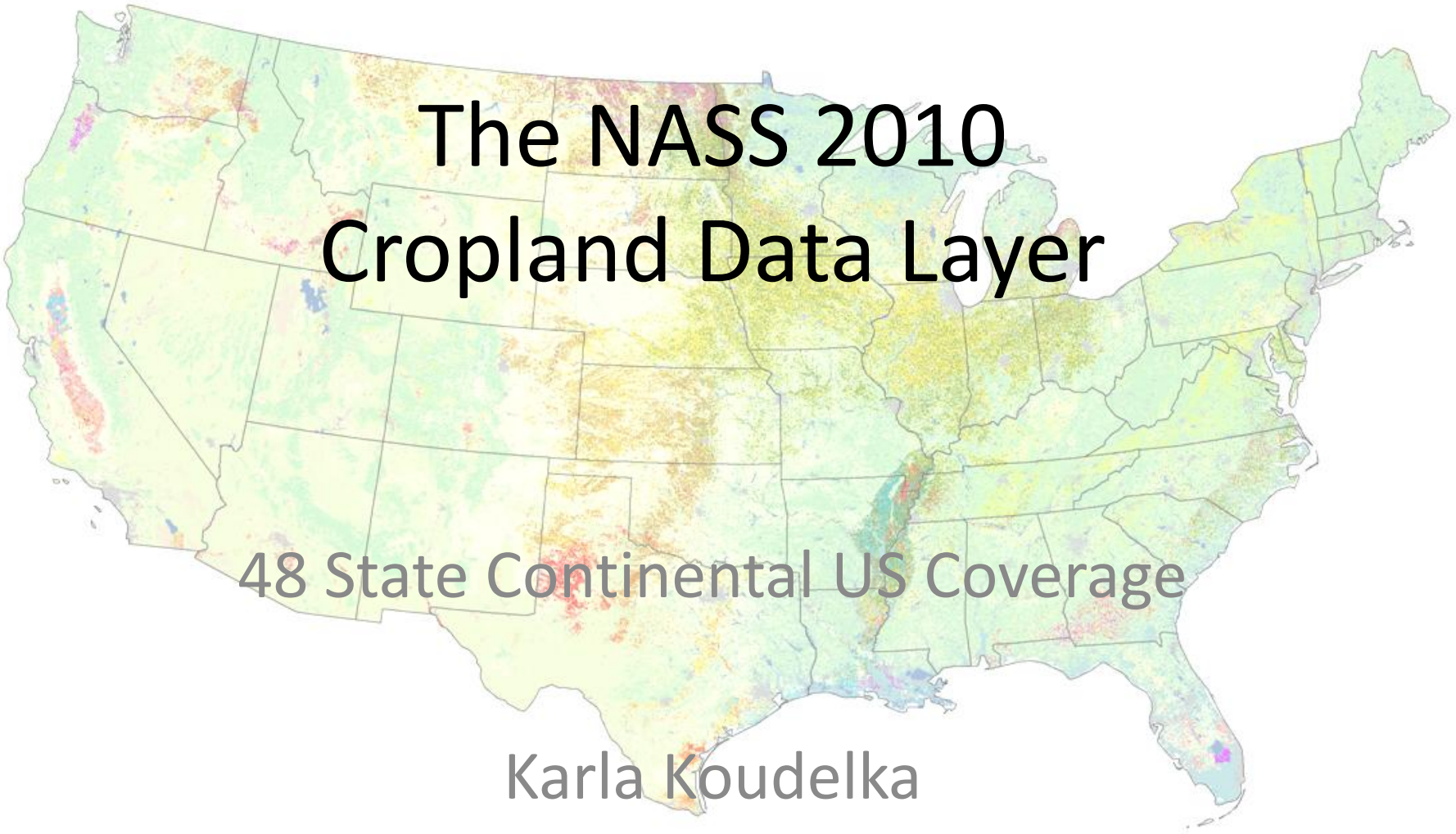


The NASS 2010 Cropland Data Layer

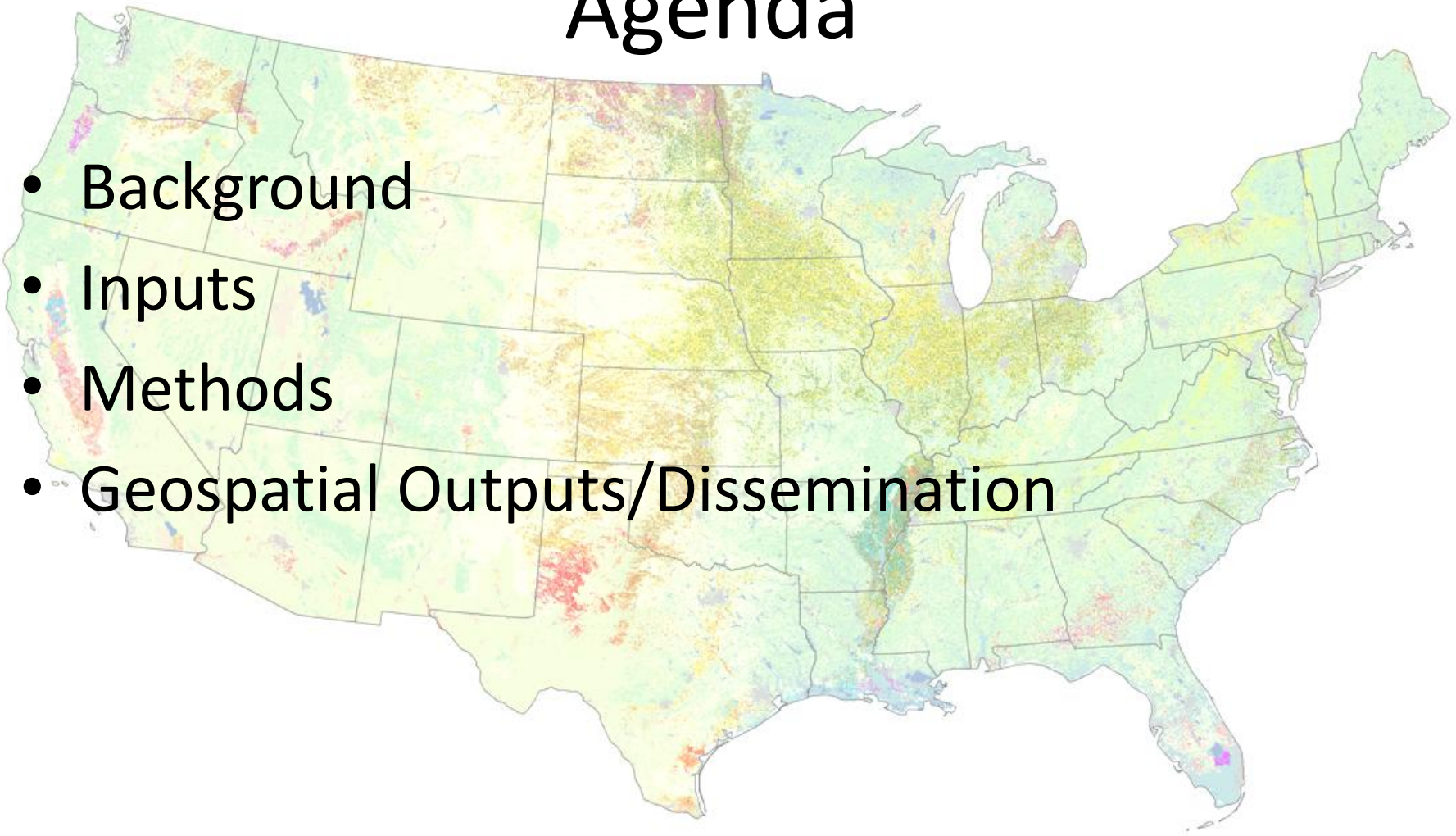
48 State Continental US Coverage

Karla Koudelka

USDA

AGRICULTURE COUNTS NASS

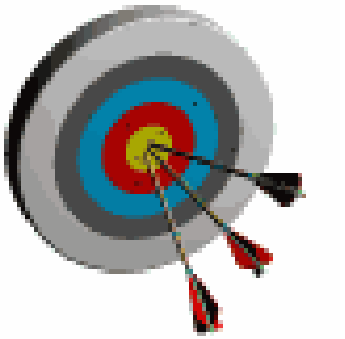
Agenda



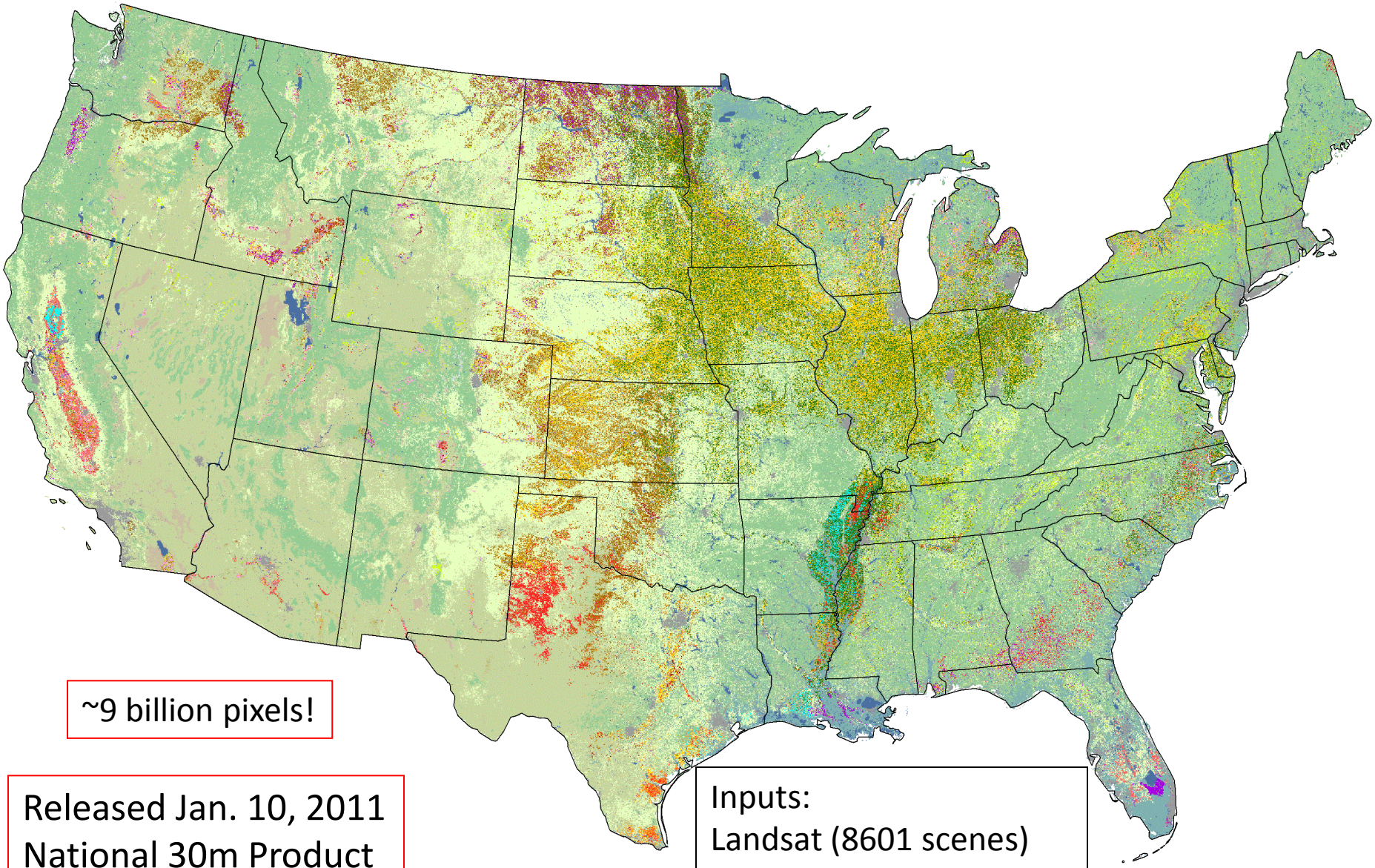
- Background
- Inputs
- Methods
- Geospatial Outputs/Dissemination

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
  - For June, August, September, and October 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
  - http://nassgeodata.gmu.edu/CropScape
  - NRCS Geospatial Data Gateway
  - http://www.nass.usda.gov/research/Cropland/SARS1a.htm
  - Google CropScape!



