Fallowed Area Mapping for Drought Impact Reporting and Decision Making

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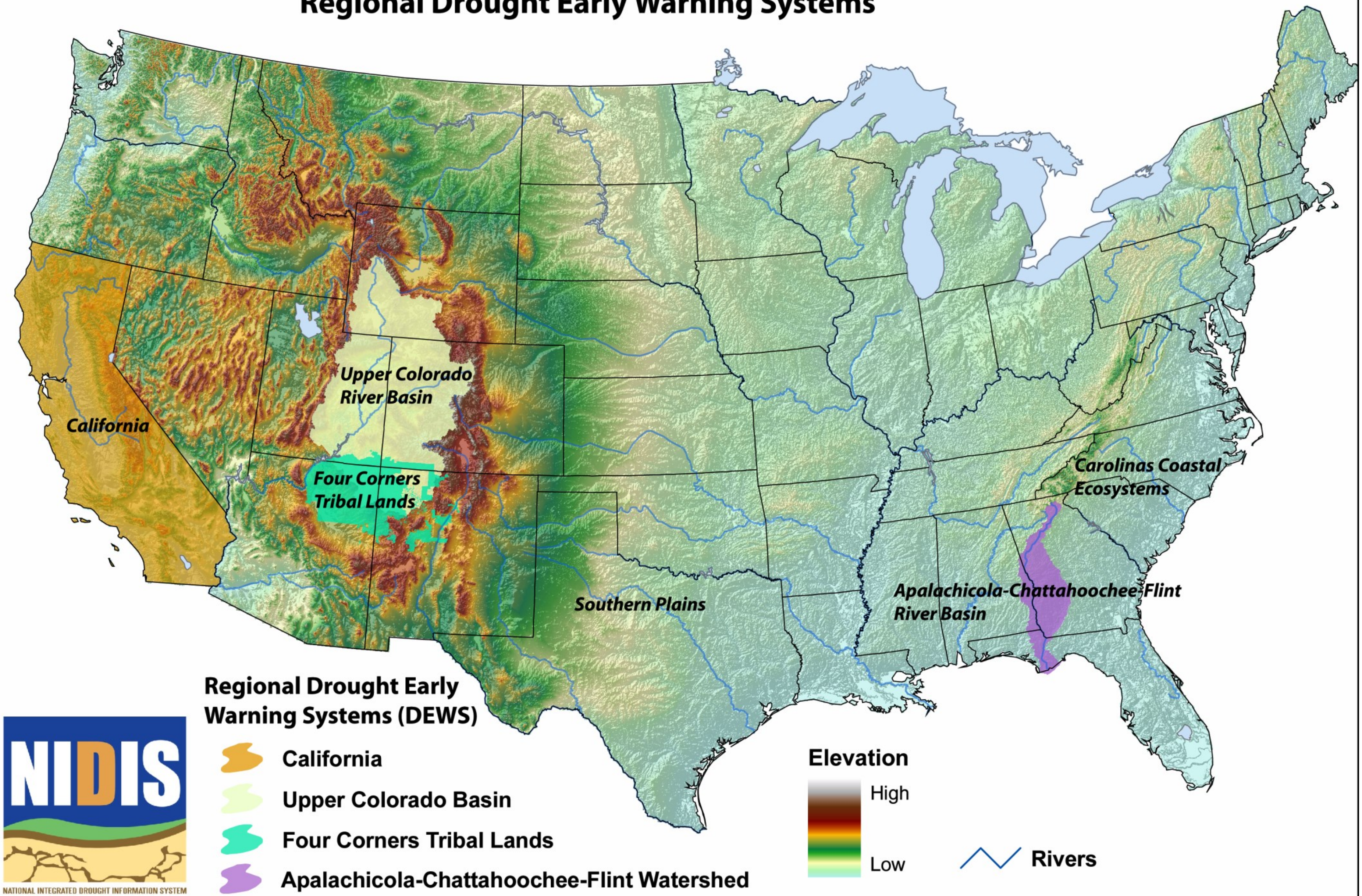
U.S. Geological Survey

WSWC Quantifying Drought Impacts Workshop

San Diego, CA, Aug. 6, 2013

National Integrated Drought Information System (NIDIS)
Regional Drought Early Warning Systems



Map courtesy of the USGS/Michael Budde

Drought Impacts on Land Fallowing

- **Background:** Mapping of fallowed areas during drought identified as a research priority for NIDIS by CA Department of Water Resources (CDWR)

- **Information needed:** Product similar to ‘idle lands’ class in NASS crop data layer for California, but on a monthly basis during growing season

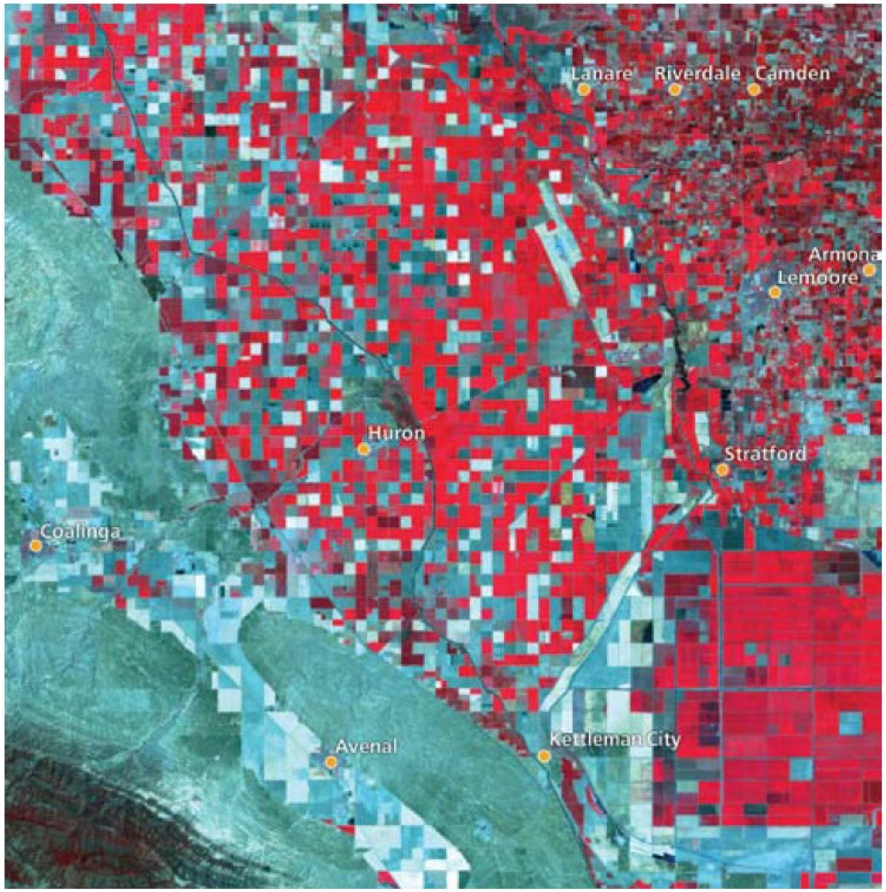
- **Project objective:** apply satellite data to provide information that will allow CDWR and other stakeholders to identify extent of, or change from historical conditions in, fallowed acreage due to water shortage

