Time | Every 5 days |
| Pixel size | 56 x 56 m |
| Scene size | 370 x 370 km |
| Radiometric Resolution | 8 or 10 bits |

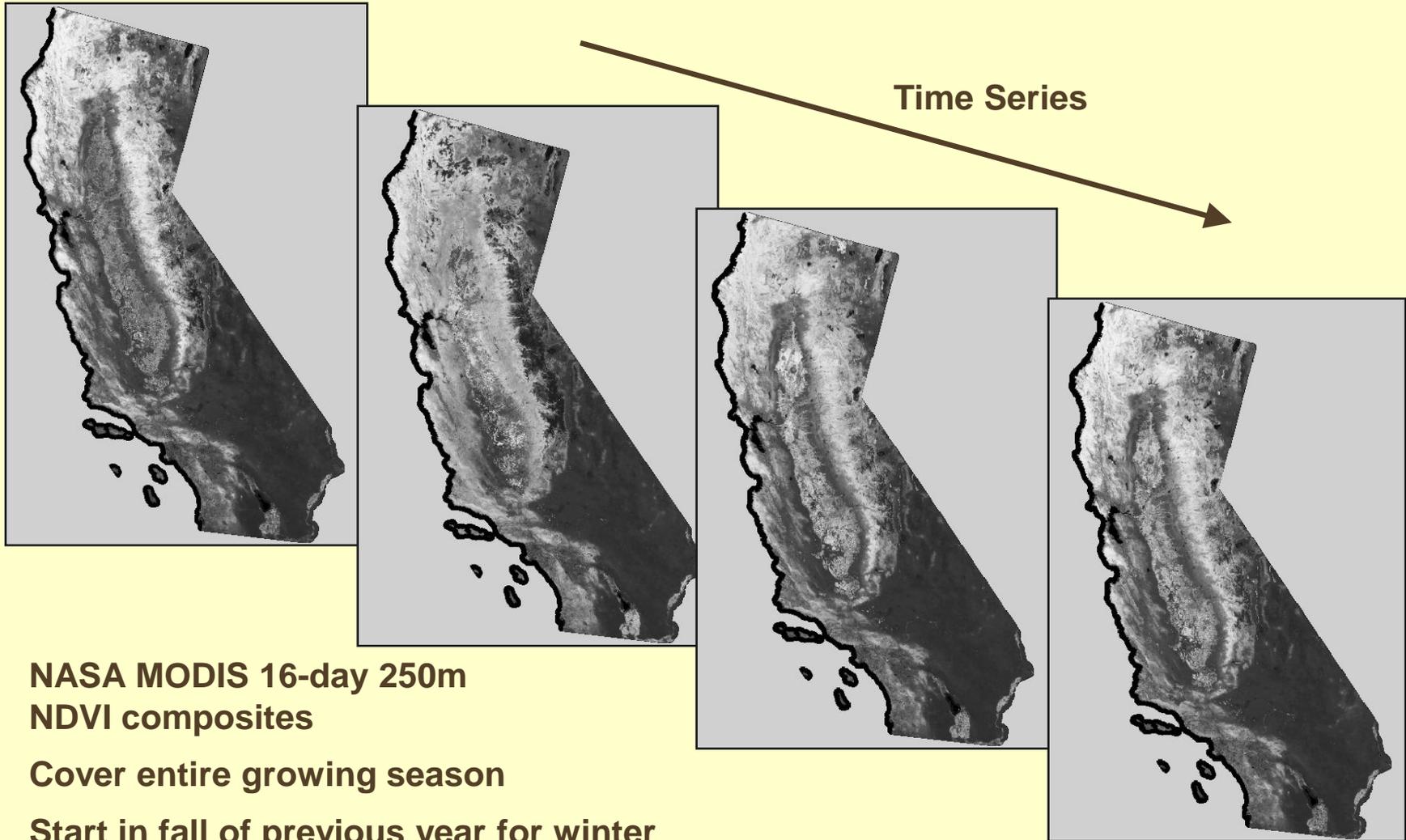


Imagery - AWiFS Scene Selection



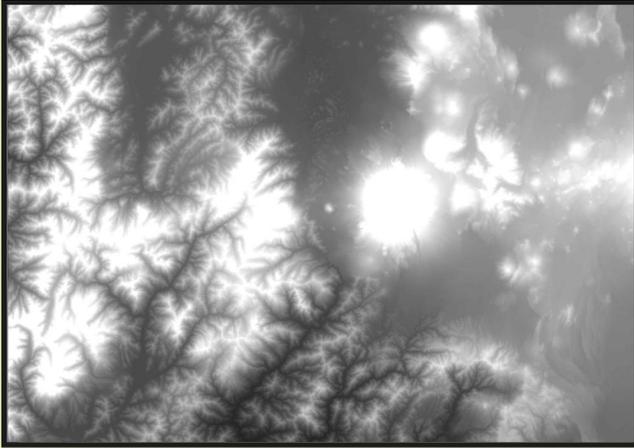
- Chosen to meet minimum scene depth
- Goal of one scene per month per “analysis district”
- Scenes span from April 1 to September 26
- Mosaics created of scenes from same date and path
- Final result: 33 out of 49 scenes selected