2010 Cropland Data Layers

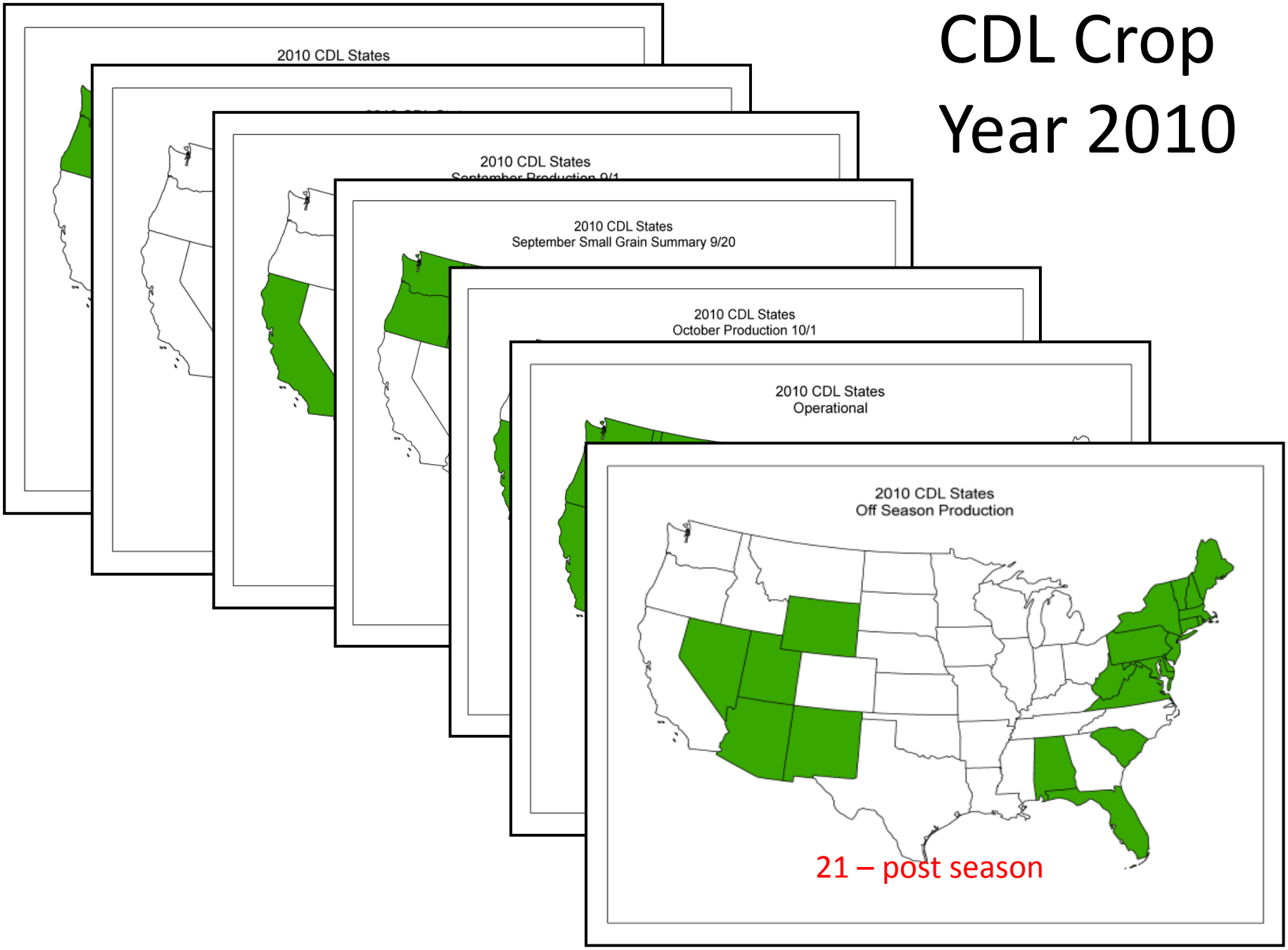


~9 billion pixels!

Released Jan. 10, 2011
National 30m Product

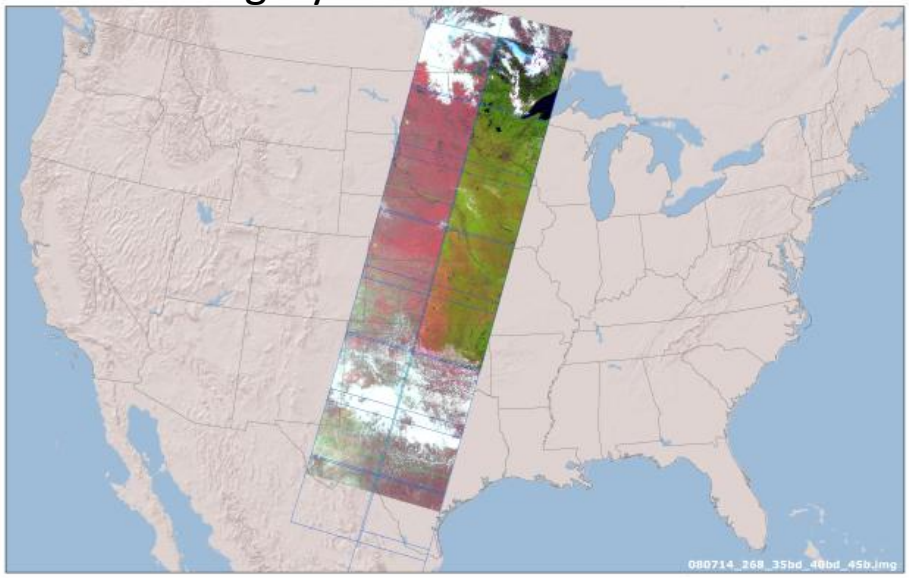
Inputs:
Landsat (8601 scenes)
AWiFS (1194 scenes)