Drought Impacts on Land Fallowing

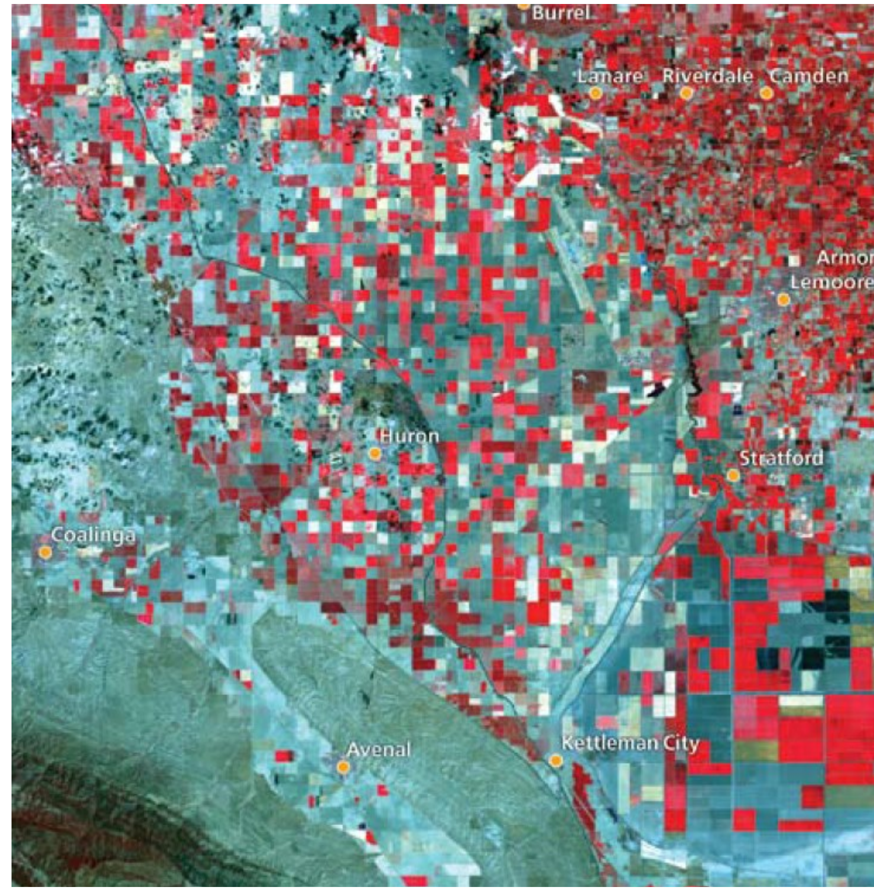
- **Decisions supported**:
  - State concurrence in county-level requests for USDA drought disaster designations
  - State proclamations of emergency pursuant to the California Emergency Services Act
  - State priorities for providing assistance with and processing of local water transfer requests

- **Limitations of previously available information:**
  - USDA NASS Cropland data layer (CDL) considered confidential and market sensitive during the growing season
  - Fallowed acreage reports from other sources do not follow standard definitions or data collection methods → often generate conflicting estimates

The Landsat View



2007

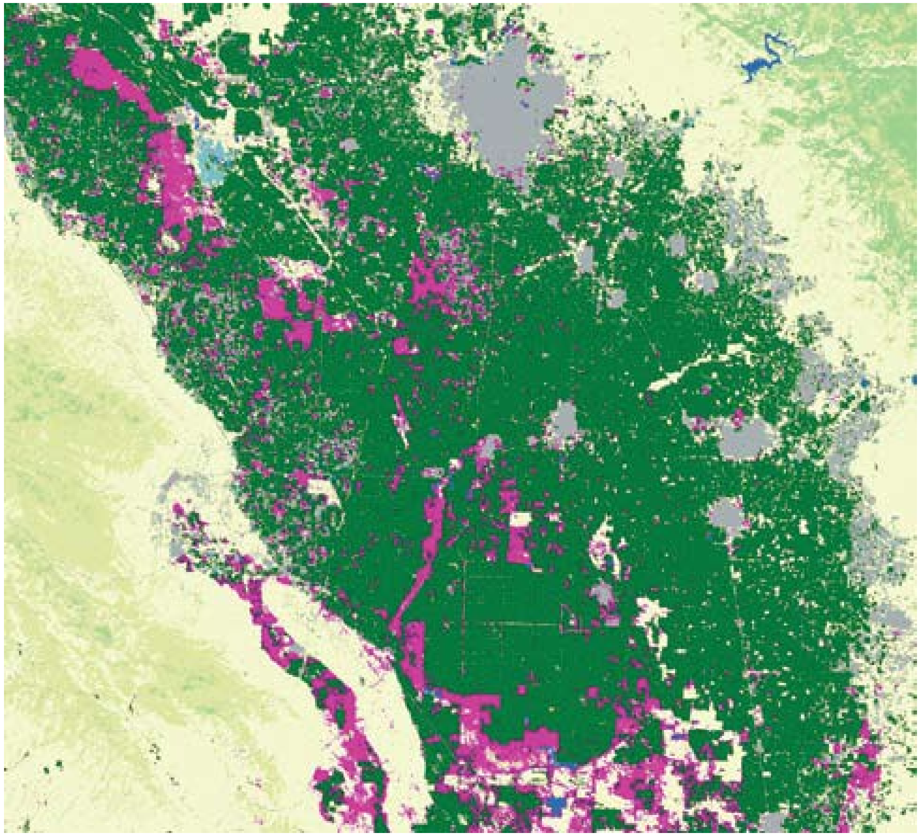


2009

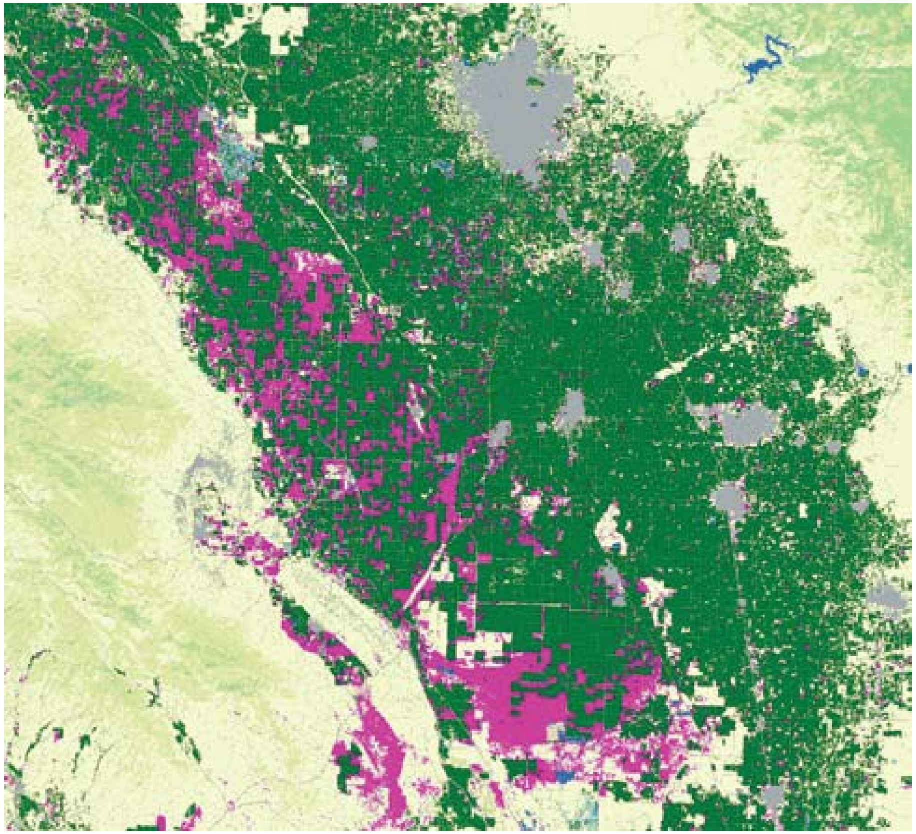
From: **California's Drought of 2007-2009: An Overview**

California Department of Water Resources, 2010

USDA NASS fallowed land mapping



2007



2009

From: **California's Drought of 2007-2009: An Overview**

California Department of Water Resources, 2010

Stakeholder requirements

- Monthly tabular acreage summaries by county for April - September
- Latency of no more than two weeks
- Uncertainty as high as +/- 25% is tolerable
- Historical figures required for context