Ancillary - MODIS



- NASA MODIS 16-day 250m NDVI composites
- Cover entire growing season
- Start in fall of previous year for winter wheat

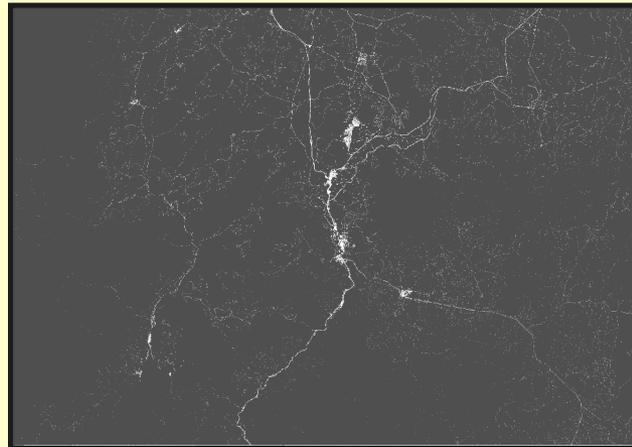
Ancillary – USGS Products



Elevation

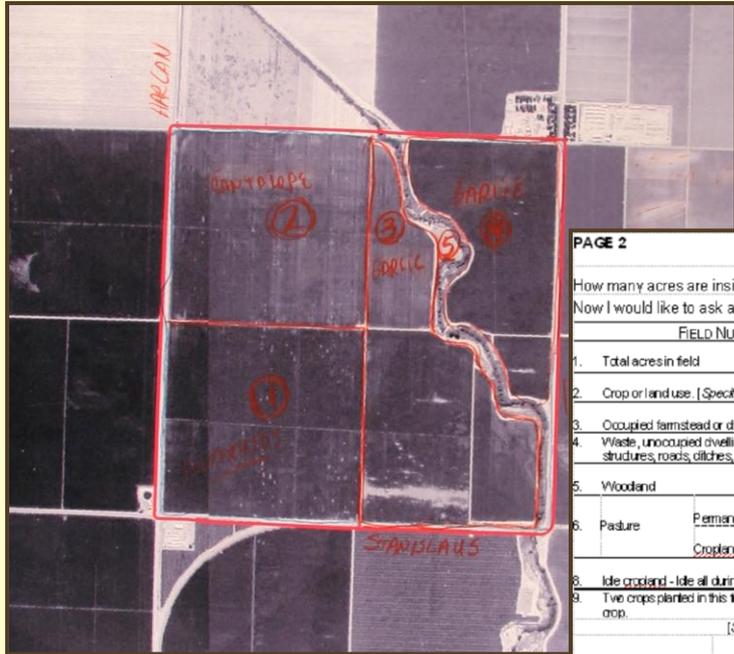


Canopy



Impervious

Ground Truth - June Area Survey (JAS) Data

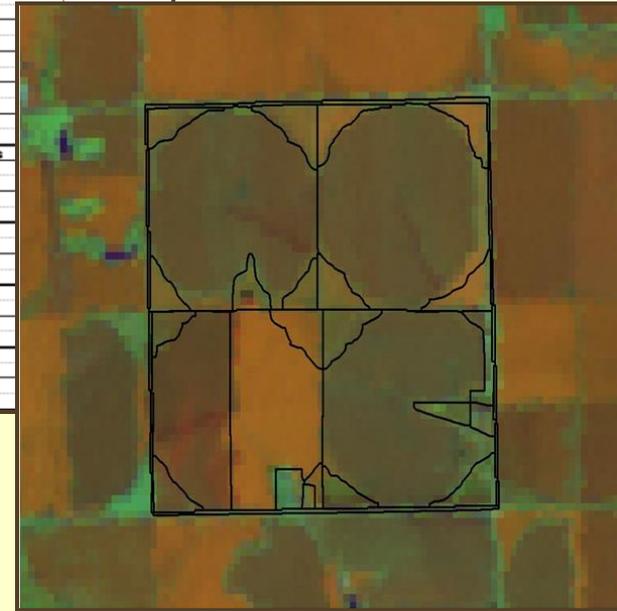


PAGE 2 SECTION D - CROPS AND LAND USE ON TRACT 17

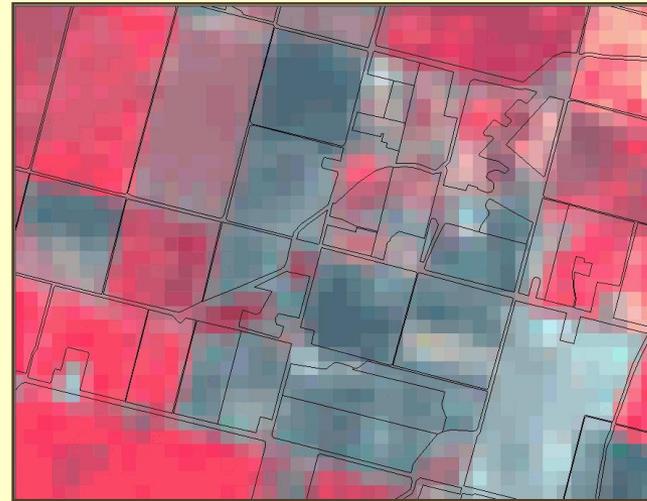
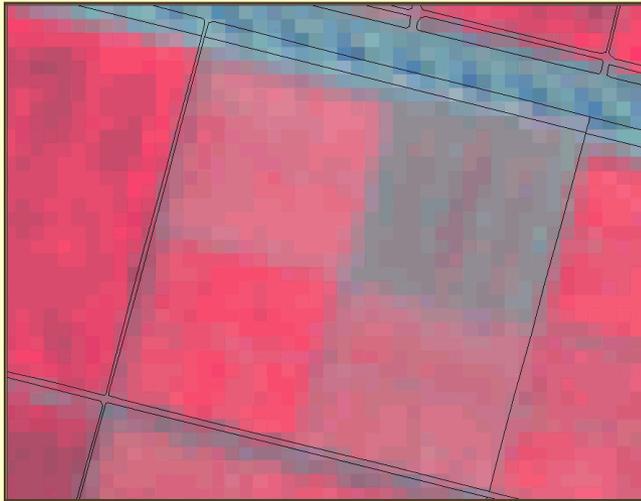
How many acres are inside this blue tract boundary drawn on the photo (map)?

Now I would like to ask about each field inside this blue tract boundary and its use during 2000.

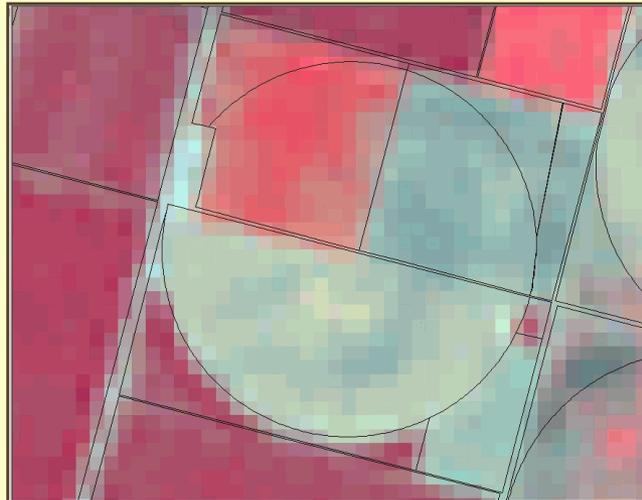
| FIELD NUMBER | 01 | 02 | 03 | 04 | 05 |
|---|--|--|--|--|--|
| 1. Total acres in field | 828 | 828 | 828 | 828 | 828 |
| 2. Crop or land use. (Specify) | R43 | | | | |
| 3. Occupied farmstead or dwelling | * | * | * | * | * |
| 4. Waste, unoccupied dwellings, buildings and structures, roads, ditches, etc. | --- | --- | --- | --- | --- |
| 5. Woodland | 831 | 831 | 831 | 831 | 831 |
| 6. Pasture | Permanent (not in crop rotation) | 842 | 842 | 842 | 842 |
| | Cropland (used only for pasture) | 856 | 856 | 856 | 856 |
| 7. Idle cropland - idle all during 2000 | 857 | 857 | 857 | 857 | 857 |
| 9. Two crops planted in this field or two uses of the same crop. (Specify second crop or use) | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| | Acres | 844 | 844 | 844 | 844 |
| 10. Acres left to be planted | 810 | 810 | 810 | 810 | 810 |
| 11. Acres irrigated and to be irrigated (If double cropped, include acreage of each crop irrigated) | 620 | 620 | 620 | 620 | 620 |
| 16. Winter Wheat (include cover crop) | Planted | 540 | 540 | 540 | 540 |
| | For grain or seed | 541 | 541 | 541 | 541 |
| 18. Rye (include cover crop) [Exclude ryegrass] | Planted | 547 | 547 | 547 | 547 |
| | For grain or seed | 548 | 548 | 548 | 548 |