CDL Crop Year 2010

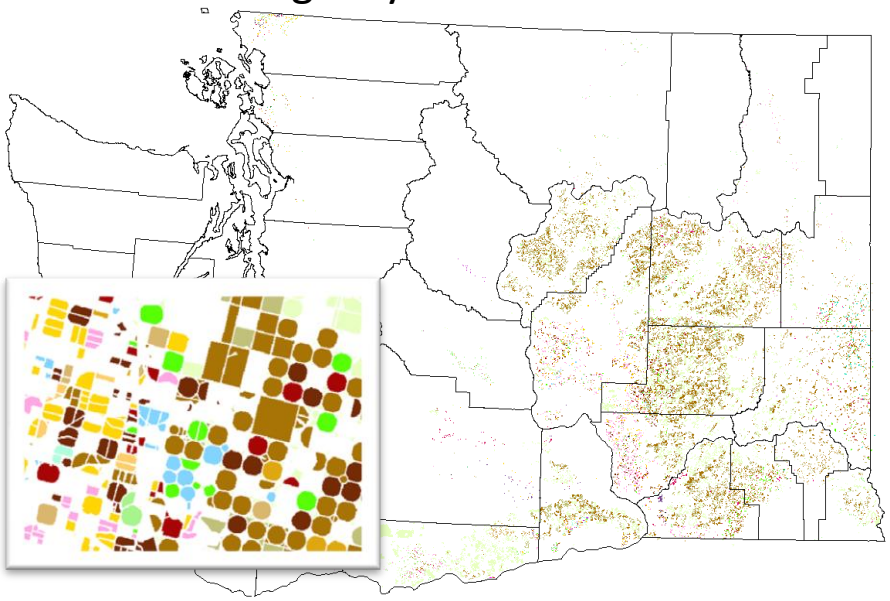


Inputs

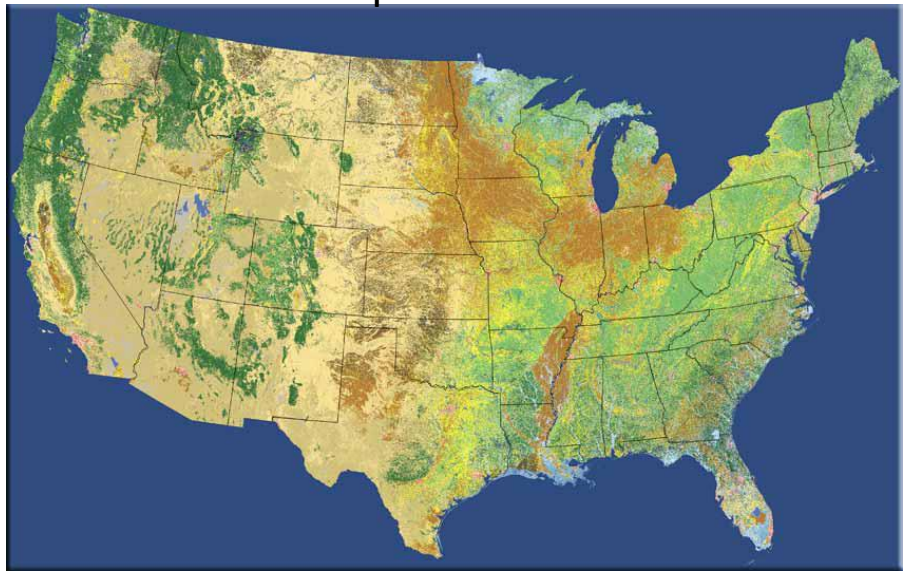
Satellite Imagery - AWiFS & Landsat TM



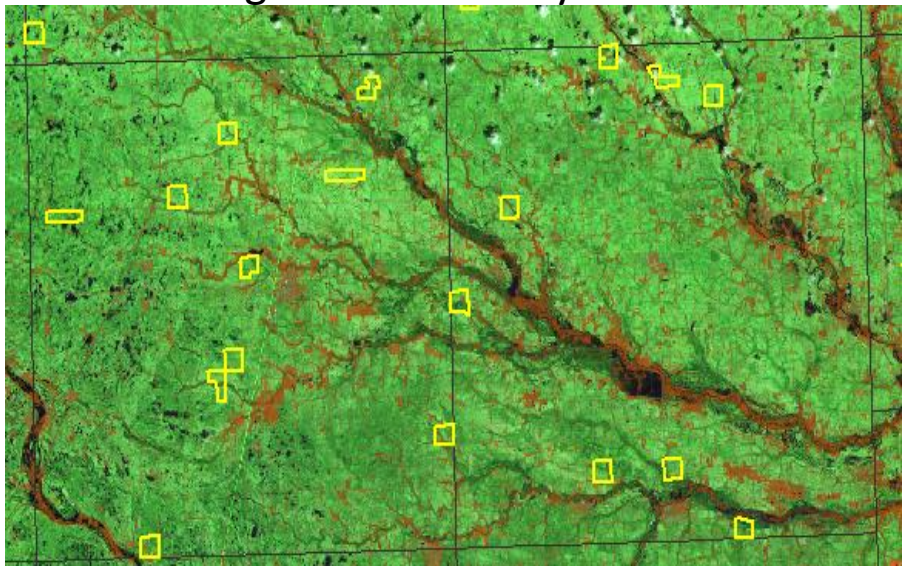
Farm Service Agency – Common Land Unit



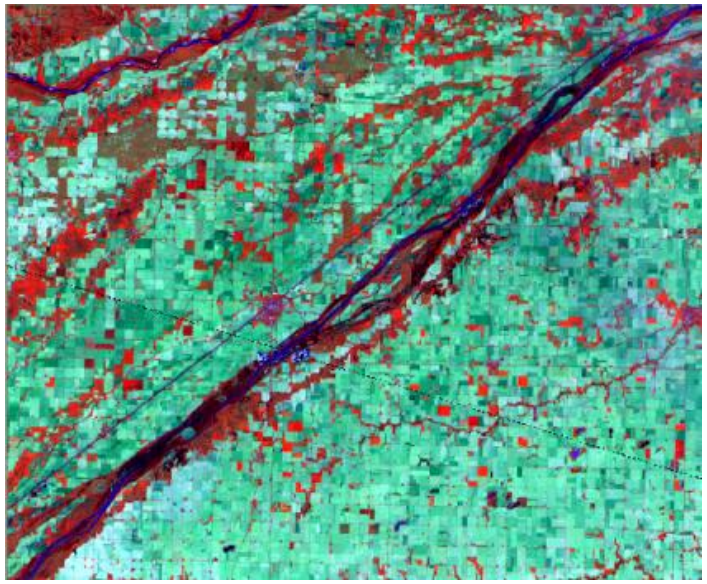
NLCD & Derivative products



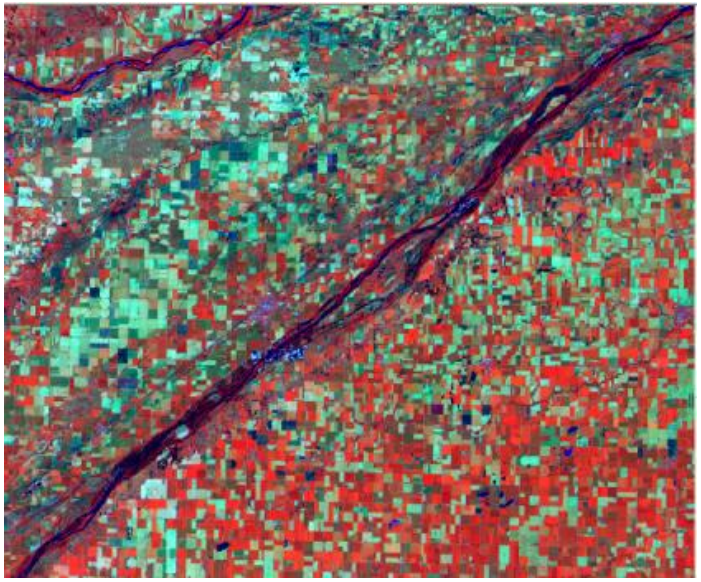
NASS June Agriculture Survey



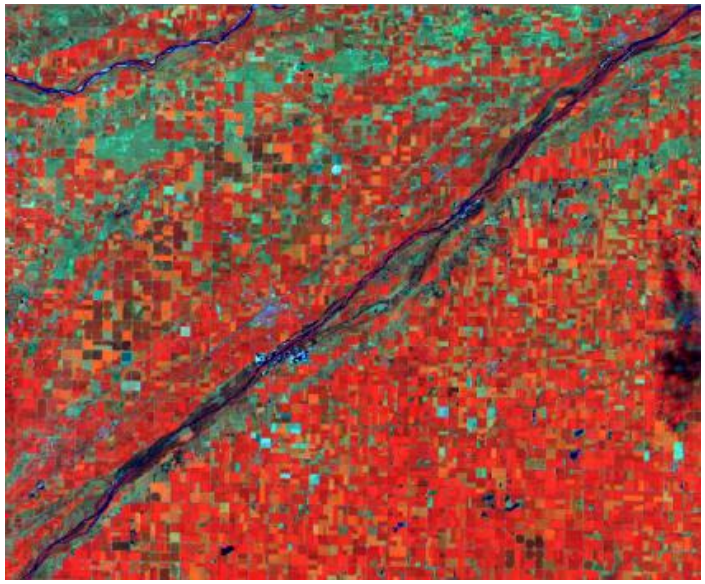
Satellite Images over time



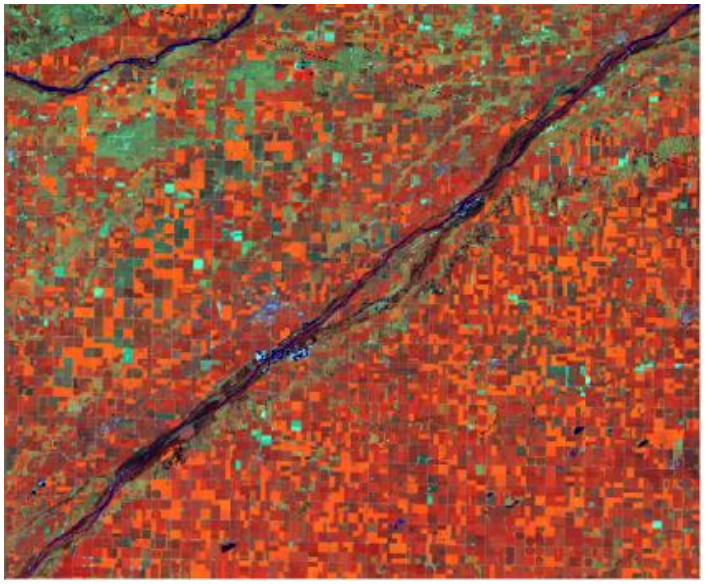
May 18



June 21



July 15



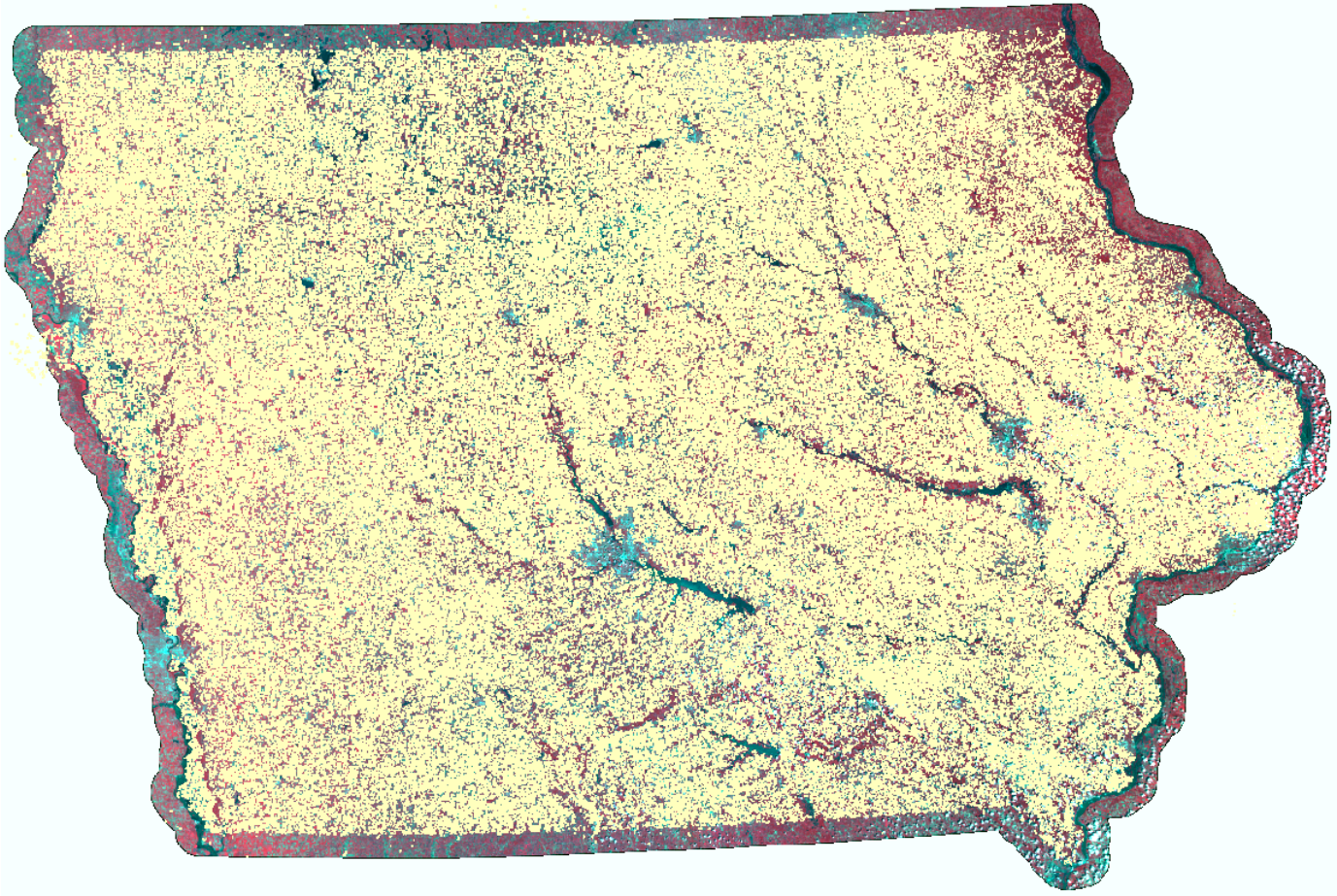
Aug 27

Sensor Specifications Compared

	TM	**AWiFS**
Altitude	705 km	817 km
Equatorial crossing time	9:45 ± 15 minutes	10:30 ± 5 minutes
Temporal Resolution	16 days	5 days
Spatial Resolution	30 x 30 m (reflective) 120 x 120 m (thermal)	56 x 56 m
Radiometric Resolution	8 bit (256)	10 bit (1024)
Spectral Resolution	6 (B, G, R, NIR, SWIR, MIR) + Thermal IR	4 (G, R, NIR,SWIR)
Swath wide	185 km	737 km
Scene size	184 x 152 km	370 x 370 km

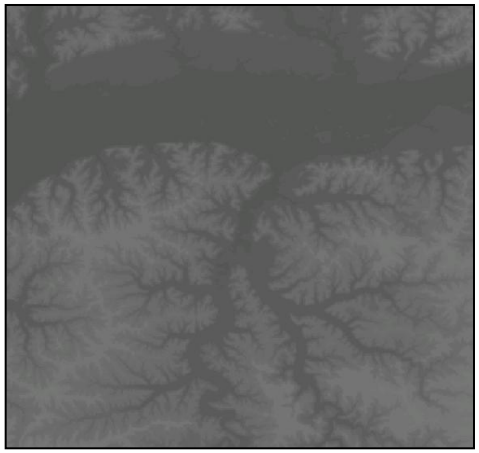
Agricultural Ground Truth
FSA Common Land Unit

USDA United States Department of Agriculture
Farm Service Agency

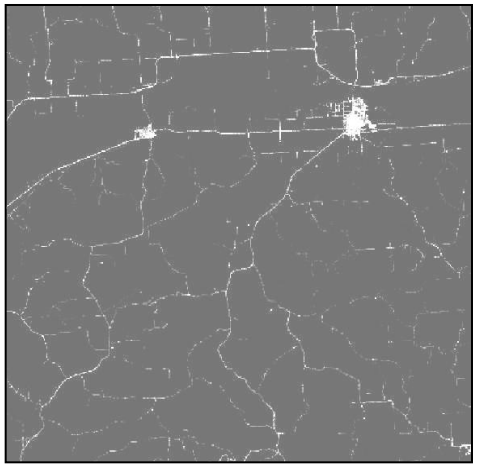


70% sample for training & 30% sample for testing
Comprehensive **program crop** coverage

Ancillary Data – USGS/NASA Products



Elevation

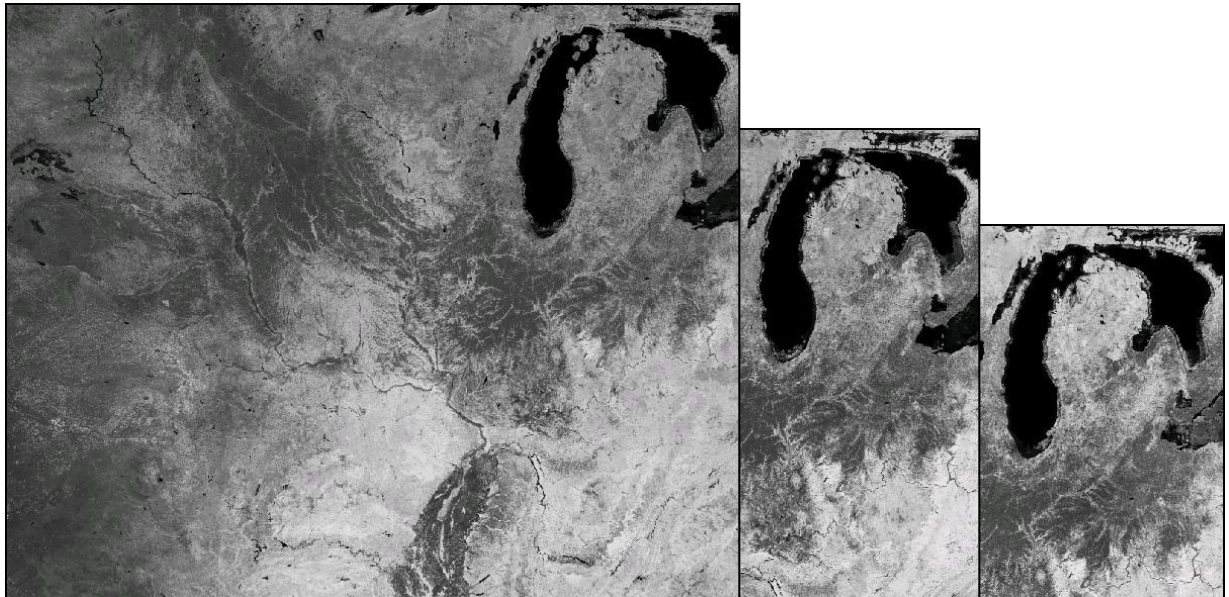


Imperviousness

Forest Canopy

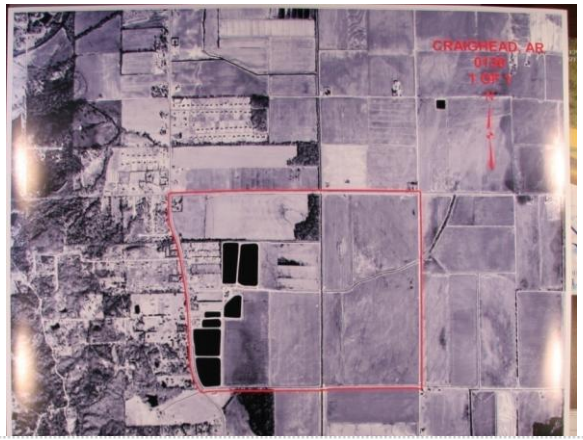
<u>2001 NLCD</u>
Improve CDL coverage of non-ag classes

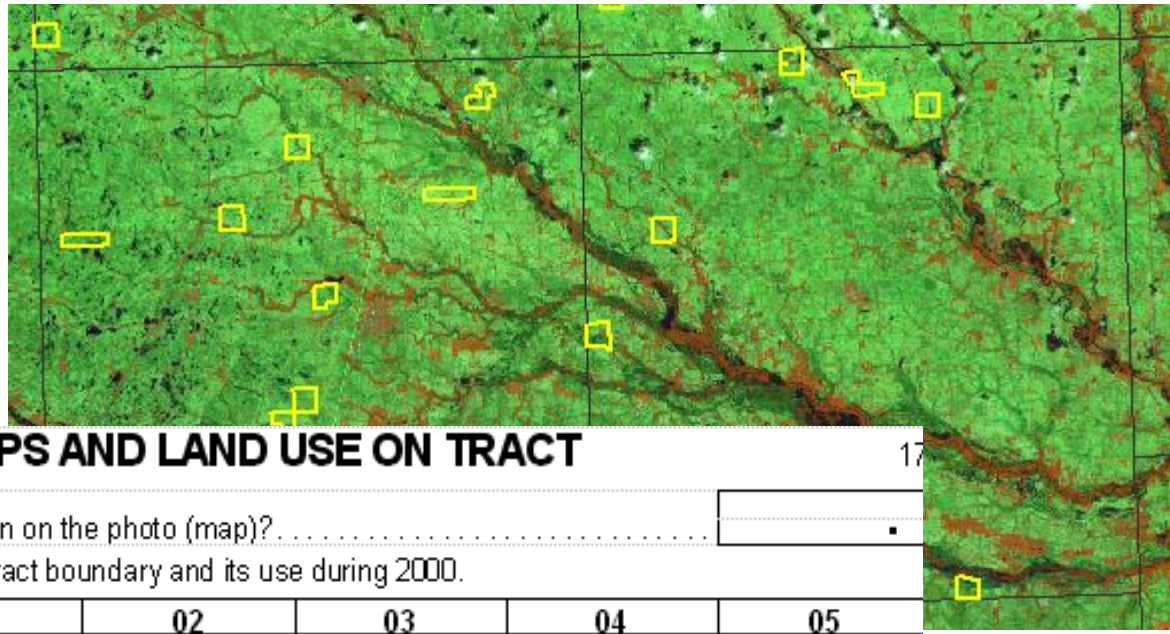
NASA MODIS Terra
(16-day NDVI composite)