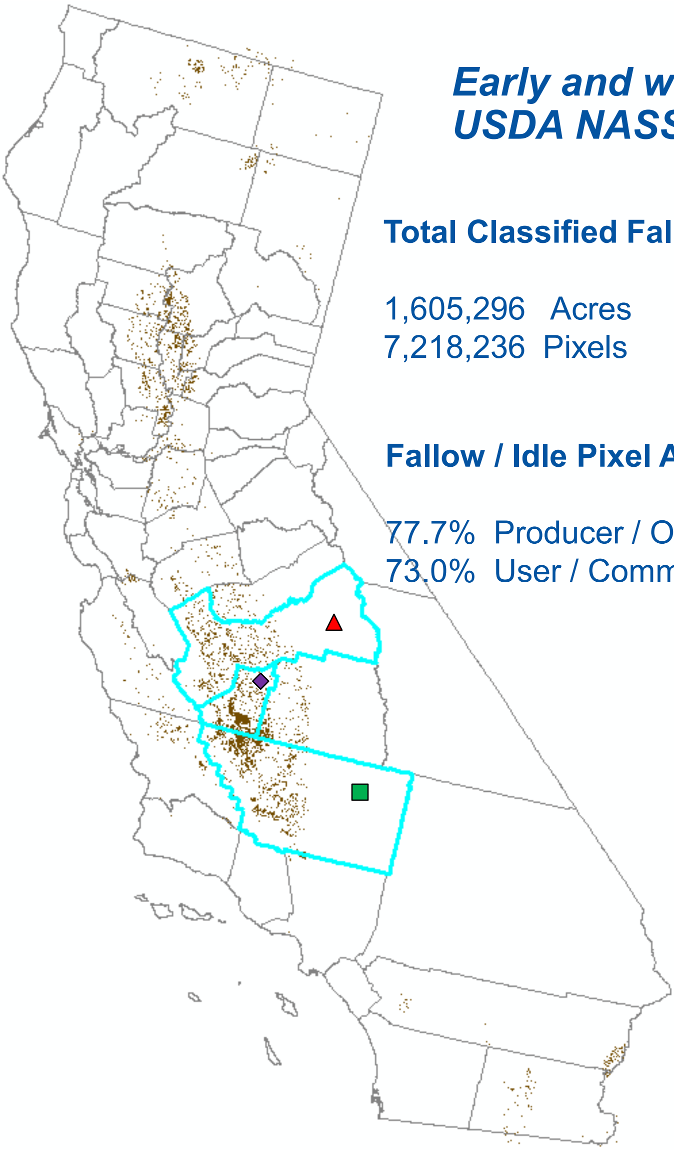
Approach

- **Within-season estimates for June, August, September from USDA NASS using CDL infrastructure**
  - USDA Farm Service Agency (FSA) data used in training decision tree algorithms for each year

- **Early-season estimates for March – May developed by NASA Ames Research Center**
  - Decision tree algorithms applied to timeseries of satellite data
  - Classification accounts for field conditions during reference period

2012 USDA NASS CDL Fallow Acreage

Early and within-season monthly maps of fallow acreage developed by USDA NASS team. Data available for June in early July.



Total Classified Fallow / Idle

1,605,296 Acres
7,218,236 Pixels

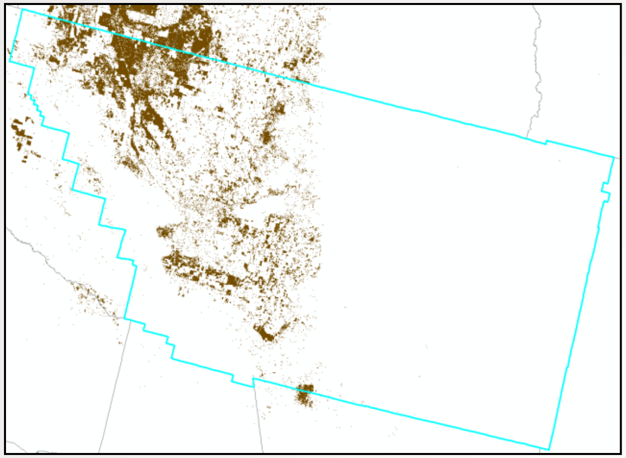
Fallow / Idle Pixel Accuracy

77.7% Producer / Ommision
73.0% User / Commission

Total Fallow Acres by CDL Iteration

	Cropland Data Layer Iterations		
County	September	August	June
Kern	366,649	345,599	322,500
Fresno	208,711	191,436	196,443
Kings	203,170	159,347	142,714
Tulare	113,399	124,151	110,825
Butte	80,742	76,546	52,709
Yolo	67,341	58,611	69,525
Sutter	52,897	45,125	32,613
Siskiyou	45,175	46,852	49,840
Colusa	43,493	40,556	22,546
Glenn	38,048	38,240	25,552