Ground Truth - FSA CLU/578 Data

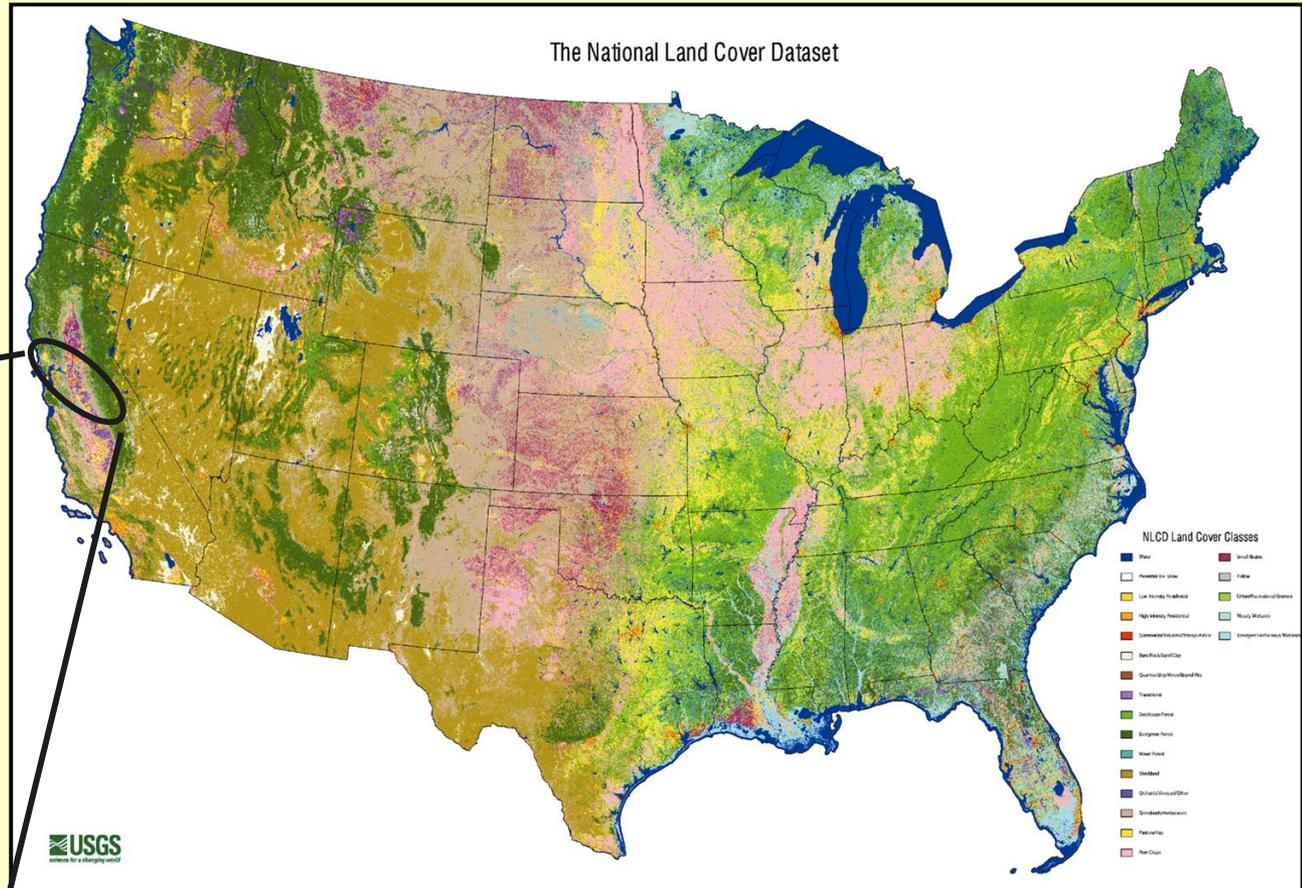


- Covers more area
- Less labor intensive
- 1/2 used for training
- 1/2 used for validation



- Fewer crop types
- Multiple crop types (in the same field)
- Not a proportional sample

Ground Truth – National Land Cover Dataset



- Proportional sampling approach
- Pasture/hay and cultivated categories ignored

Classification – Software

Commercial Software Suite

- Imagery Preparation:
 - Leica Geosystems ERDAS Imagine 9.1
- Ground Truth Preparation:
 - ESRI ArcGIS
- Image Classification:
 - Decision-tree software
 - Rulequest See 5.0
- Acreage Estimation:
 - SAS