NASS June Ag Survey

- Probability based
- Area frame stratification based on land use
- Sample units one square mile





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*]					

Data Partnerships

- Foreign Agricultural Service
  - Resourcesat-1 AWiFS

Linking U.S. Agriculture FAS to the World

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

USDA Farm Service Agency

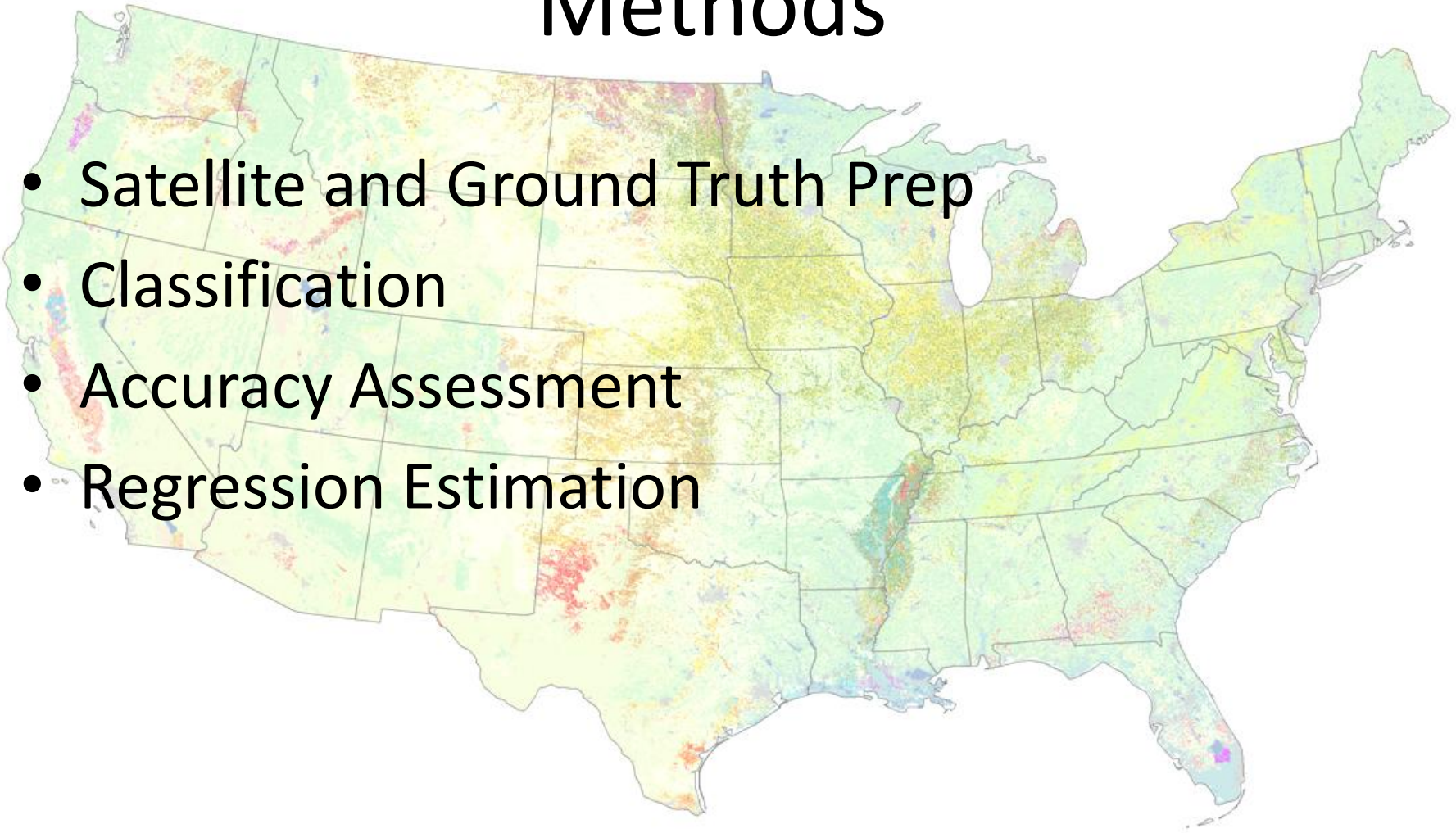
- US Geological Survey
  - National Land Cover Dataset

MRLC Consortium

- US Geological Survey/ NASA
  - Landsat TM 5 & 7

USGS science for a changing world NASA

Methods

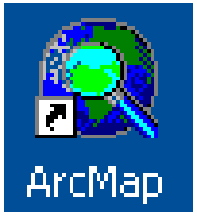


- Satellite and Ground Truth Prep
- Classification
- Accuracy Assessment
- Regression Estimation

Commercial Software Suite

- Imagery Preparation
  - ERDAS Imagine

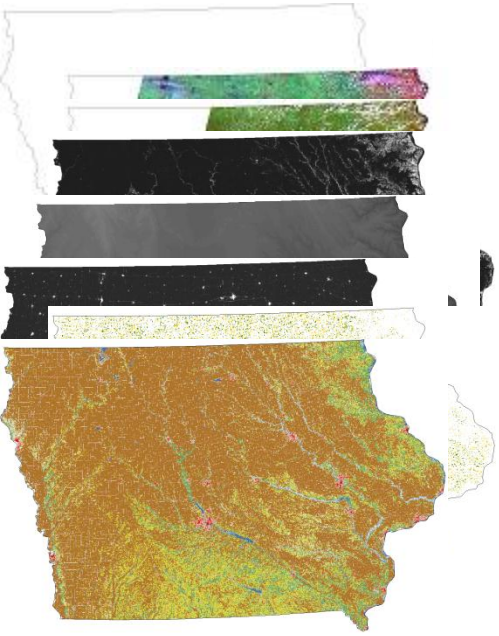
- Image classification
  - Decision tree software
    - See5 www.rulequest.com



- Ground Truth Preparation
  - ESRI ArcGIS

- Acreage Estimation
  - SAS

CDL Processing Method



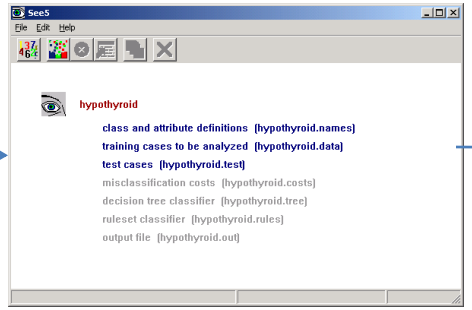
Sampling Done by

Satellite Imagery

Ancillary Data

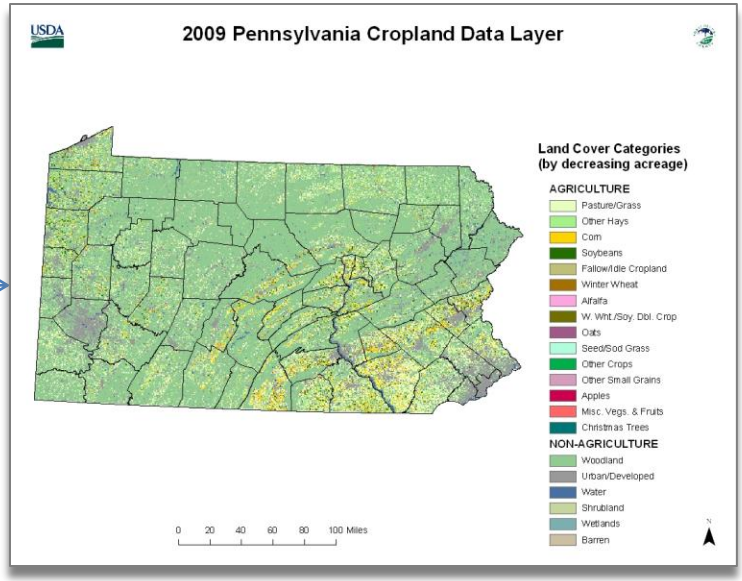
Ground Truth

See5



Decision Tree

Classification



Accuracy Statistics

Crop-specific covers only	*Correct	Accuracy	Error	Kappa
OVERALL ACCURACY**	2368649	83.10%	16.90%	0.7891

Cover Type	Attribute Code	*Correct Pixels	Producer's Accuracy	Omission Error	Kappa	User's Accuracy	Commission Error	Cond'l Kappa
Corn	1	460221	93.78%	6.22%	0.9272	94.47%	5.53%	0.9351
Sorghum	4	63253	57.82%	42.18%	0.5677	77.37%	22.63%	0.7660
Soybeans	5	1870	48.85%	51.15%	0.4882	94.02%	5.98%	0.9401
Sunflower	6	26389	61.28%	38.72%	0.6087	74.09%	25.91%	0.7375
Sweet Corn	12	905	54.75%	45.25%	0.5474	92.73%	7.27%	0.9272
Barley	21	7877	66.47%	33.53%	0.6636	71.55%	28.45%	0.7145
Durum Wheat	22	0	n/a	n/a	n/a	0.00%	100.00%	0.0000
Spring Wheat	23	2286	48.46%	51.54%	0.4839	49.02%	50.98%	0.4895
Winter Wheat	24	817165	92.79%	7.21%	0.9030	95.50%	4.50%	0.9389
Rye	27	285	14.57%	85.43%	0.1455	31.39%	68.61%	0.3135
Oats	28	4483	33.63%	66.37%	0.3344	47.41%	52.59%	0.4720
Millet	29	70479	79.66%	20.34%	0.7900	66.96%	33.04%	0.6606
Speltz	30	85	85.00%	15.00%	0.8500	49.13%	50.87%	0.4913
Canola	31	0	n/a	n/a	n/a	0.00%	100.00%	0.0000
Flaxseed	32	0	n/a	n/a	n/a	0.00%	100.00%	0.0000
Safflower	33	577	31.26%	68.74%	0.3120	19.97%	80.03%	0.1992
Alfalfa	36	174154	72.85%	27.15%	0.7109	85.82%	14.18%	0.8472
Other Hay	37	54825	39.87%	60.13%	0.3862	80.78%	19.22%	0.7995
Sugarbeets	41	4381	80.64%	19.36%	0.8061	83.04%	16.96%	0.8301
Dry Beans	42	12029	68.64%	31.36%	0.6844	54.83%	45.17%	0.5459
Potatoes	43	12742	85.17%	14.83%	0.8511	91.00%	9.00%	0.9096
Other Crops	44	0	0.00%	100.00%	0.0000	n/a	n/a	n/a
Misc. Vegs. & Fruits	47	0	n/a	n/a	n/a	0.00%	100.00%	0.0000
Watermelons	48	25	6.35%	93.65%	0.0634	39.68%	60.32%	0.3968

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

Accuracy Assessments

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

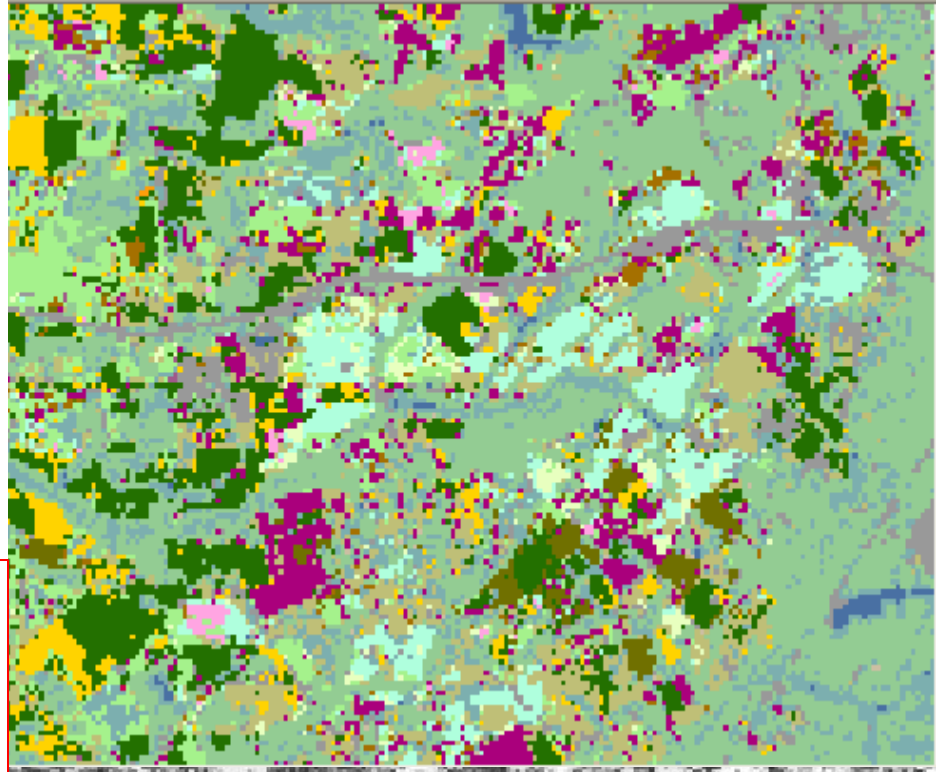
	Crop-specific covers only	*Correct	Accuracy	Error	Kappa
IA	OVERALL ACCURACY	3688803	95.74%	4.26%	0.9145
IL	OVERALL ACCURACY	3730093	97.05%	2.95%	0.9426
NE	OVERALL ACCURACY	3071960	94.05%	5.95%	0.8981
SD	OVERALL ACCURACY	2306428	87.51%	12.49%	0.8416