2012 September NASS CDL Fallow Acreage



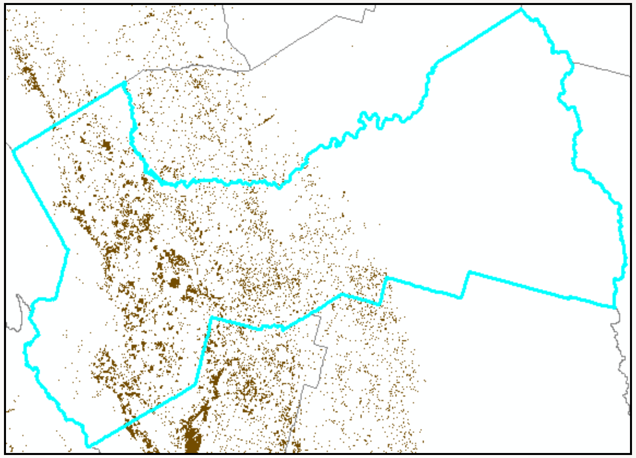
Kern County

Total Classified Fallow / Idle

366,649 Acres
1,648,644 Pixels

Fallow / Idle Pixel Accuracy

84.3% Producer / Omission
66.3% User / Commission



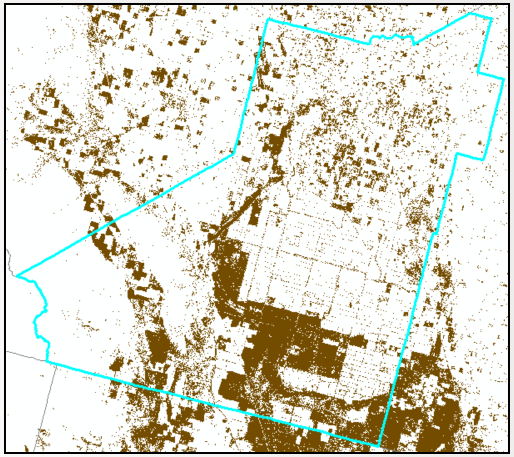
Fresno County

Total Classified Fallow / Idle

208,711 Acres
938,472 Pixels

Fallow / Idle Pixel Accuracy

69.6% Producer / Omission
59.7% User / Commission



Kings County

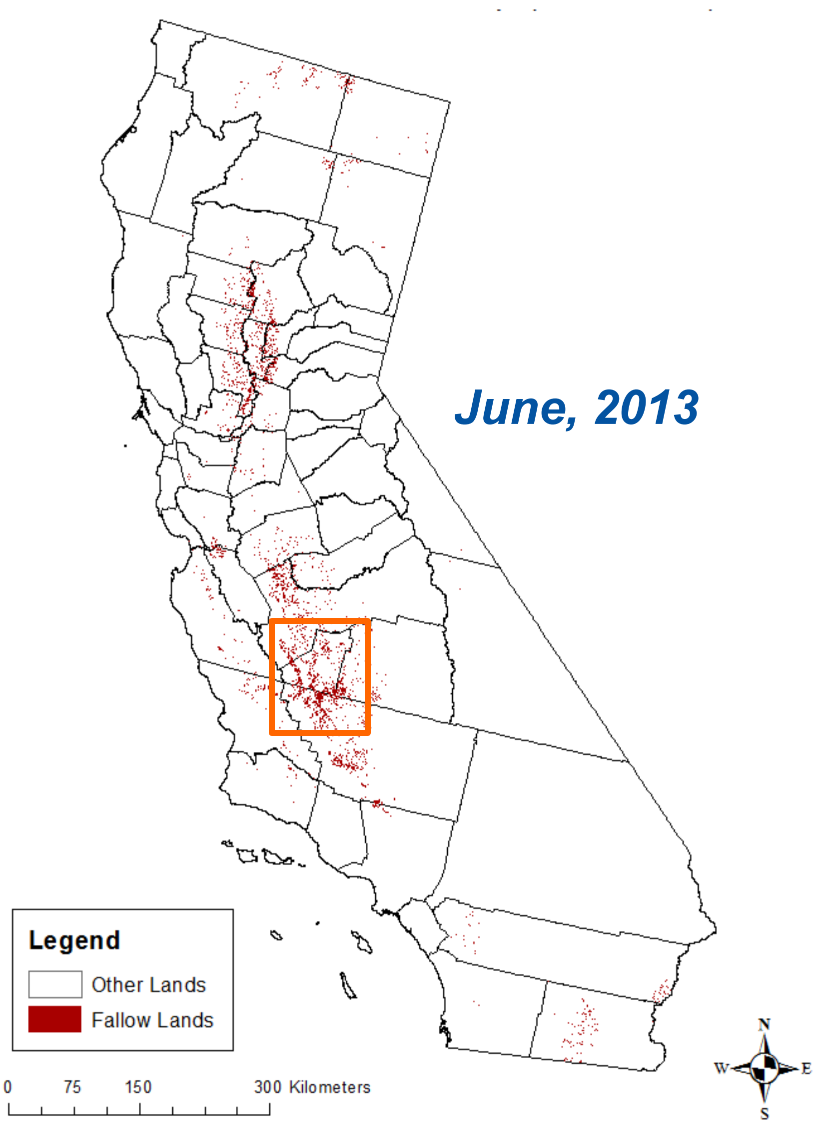
Total Classified Fallow / Idle

203,170 Acres
913,556 Pixels

Fallow / Idle Pixel Accuracy

85.4% Producer / Omission
60.1% User / Commission

2013 USDA NASS CDL Fallow Acreage

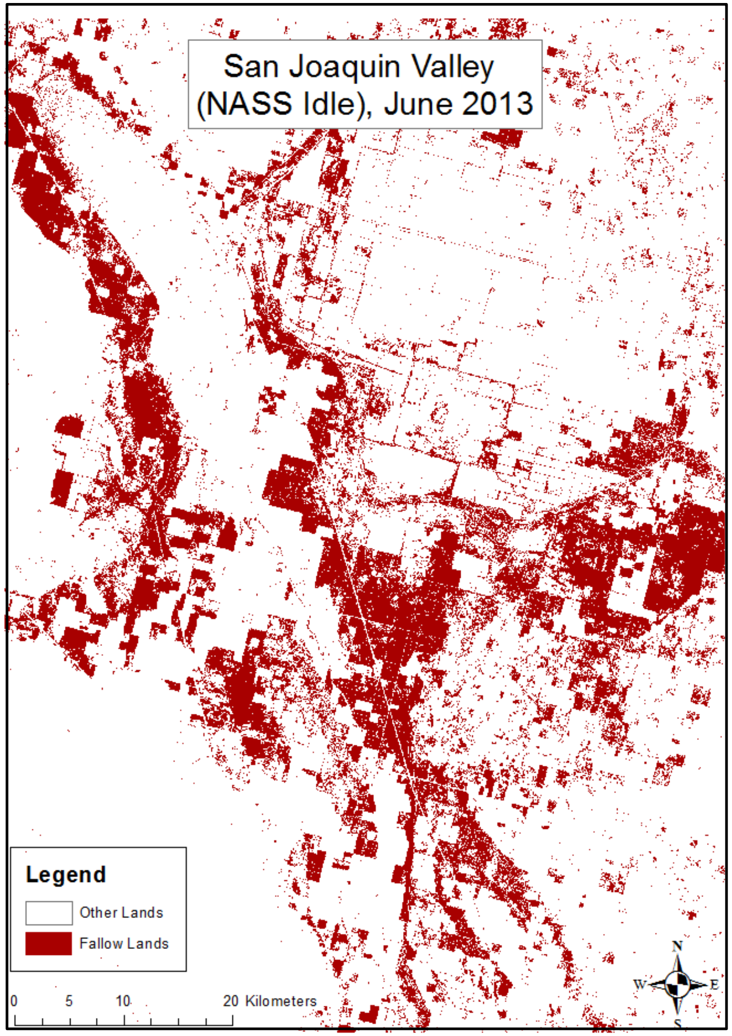


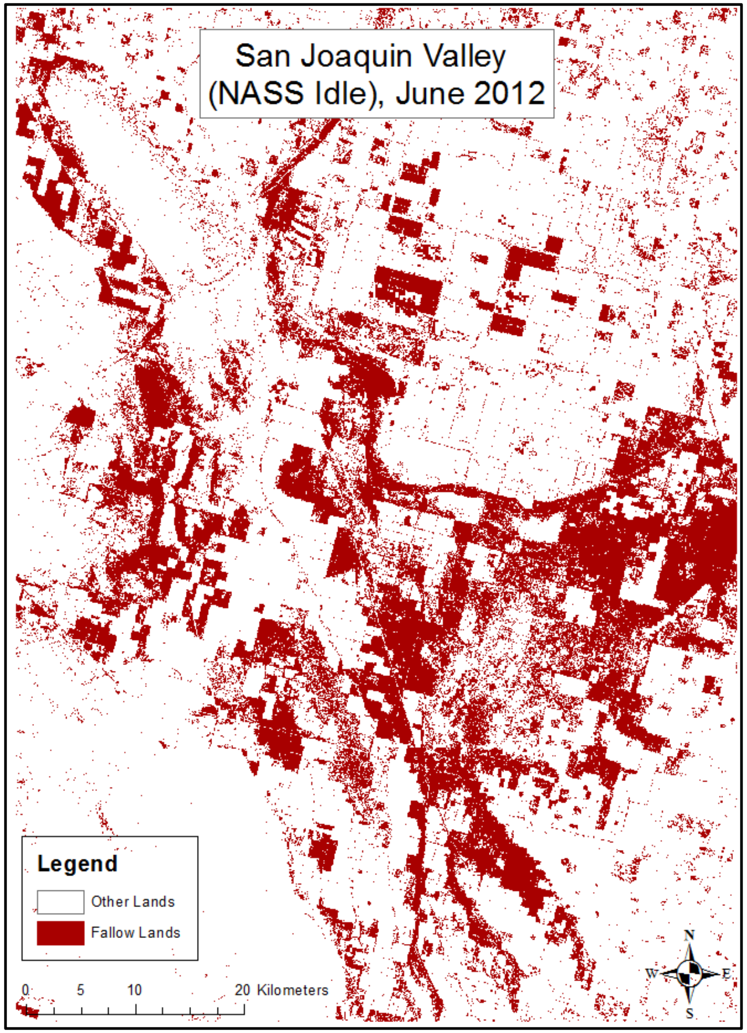
aps of idle lands developed by USDA able for June in early July.