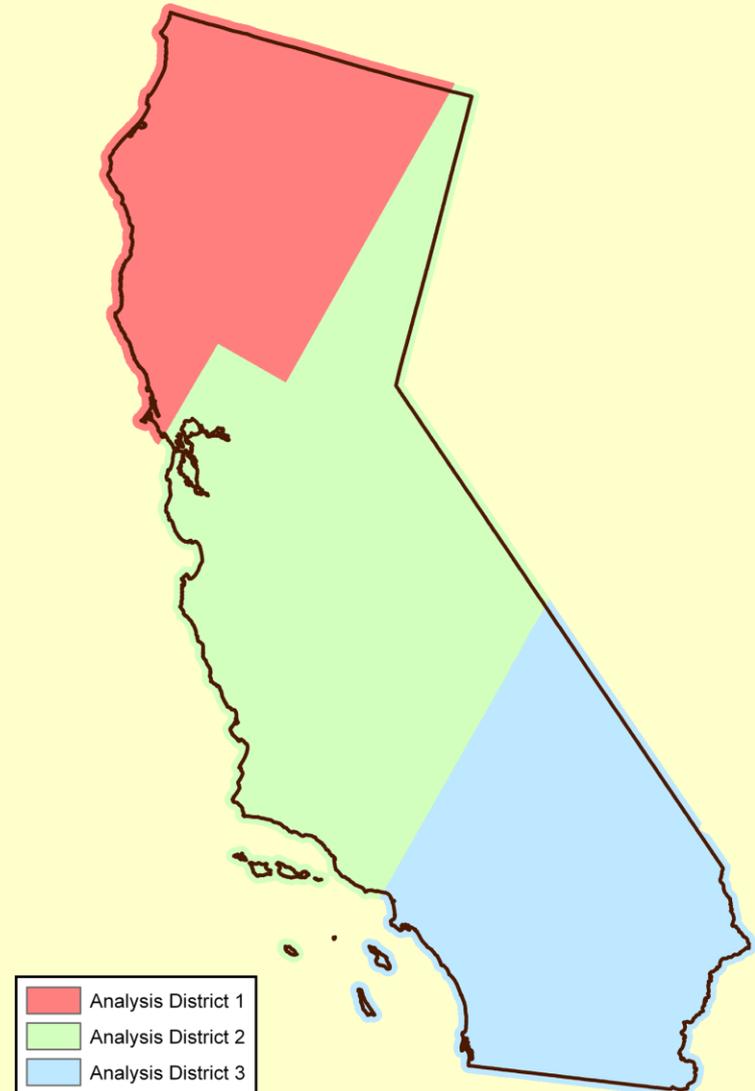
Classification – See 5 Decision Tree

The screenshot displays the See5 software interface. The main window shows a project named 'combined_samples_2000000' with various class and attribute definitions. Overlaid on this is the 'NLCD Mapping Tool' dialog box, which contains several buttons: 'Percent Calculation...', 'NLCD Sampling Tool...', 'Cubist Classifier...', 'See5 Classifier...', 'Accuracy Assessment...', 'Smart Eliminate...', 'Cubist Info', 'See5 Info', and 'Close'. To the right, the 'Classifier Construction Options' dialog box is open, showing settings for 'Winnow attributes' (checked), 'Boost' (checked, 10 trials), 'Global pruning' (checked, 25% Pruning CF, 2 cases Minimum), and other options like 'Rulesets', 'Sort by utility', 'Subsets of values', 'Use sample of', 'Lock sample', 'Cross-validate', and 'Ignore costs file'. The background shows a text window with decision tree rules such as 'band01 > 1078: 142 (18/4)'.

- Capable of handling large and complex data sets
- Able to incorporate missing and non-continuous data
- NLCD Mapping Tool acts as an interface between Imagine and See 5

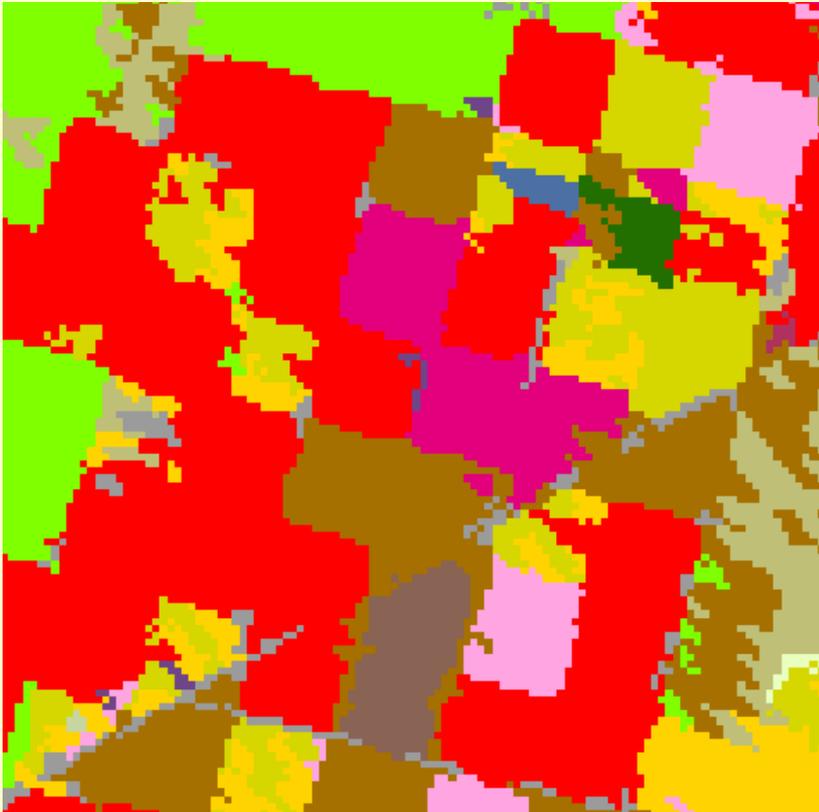
Classification – Three Approaches

- **Analysis District 1:**
 - 11 AWiFS scenes
 - 2 million sample points
 - Smart Eliminate MMU = 5
- **Analysis District 2:**
 - 9 AWiFS scenes
 - 2 million sample points
 - Smart Eliminate MMU = 5
- **Analysis District 3:**
 - 14 AWiFS scenes
 - 924,872 sample points
 - Smart Eliminate MMU = 5