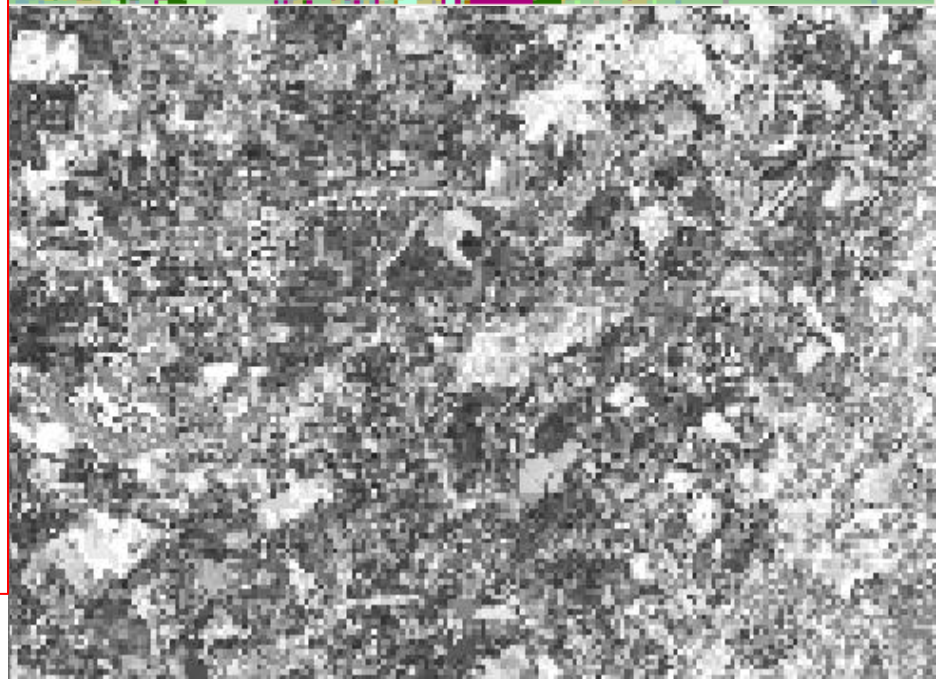
State level accuracies are very high

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.
Kappa Coefficient: A statistics measure of agreement, beyond chance, between two maps.

Confidence Layer

Defined not as a measure of accuracy for a given pixel;
but rather how well it fit within the decision tree ruleset.





Remote Sensing
Regression Estimation

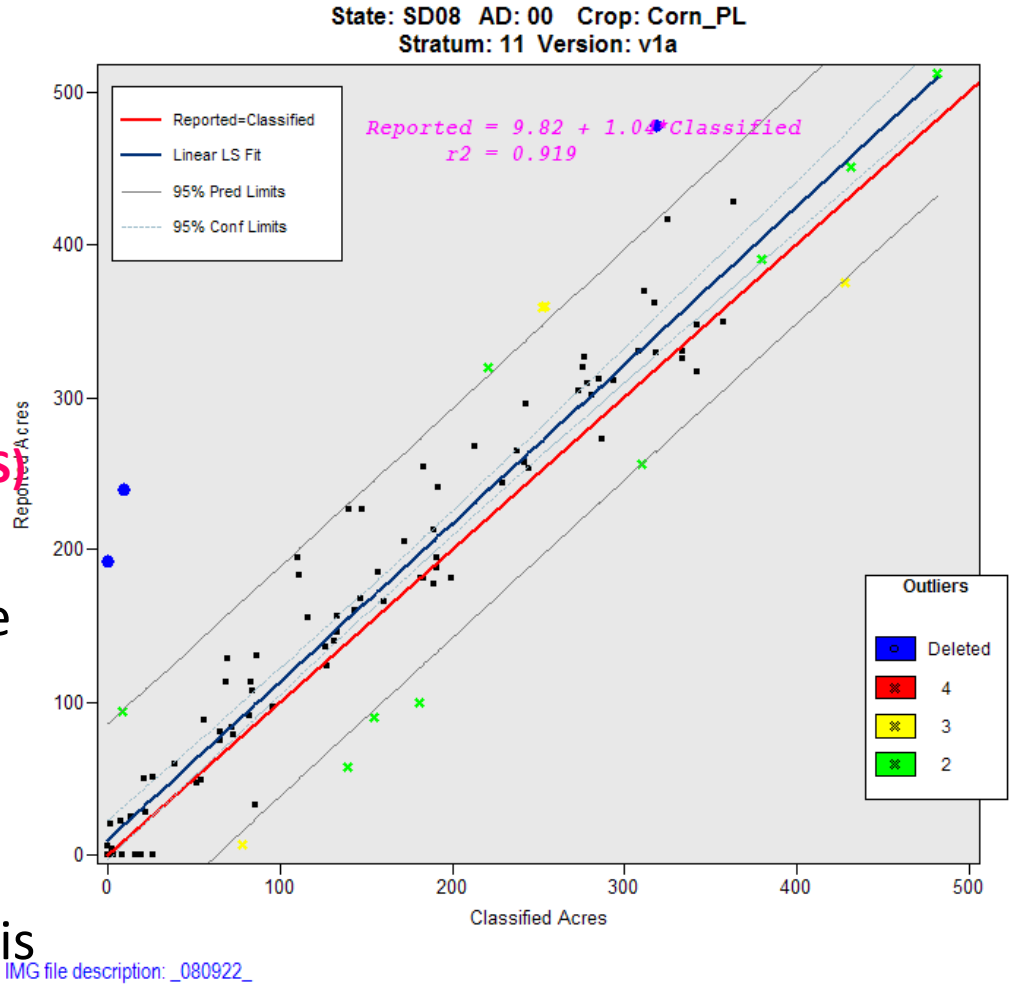
Regression-based Acreage Estimator

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**

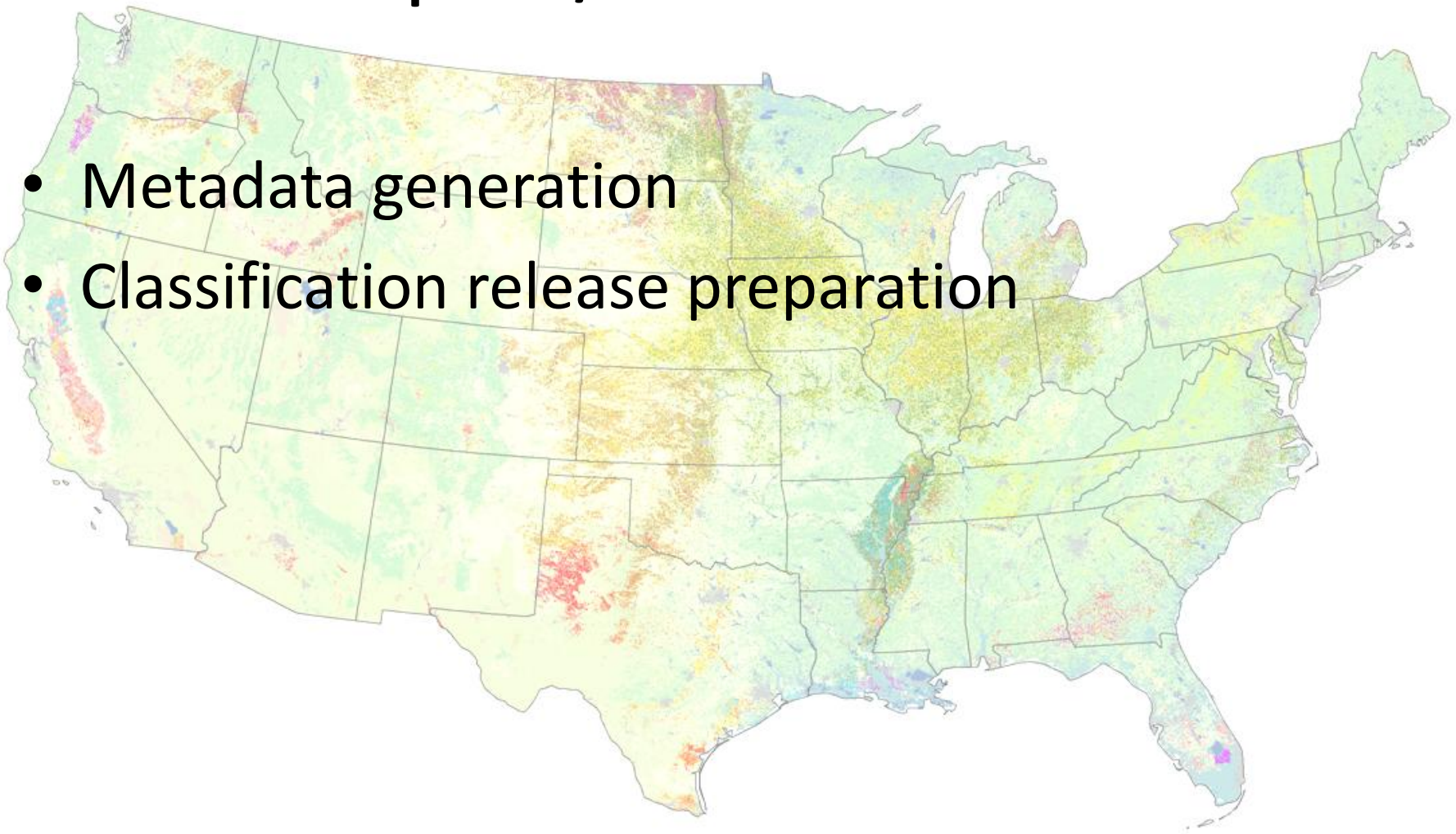
Using both CDL and JAS acreage results in estimates with reduced error rates over JAS alone

Outlier segment detection - removal from regression analysis



Acreage not just about counting pixels

Outputs/Dissemination



- Metadata generation
- Classification release preparation

CDL Metadata

- Published on each CDL product

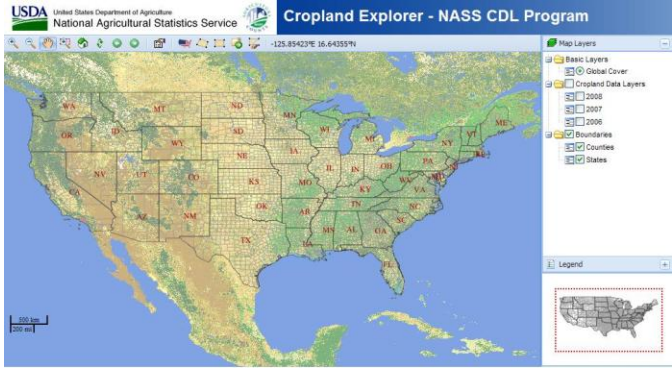
```
Raster
Attribute Domain Values and Definitions: ROW CROPS 1-20

Categorization Code   Land Cover
        "1"           Corn
        "2"           Cotton
        "3"           Rice
        "4"           Sorghum
        "5"           Soybeans
        "6"           Sunflowers
        "10"          Peanuts
        "11"          Tobacco
        "12"          Sweet Corn
        "13"          Popcorn or Ornamental Corn


Map_Projection_Name: Albers Conical Equal Area
Albers_Conical_Equal_Area:
Standard_Parallel: 29.500000
Standard_Parallel: 45.500000
Longitude_of_Central_Meridian: -96.000000
Latitude_of_Projection_Origin: 23.000000
False_Easting: 0.000000
False_Northing: 0.000000
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: row and column
Coordinate_Representation:
Abscissa_Resolution: 56
Ordinate_Resolution: 56
Planar_Distance_Units: meters
Geodetic_Model:
Horizontal_Datum_Name: North American Datum of 1983
Ellipsoid_Name: Geodetic Reference System 80
Semi-major_Axis: 6378137.000000
Denominator_of_Flattening_Ratio: 298.257223563
```

```
CLASSIFICATION INPUTS:
AWIFS DATE 20080413 PATH 264 ROW(S)&QUADRANT(S) 35b 40d 45bd
AWIFS DATE 20080418 PATH 265 ROW(S)&QUADRANT(S) 35bd 40abcd 45ab
AWIFS DATE 20080427 PATH 262 ROW(S)&QUADRANT(S) 40bd
AWIFS DATE 20080428 PATH 267 ROW(S)&QUADRANT(S) 40d 45bd
AWIFS DATE 20080503 PATH 268 ROW(S)&QUADRANT(S) 35bd 40bcd 45abc
AWIFS DATE 20080512 PATH 265 ROW(S)&QUADRANT(S) 40bcd 45abd
AWIFS DATE 20080517 PATH 266 ROW(S)&QUADRANT(S) 35d 40bd 45b
AWIFS DATE 20080606 PATH 270 ROW(S)&QUADRANT(S) 40d 45b
AWIFS DATE 20080614 PATH 262 ROW(S)&QUADRANT(S) 35bd 40bd 45b
AWIFS DATE 20080625 PATH 269 ROW(S)&QUADRANT(S) 40d 45b 50bd
AWIFS DATE 20080629 PATH 265 ROW(S)&QUADRANT(S) 40bd 45b
AWIFS DATE 20080704 PATH 266 ROW(S)&QUADRANT(S) 35a 40d 45bd
AWIFS DATE 20080713 PATH 263 ROW(S)&QUADRANT(S) 35abcd 40abd 45b
AWIFS DATE 20080715 PATH 273 ROW(S)&QUADRANT(S) 35cd 40abcd 45ab
AWIFS DATE 20080802 PATH 267 ROW(S)&QUADRANT(S) 35d 40abcd 45abc
AWIFS DATE 20080808 PATH 273 ROW(S)&QUADRANT(S) 35d 40bc 45a
AWIFS DATE 20080812 PATH 269 ROW(S)&QUADRANT(S) 35c 40ac 45a
AWIFS DATE 20080904 PATH 264 ROW(S)&QUADRANT(S) 40bd 45bd
AWIFS DATE 20080909 PATH 265 ROW(S)&QUADRANT(S) 35bd 40bd
AWIFS DATE 20080914 PATH 266 ROW(S)&QUADRANT(S) 40d 45bd
AWIFS DATE 20080915 PATH 271 ROW(S)&QUADRANT(S) 45bd 50b

MODIS 16 DAY NDVI COMPOSITE DATE 20071016
MODIS 16 DAY NDVI COMPOSITE DATE 20071101
MODIS 16 DAY NDVI COMPOSITE DATE 20071117
MODIS 16 DAY NDVI COMPOSITE DATE 20080305
MODIS 16 DAY NDVI COMPOSITE DATE 20080321
MODIS 16 DAY NDVI COMPOSITE DATE 20080406
MODIS 16 DAY NDVI COMPOSITE DATE 20080422
MODIS 16 DAY NDVI COMPOSITE DATE 20080508
MODIS 16 DAY NDVI COMPOSITE DATE 20080524
MODIS 16 DAY NDVI COMPOSITE DATE 20080609

USGS, NATIONAL ELEVATION DATASET ELEVATION
USGS, NATIONAL LAND COVER DATASET 2001 TREE CANOPY
USGS, NATIONAL LAND COVER DATASET 2001 IMPERVIOUSNESS
```