al Fallow / Idle Acres by CDL Iteration

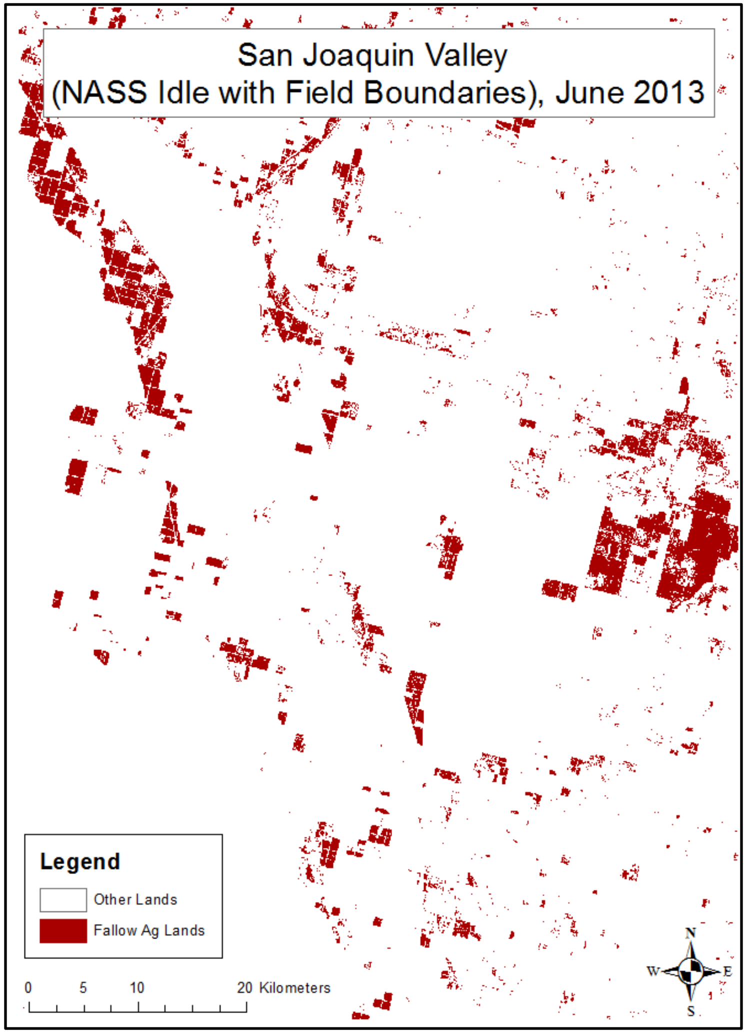
	Cropland Data Layer Iterations	
ounty	June 2013	June 2012
Kern	246,576	322,500
resno	162,672	196,443
Kings	118,121	142,714
ulare	74,453	110,825
Butte	54,601	52,709
Yolo	70,604	69,525
Sutter	49,416	32,613
olusa	31,404	22,546
Glenn	28,641	25,552

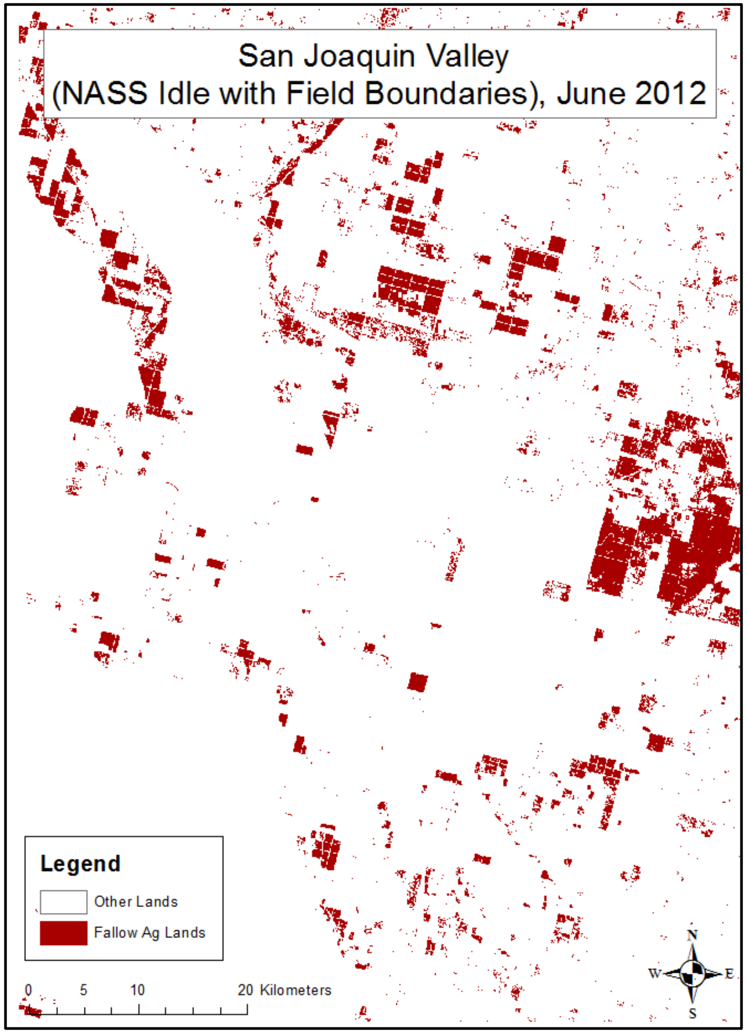
USDA NASS CDL Fallow Acreage
San Joaquin Valley, CA, June 2012 & 2013





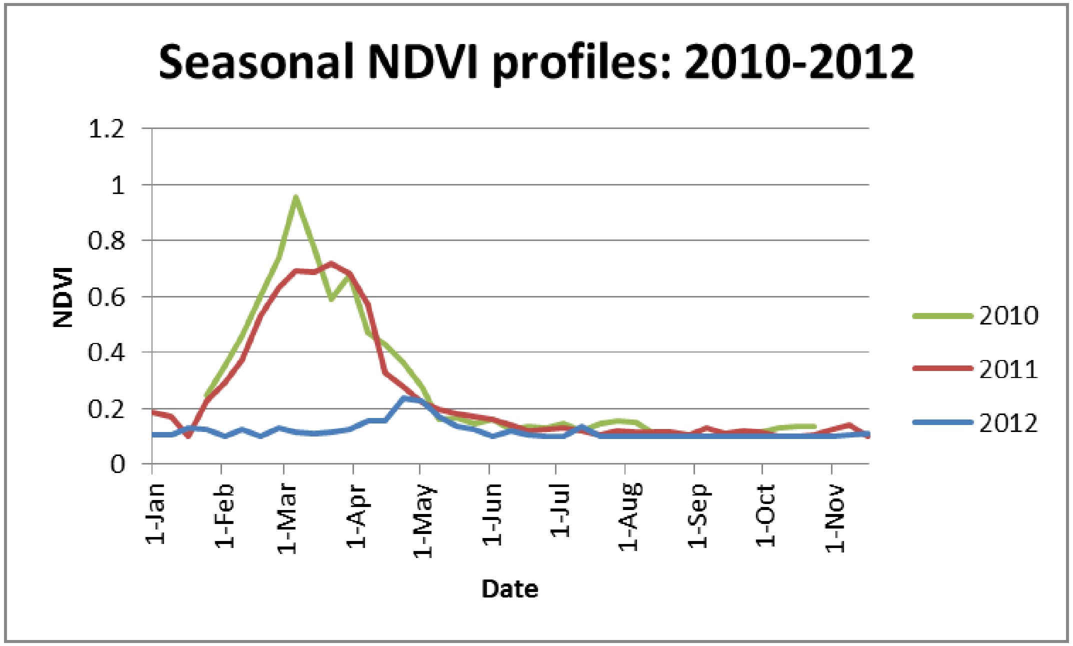
USDA NASS CDL Fallow Acreage, San Joaquin Valley, CA
June 2012 & 2013 (Active Production Areas Only)





Early Season Mapping of Fallowed Area (March – June)

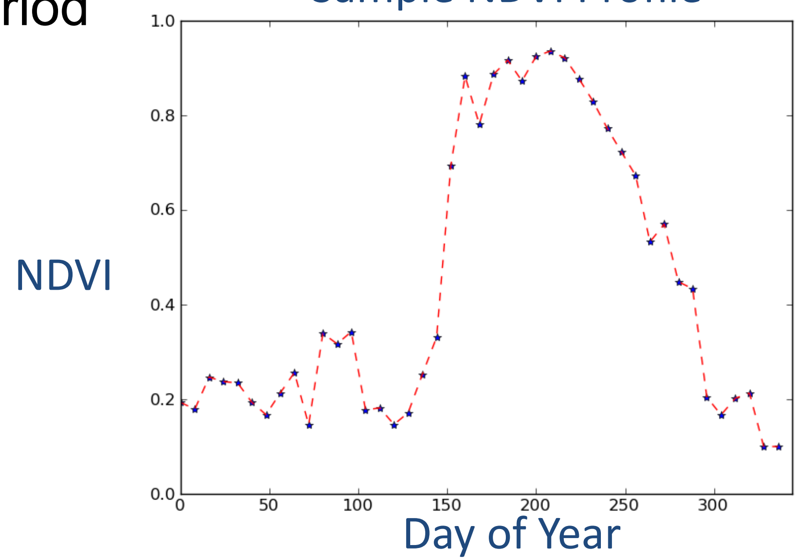
- Idling of land results in detectable change in seasonal NDVI profiles