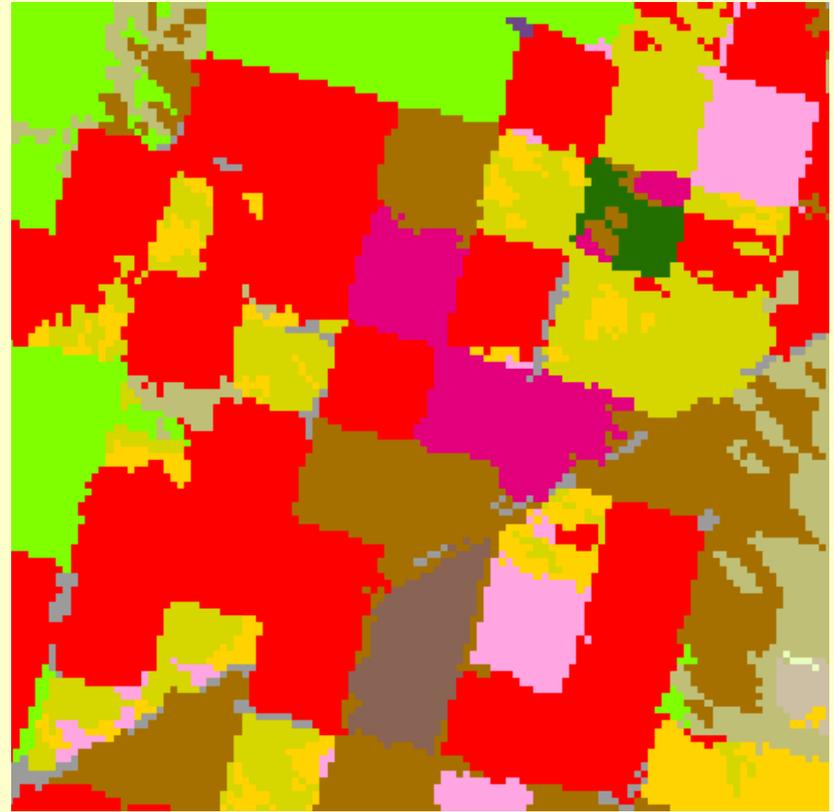


Classification – Visual Assessment

Hybrid Approach – Smart Eliminate 5 MMU

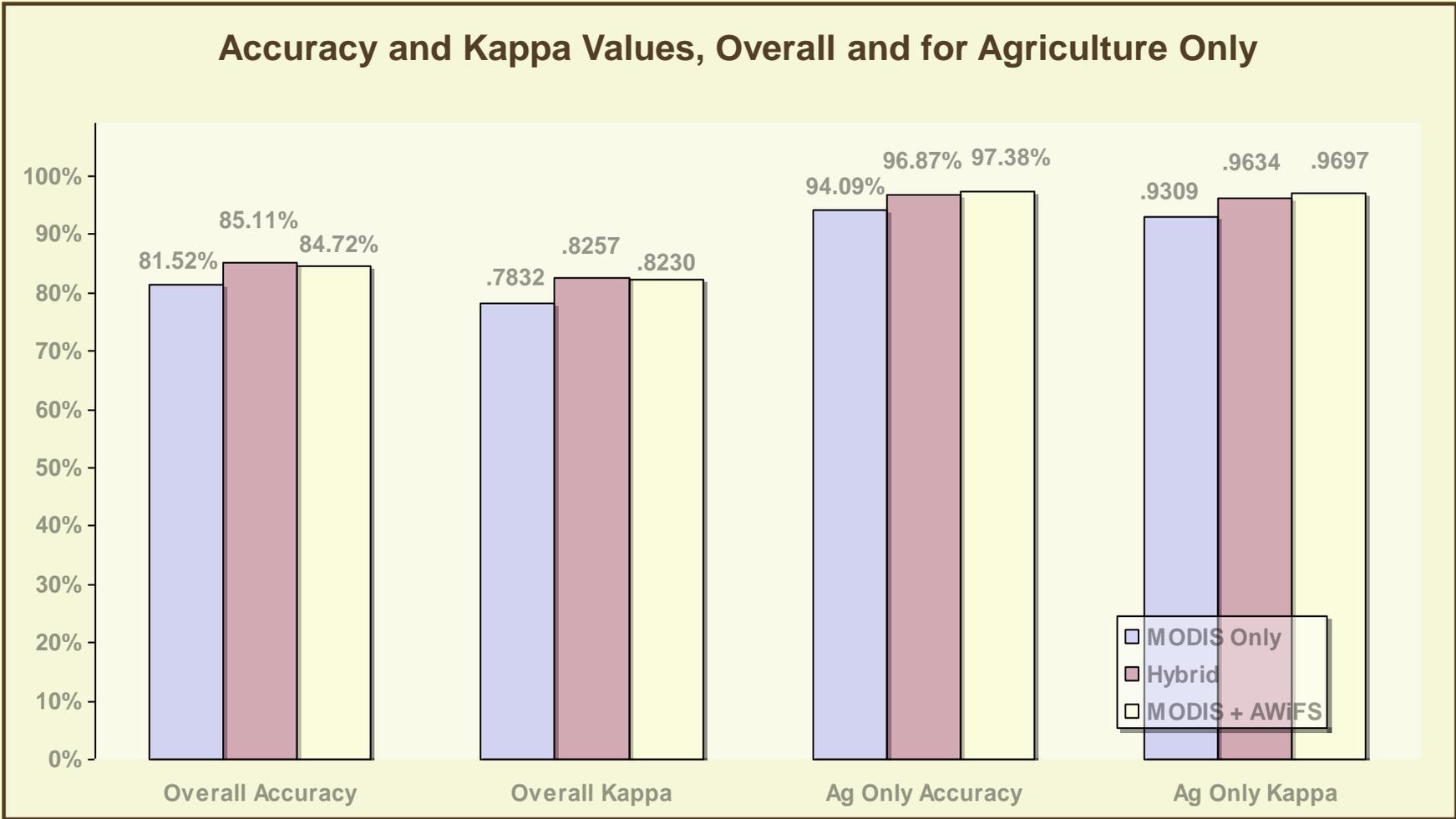


Standard Approach – Smart Eliminate 5 MMU



Classification – Quantitative Assessment

Accuracy and Kappa Values, Overall and for Agriculture Only

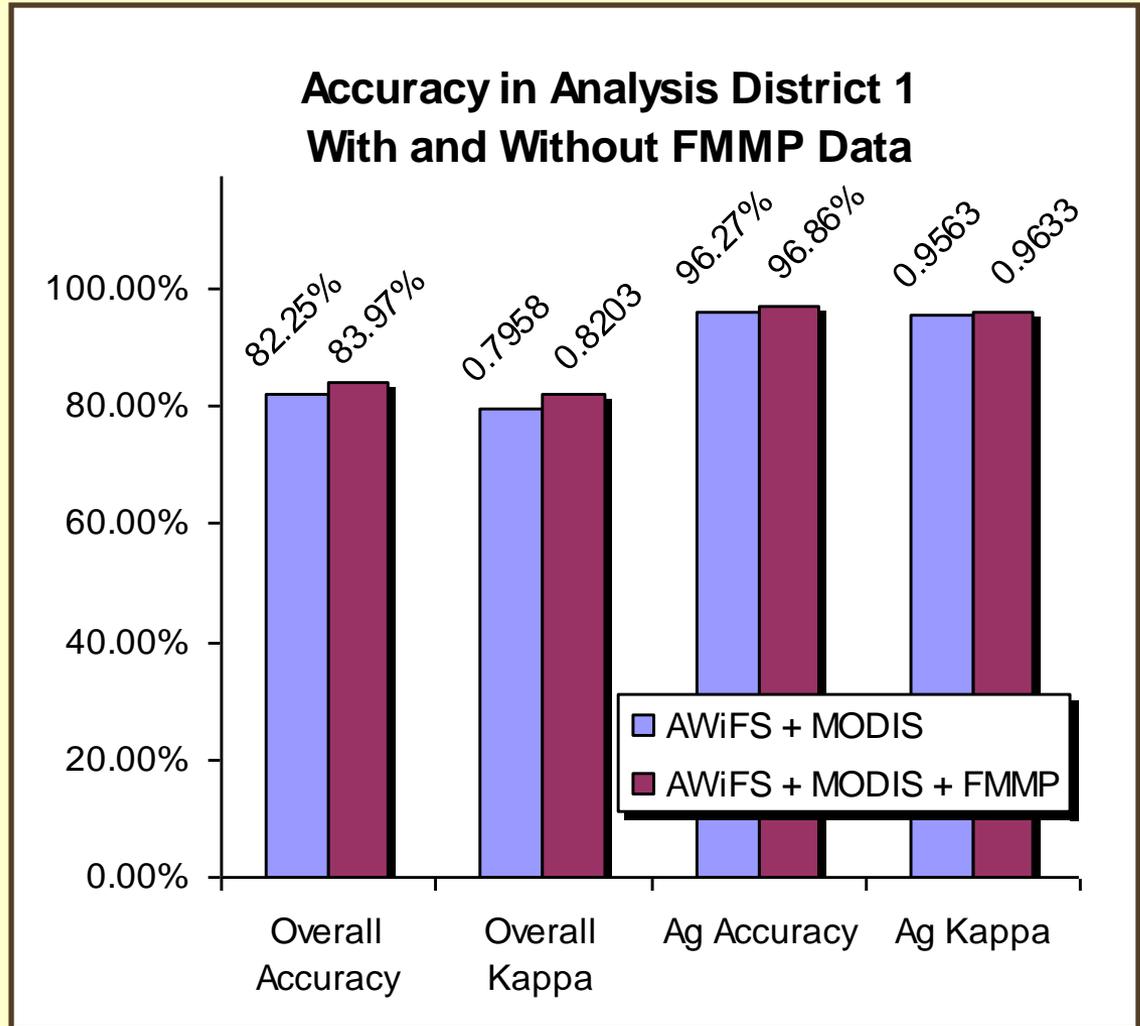


Classification – FMMP Assessment

With FMMP Data



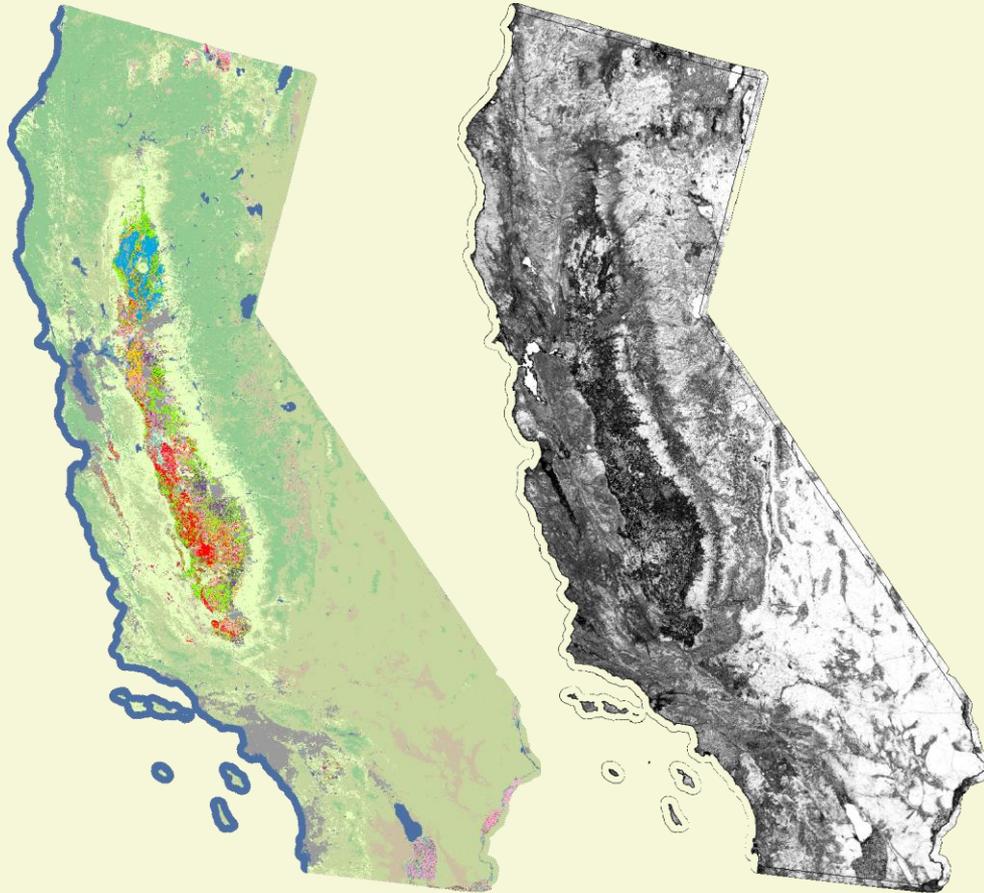
Without FMMP Data



California Cropland Data Layer



- Available July 2008
- Downloadable at USDA Geospatial Data Gateway
- Includes:
 - Cropland data layer
 - Confidence image
 - 30m resolution version



Conclusions

- Abundance of ground truth probably largest contributor to accuracy
- Improving overall accuracy should address improving the accuracy of non-ag classes
- Accuracy boost using FMMP data indicates soil data should be considered as an input layer in other classifications

Future Research

- Investigate other MMU combinations for crops and non-crops
- Use of minimum sample size in the stratified sampling approach for smaller acreage crops
- Identify areas of change in the NLCD to exclude from sampling

Acknowledgments

- Thanks to Rick Mueller, Claire Boryan, Patrick Willis, Dave Johnson, and Lee Ebinger at USDA for their invaluable help and advice!
- Thanks also to Chris Justice, Jessica McCarty, and Katie Martini at the University of Maryland
- Closing photo by Josh Jackson, used under the Creative Commons license.
- And thanks to you!