NASS Geospatial Dissemination Needs

- No online geospatial information access
  - No geospatial crop visualization & browsing
  - No geospatial query capability
  - No geospatial online analytics
- NASS needed…
  - Capabilities for on-line geospatial crop information access, geospatial query and on-line analytics via interactive maps
  - Disseminate all data to decision makers and users via real time retrieval, processing and publishing over the web through standards-based geospatial web services

CropScape

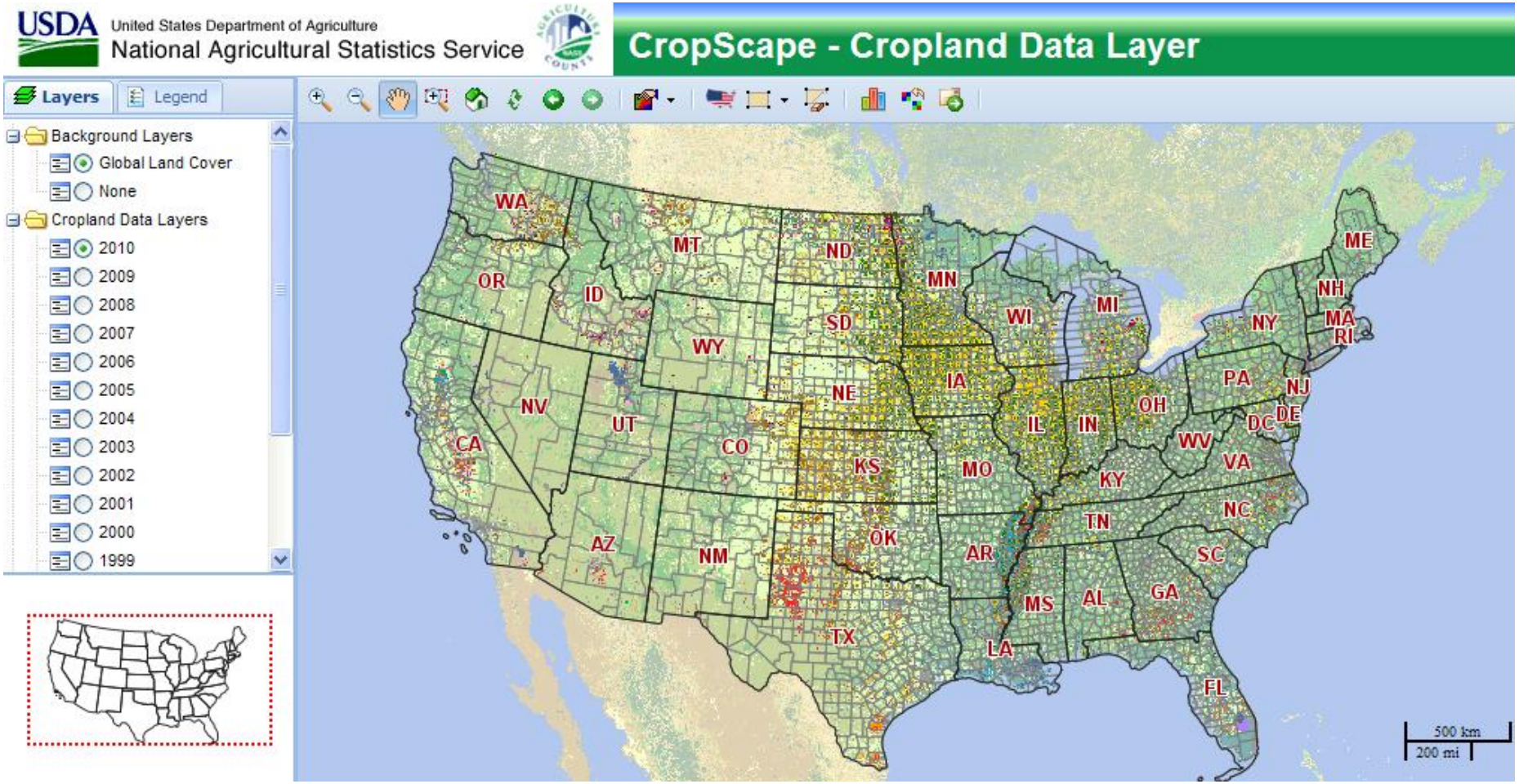


- Develop CropScape web portal
- A web service based interactive map visualization, dissemination and querying system for U.S. cropland
  - No burden on users
    - No client software development & installation
    - No special software tools needed
  - Equitable cropland information access, automatic and timely delivery, geospatial navigation, retrieval, queries and dissemination
- Collaboration with George Mason University/ Center for Spatial Information Science and Systems

CropScape Cont.

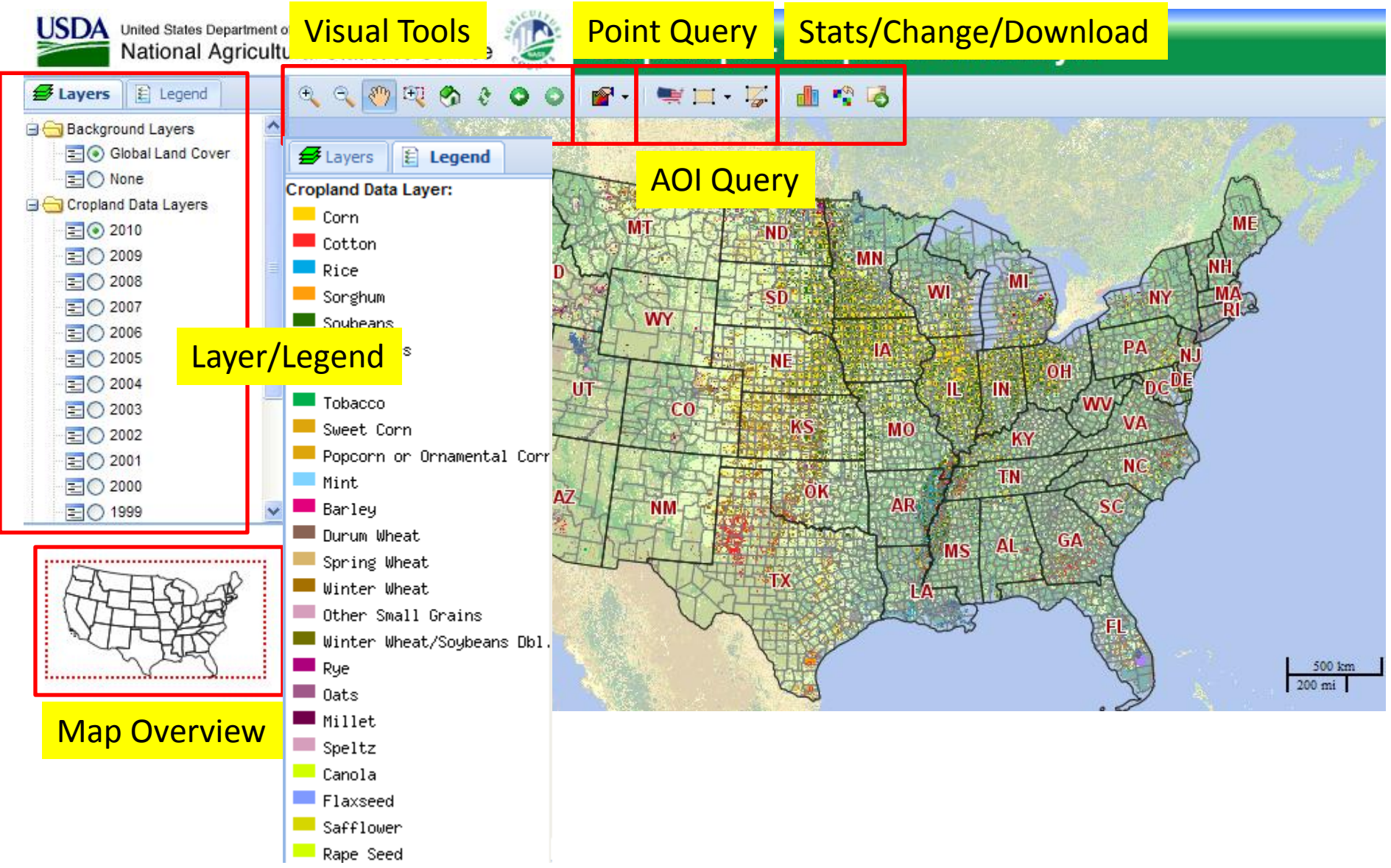
- State of the art CDL visualization, querying and dissemination tool
- Interactive geospatial statistical analysis tools
  - Online/interactive analytics, charting and mapping
  - Geospatial information access, navigation
  - CDL map and statistical result retrieval and dissemination web services
- Open geospatial standards compliant

CropScape Portal

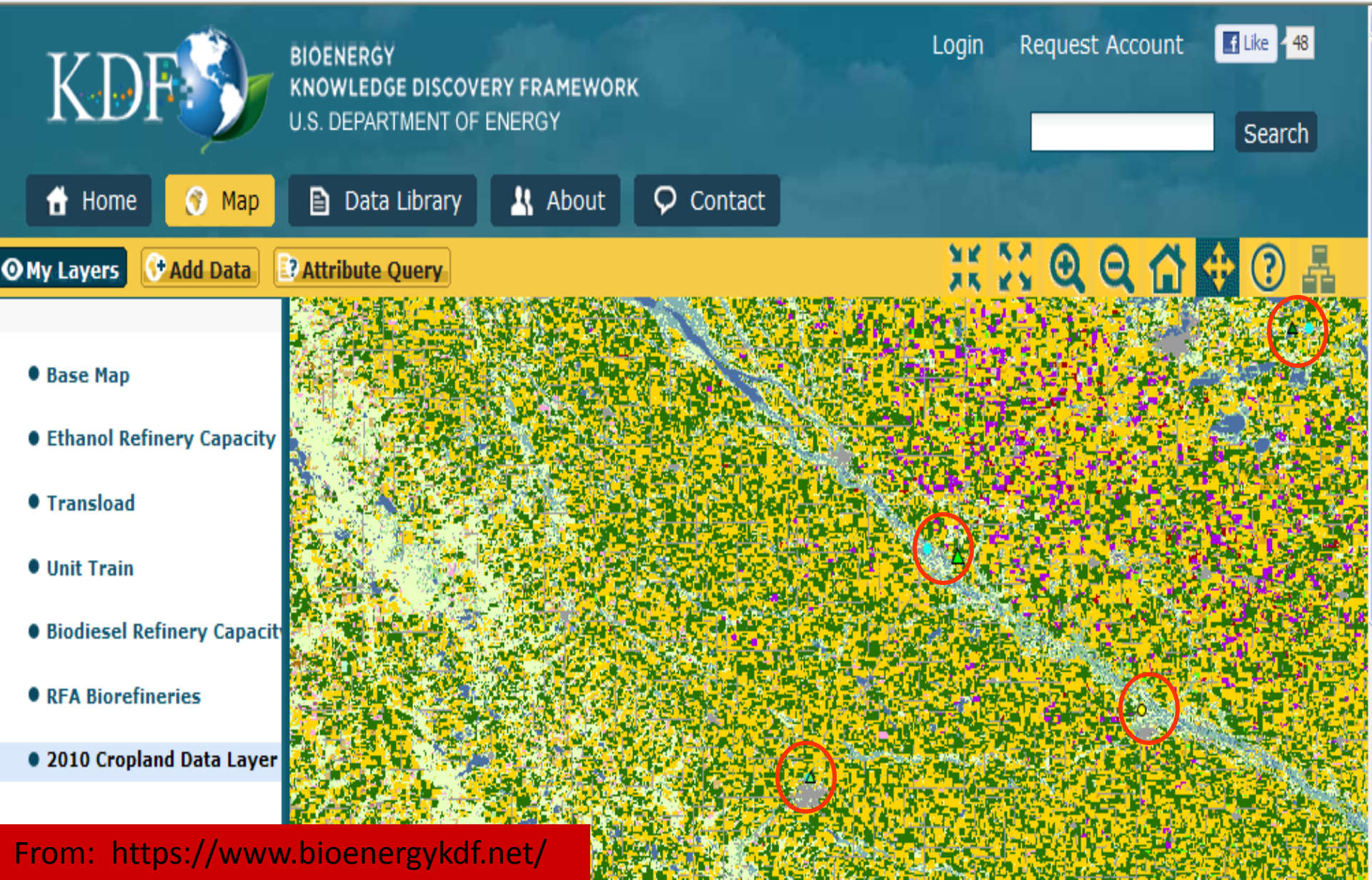


Harmonize ALL historical CDL products to standards:
color scheme, categories, projection, metadata