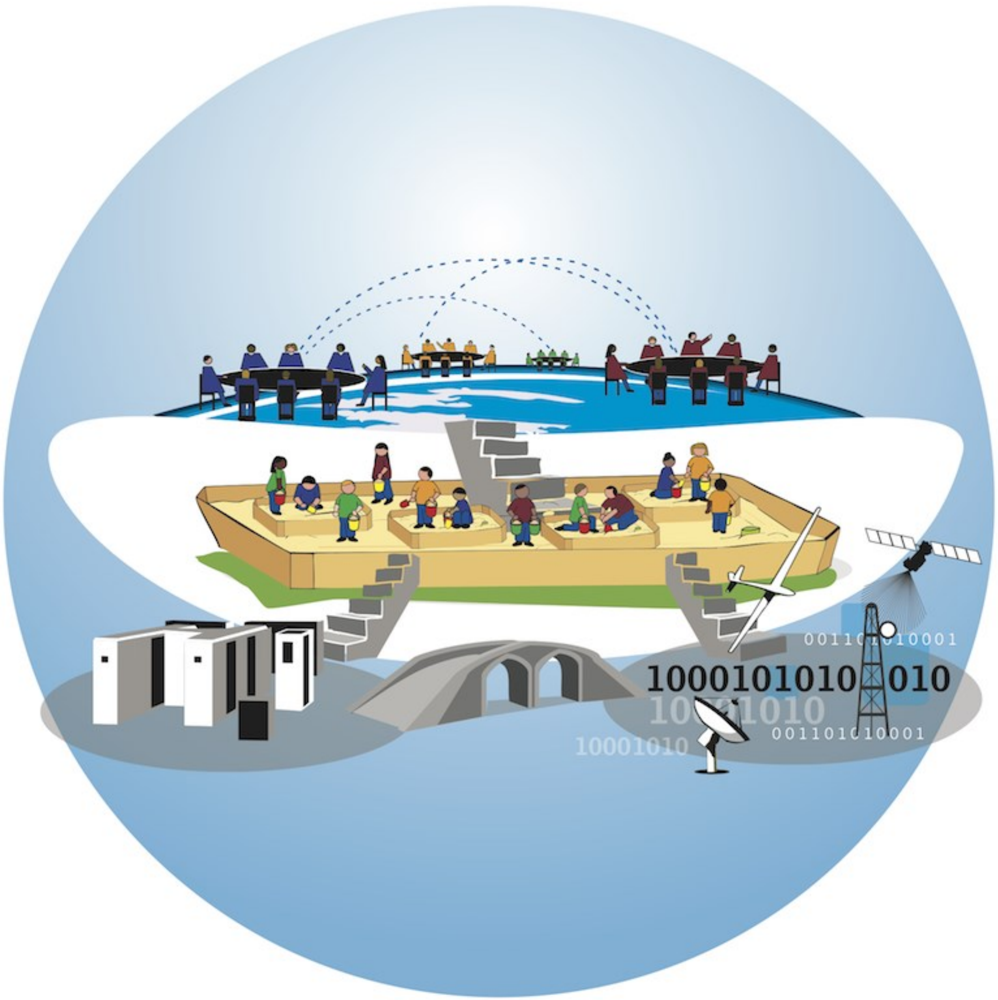
Early Season Mapping of Fallowed Area (March – June): *Approach*

- Normalized Difference Vegetation Index (NDVI) composites for California generated from timeseries of 8-day composites from Landsat 5/7/8 (30m) + MODIS (250m)
- Using field boundary shapefiles from County Ag Commissioner offices, extracted NDVI profiles (field averages) for every field in the Central Valley
- Calculated max, min, slope, monthly means, etc., for each month
- 2010-2012 used as the reference period
- Rapid development and testing utilizes Landsat and MODIS repositories on NASA Earth Exchange

Sample NDVI Profile



NASA Earth Exchange

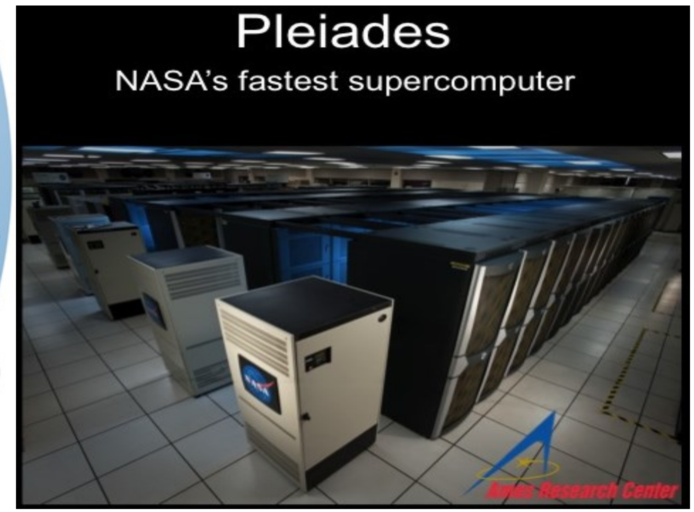


9PB of on-line storage

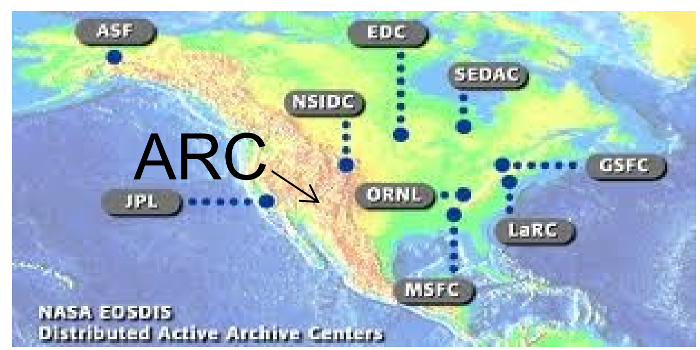
50PB of tape storage

512 CPUs readily accessible, 180,000 total

COLLABORATION (over 250 members)

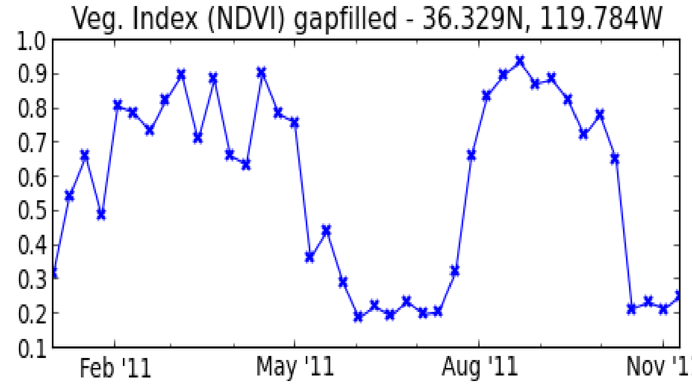


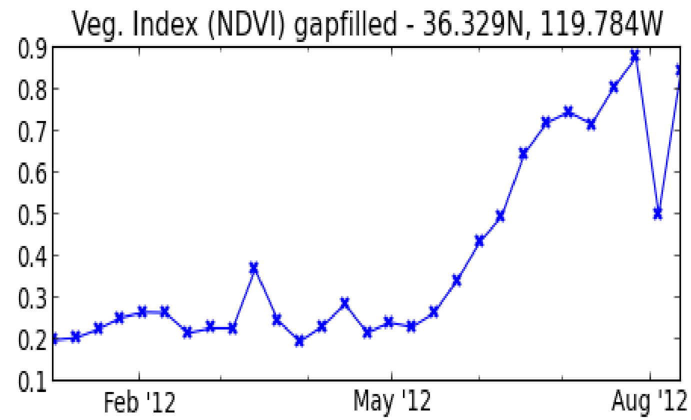
Centralized COMPUTING (9PB, 180,000 cores)



Data Repository (over 400 TB of data)

Early Season Mapping of Fallowed Area (March – June): *Approach*



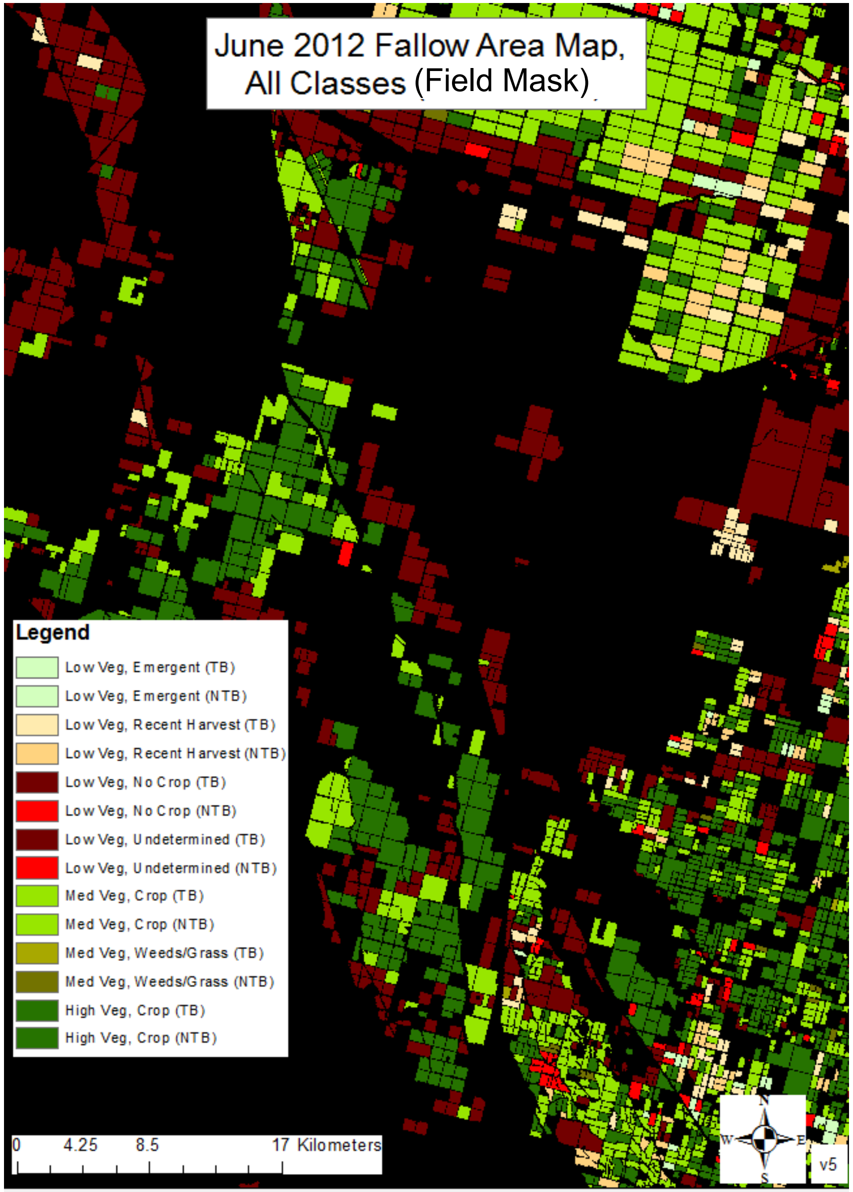


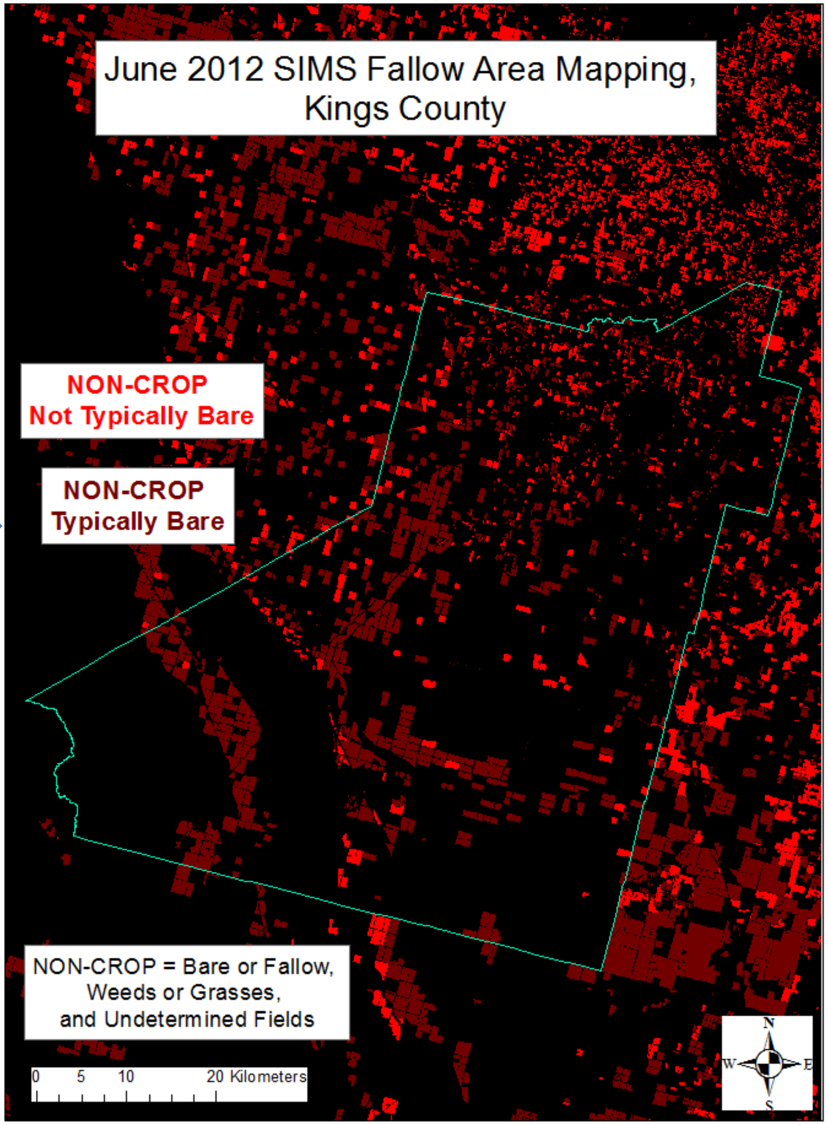
Ground truth: April-May, 4/10/12.

Observation: Fields that are fallowed as a result of drought are often still maintained, and are typically bare, or have a much lower vegetation fractional cover / NDVI than previous or reference years.