CropScape Portal Defined

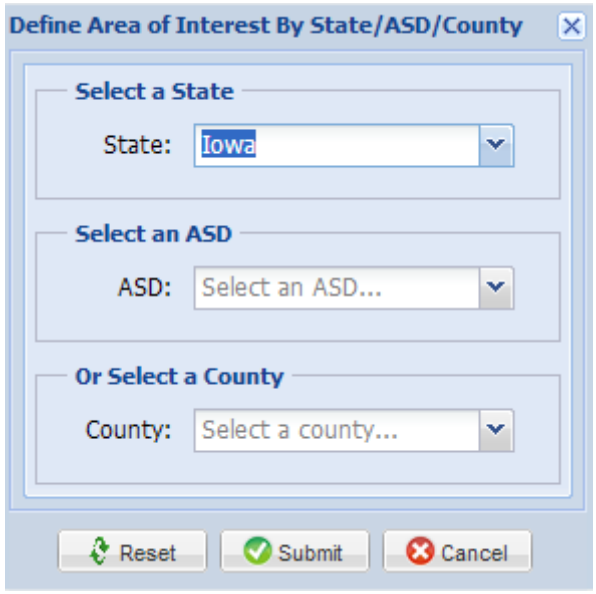


CropScape Mashups

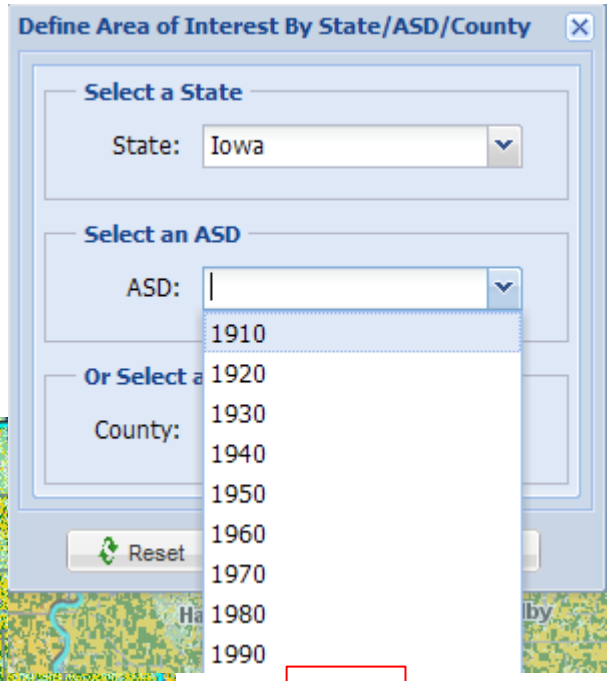


From: https://www.bioenergykdf.net/

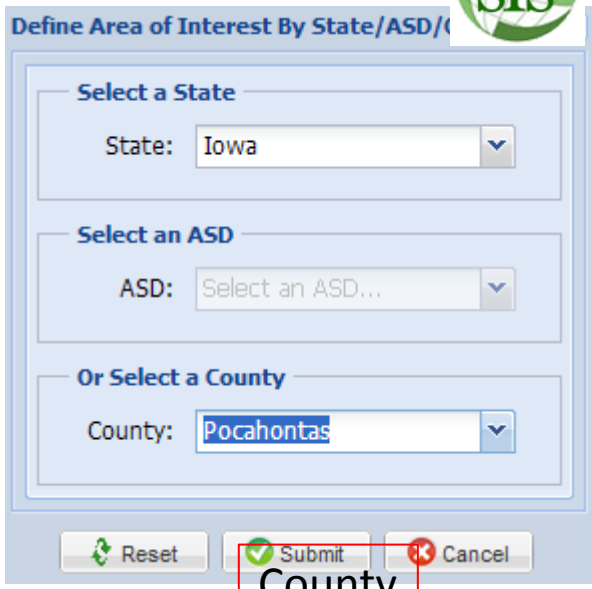
Select Area of Interest



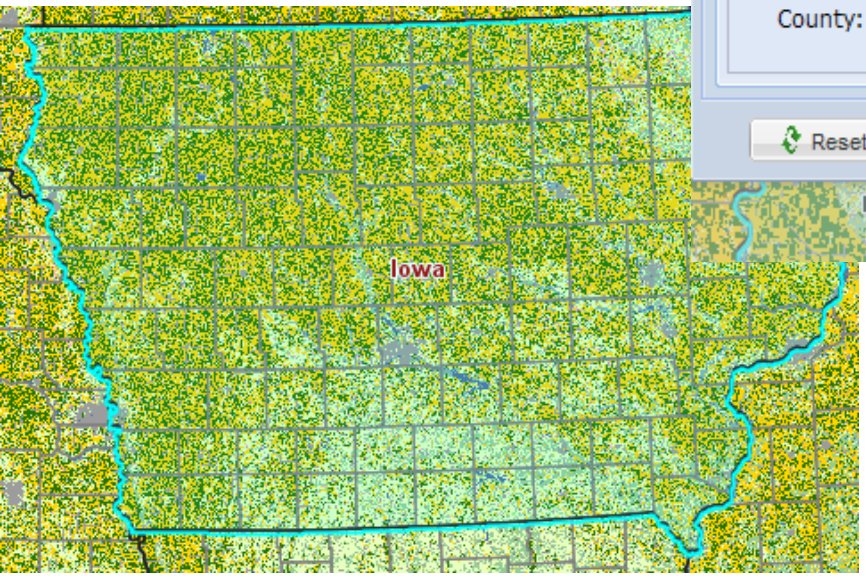
State

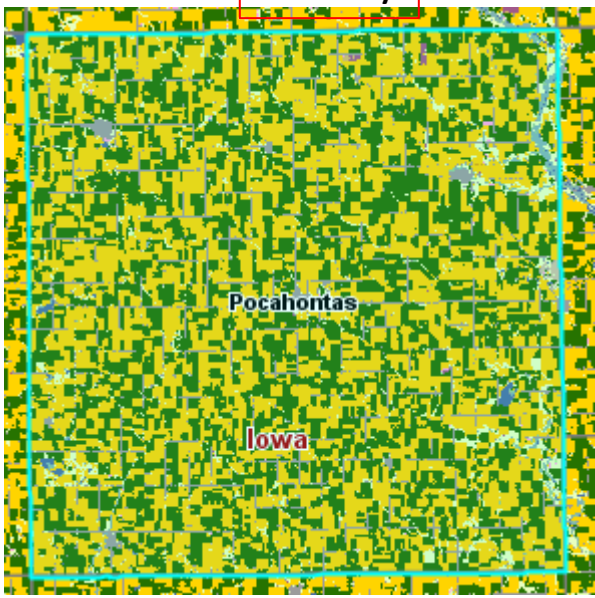


ASD



County





USDA

www.nassgeodata.gmu/CropScape

AGRICULTURE COUNTS NASS

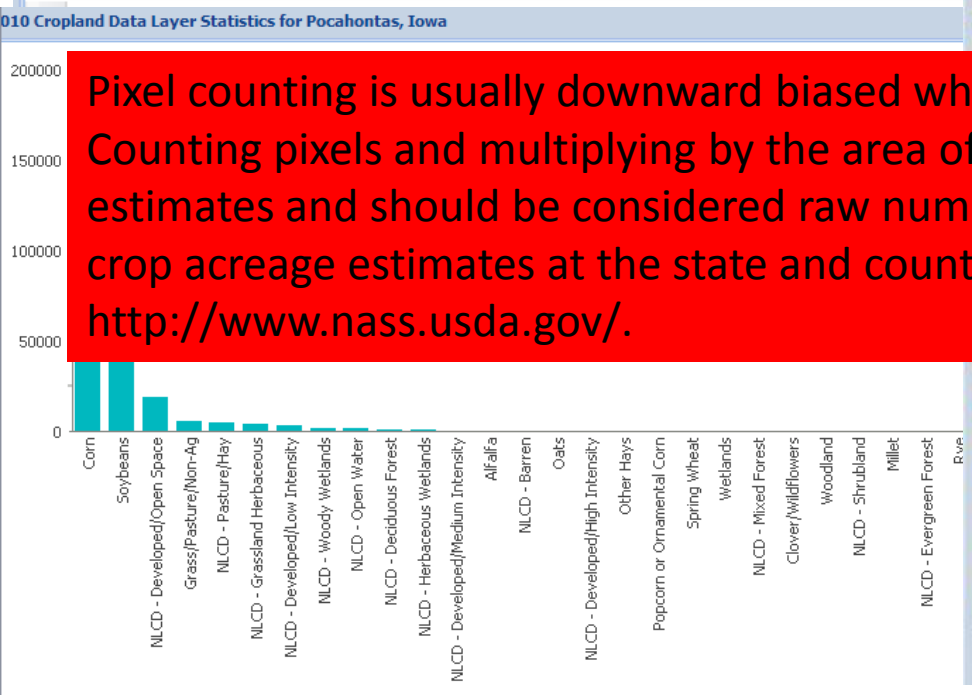
CropScape Stats

Pie/Histogram/Graphic

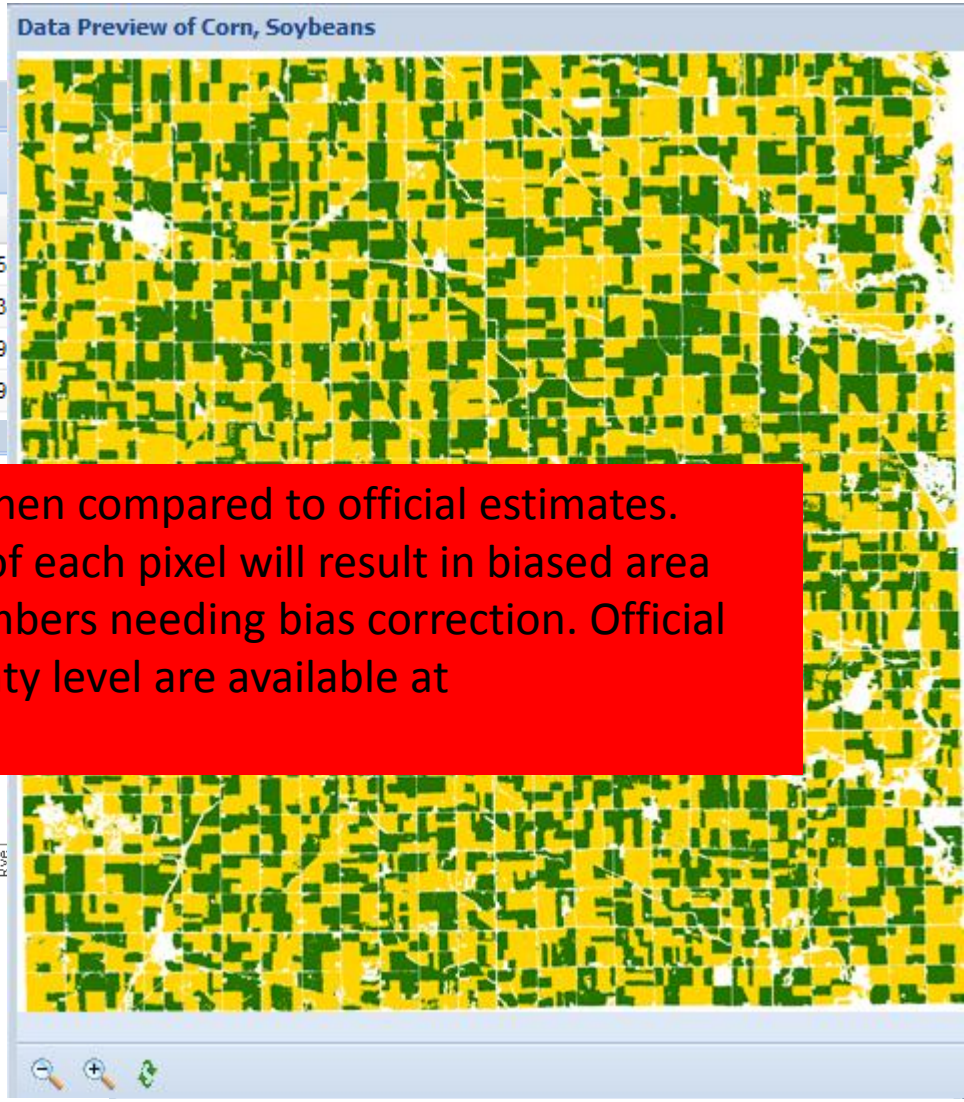
2010 Cropland Data Layer Statistics for Pocahontas, Iowa

Note: Pixel counts are not official estimates.

Value	Category	Pixel Counts	Acreage
1	Corn	807149	179505
5	Soybeans	669233	148833
121	NLCD - Developed/Open Space	84172	18719
62	Grass/Pasture/Non-Ag	23425	5209

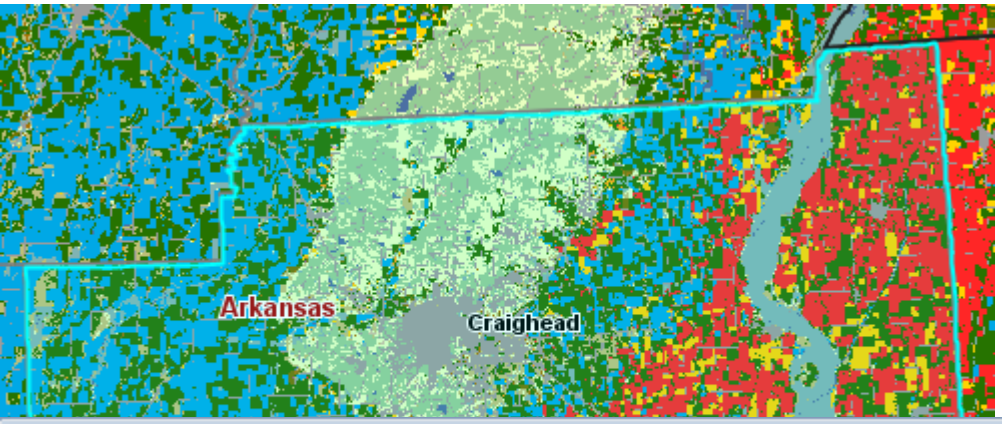


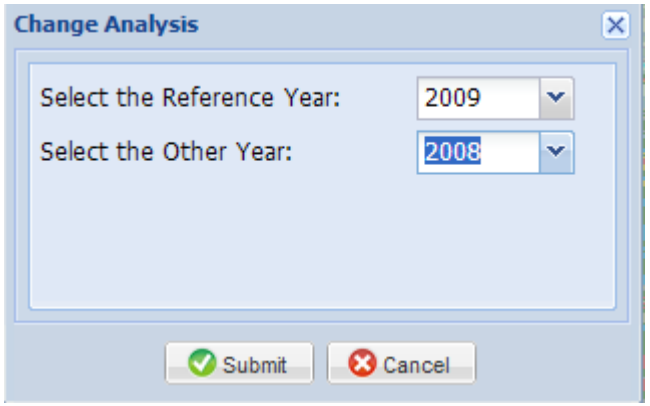
Pixel counting is usually downward biased when compared to official estimates. Counting pixels and multiplying by the area of each pixel will result in biased area estimates and should be considered raw numbers needing bias correction. Official crop acreage estimates at the state and county level are available at http://www.nass.usda.gov/.



nassgeodata.gmu/CropScape

CropScape Change Analysis



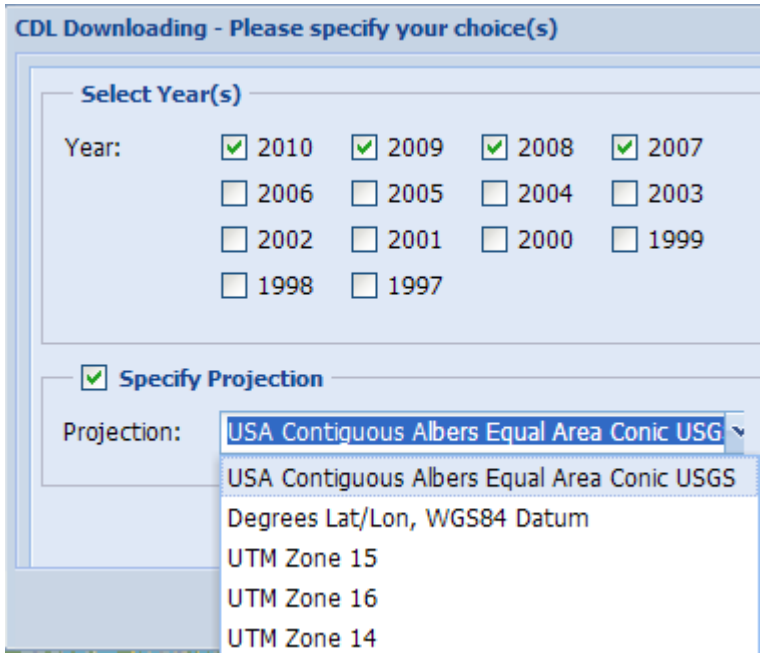


Cropland Data Layer Changes between 2009 and 2008

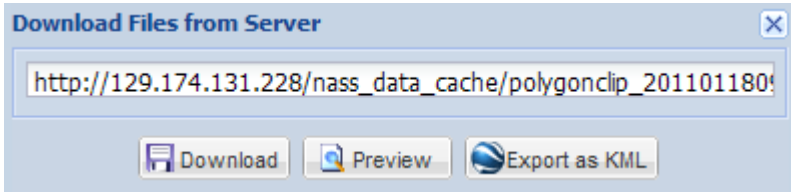
Note: Pixel counts are not official estimates.

2009	2008	Pixel Counts	Acreage
Rice	Soybeans	133502	103453.6
Soybeans	Rice	129916	100674.7
Cotton	Cotton	120872	93666.3
Soybeans	Soybeans	106428	82473.4
NLCD - Developed/Open Space	NLCD - Developed/Open Space	85414	66189.2
NLCD - Woody Wetlands	NLCD - Woody Wetlands	83660	64830
NLCD - Deciduous Forest	NLCD - Deciduous Forest	73312	56811.1
Other Hays	Other Hays	61496	47654.6
Rice	Rice	39116	30311.8
		1177212	**912239.6**

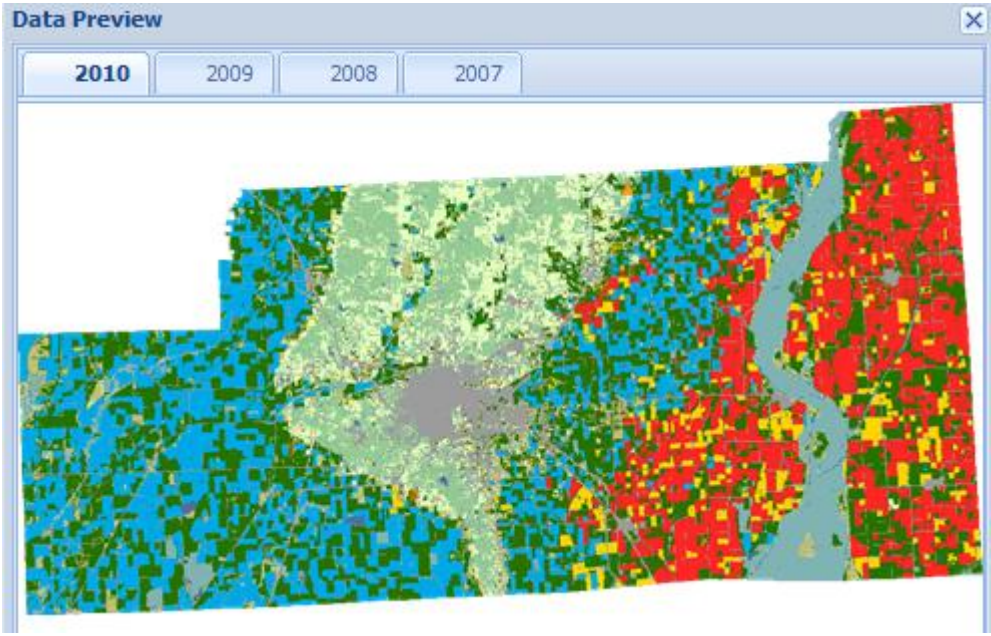
CropScape Download & Export



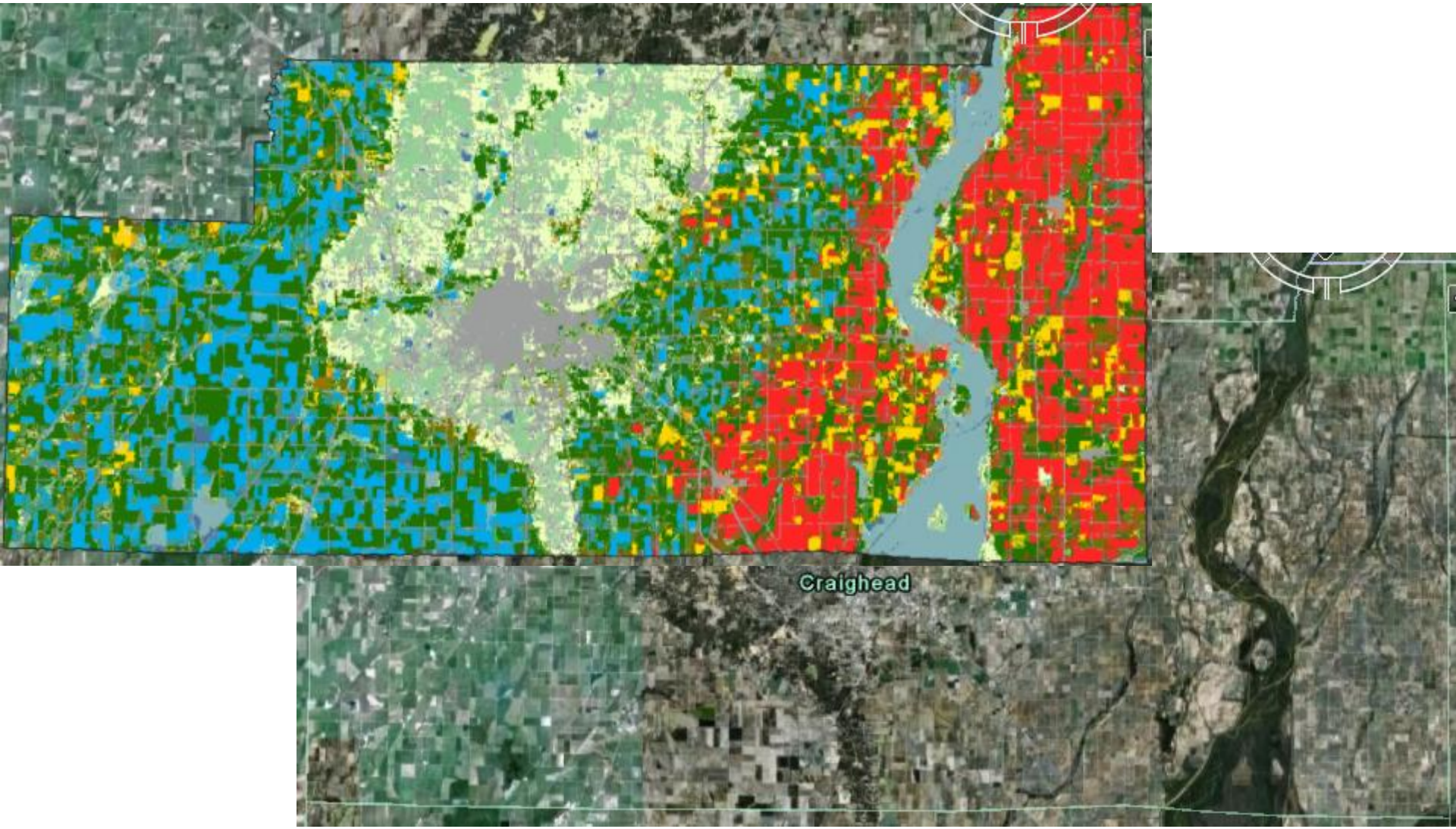
Specify Years and Projection



Preview and Download



CropScape w/ Google Earth



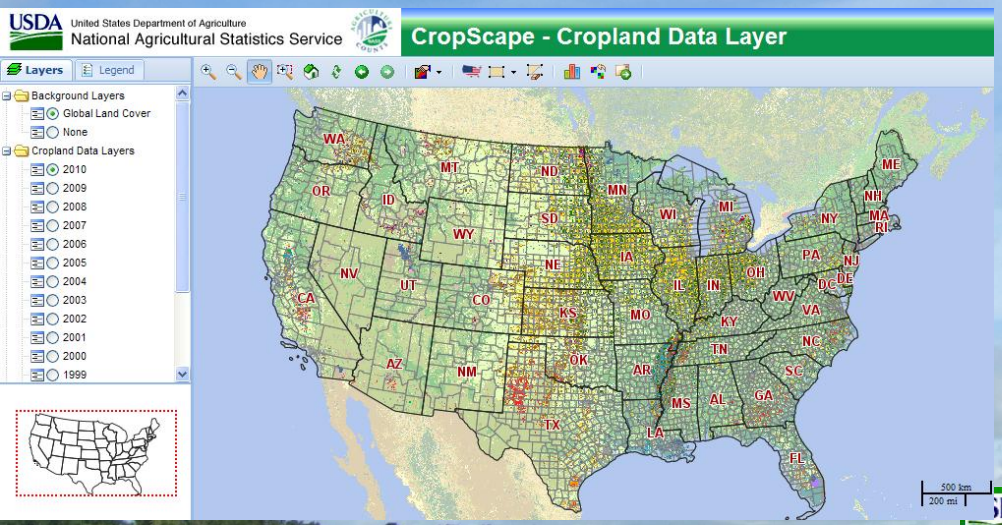
nassgeodata.gmu/CropScape

CropScape Future

- Enhance existing functions
  - Change analysis mapping
  - Online map generation for production & printing
- Add new capabilities
  - Multi-county analysis
  - Client data layer mash-up (capability to add data by user)
  - Multi-year crop acreage statistical change graphics for state, county, or area
- Feasibility study for hosting on commercial cloud computing service, such as Amazon Cloud

CDL Distribution

- http://nassgeodata.gmu.edu/CropScape
- http://datagateway.nrcs.usda.gov
- http://www.nass.usda.gov/Research_and_Science



Thank you!

Spatial Analysis Research Section
USDA/NASS R&D Division

nassgeodata.gmu/CropScape