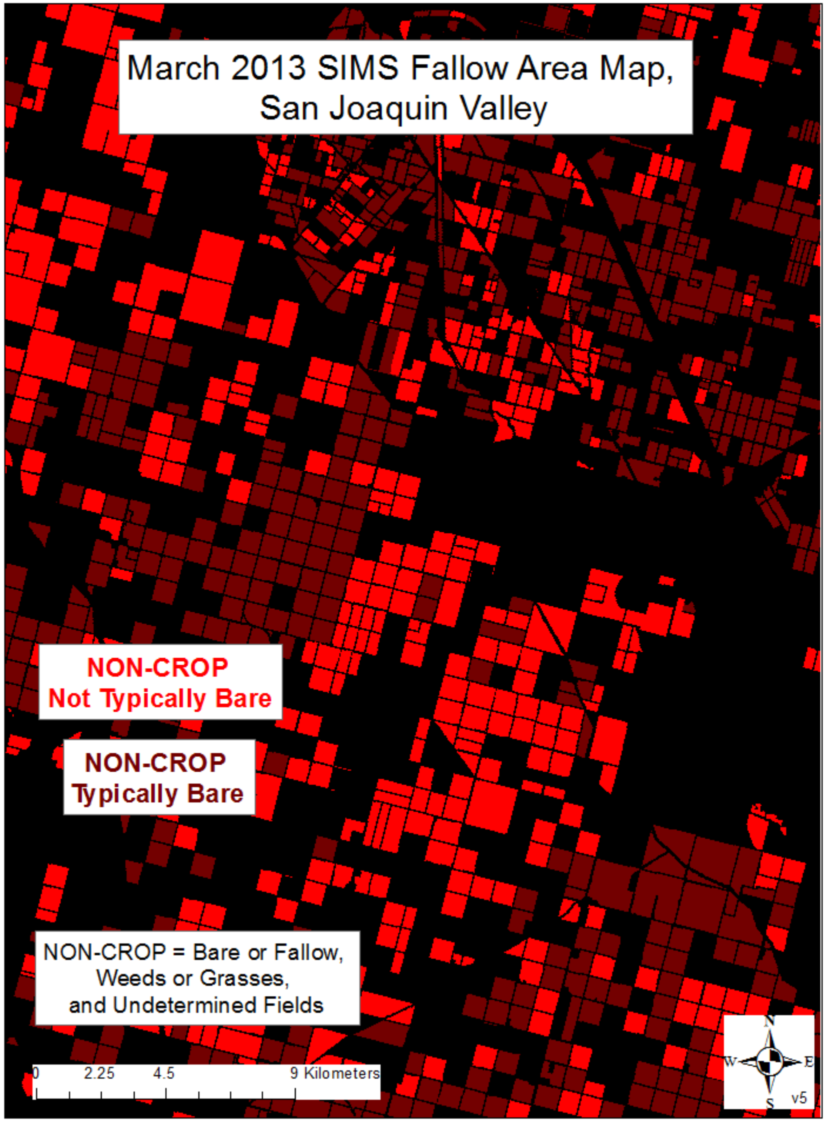
Early Season Classification Output

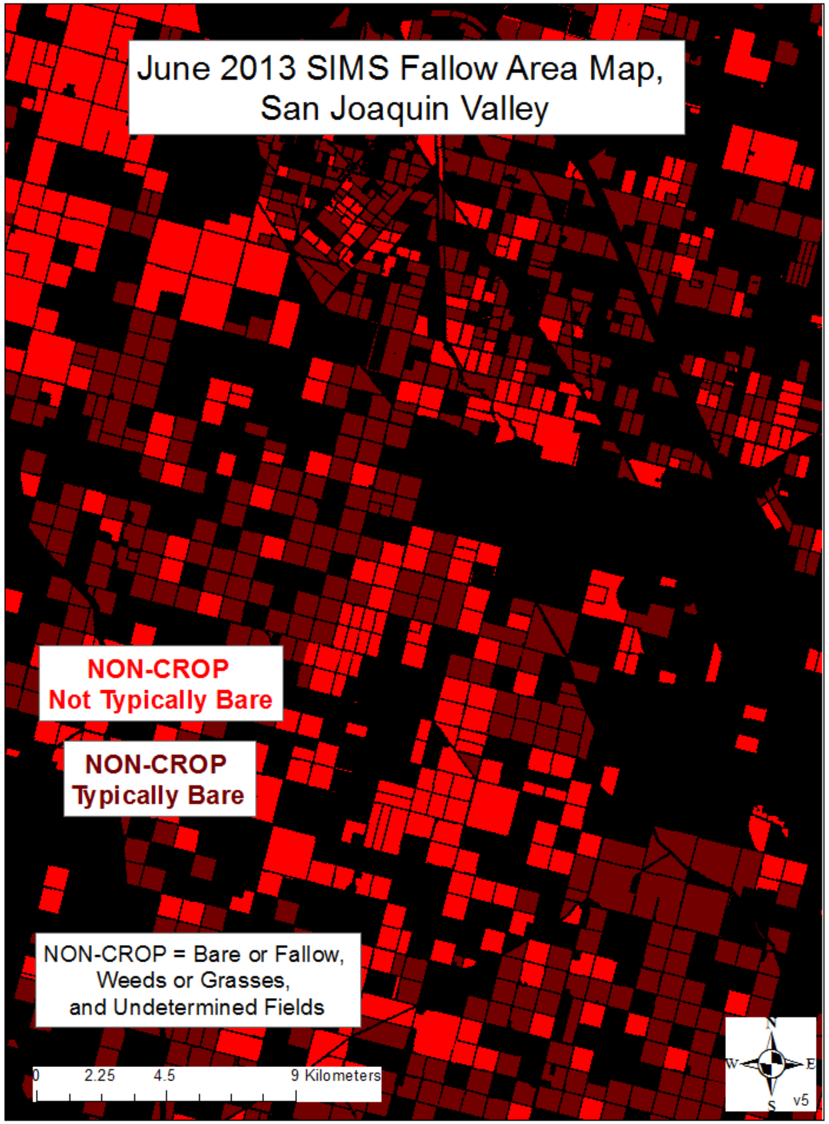
Classes grouped into crop/non-crop and field history is assessed





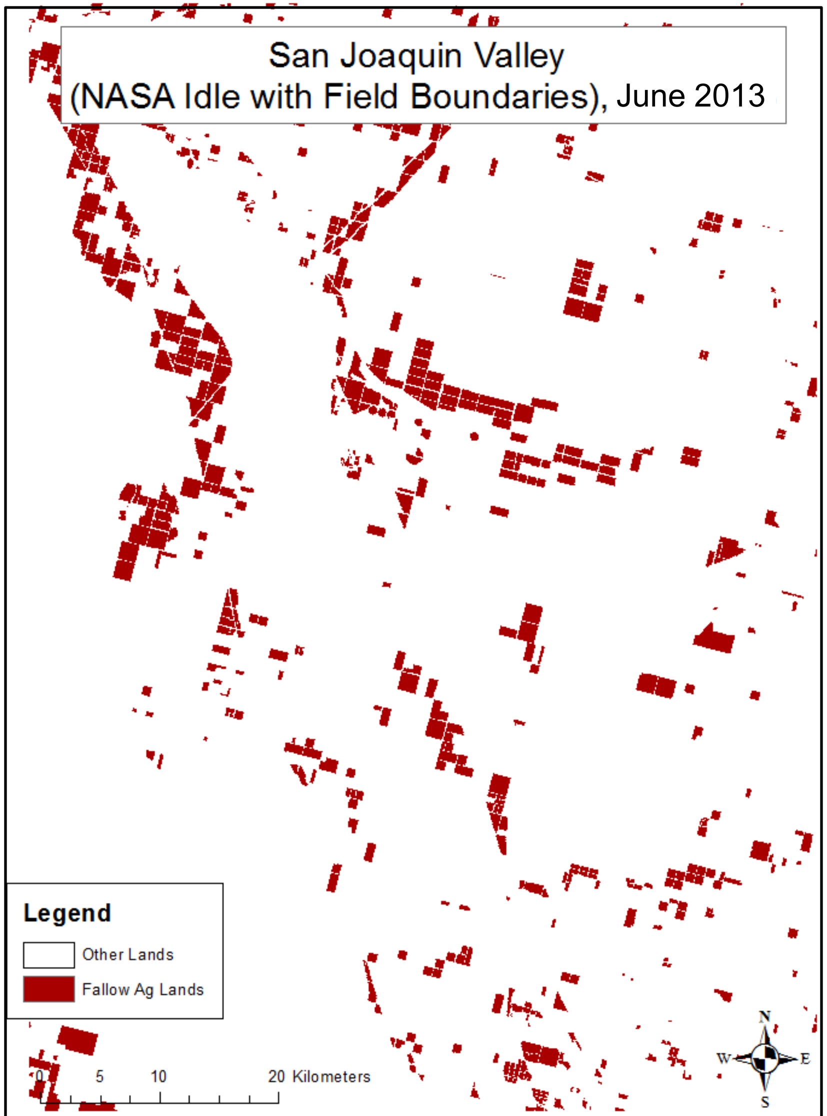
Early Season Classification Output:
Tracking Progress Early in the Season

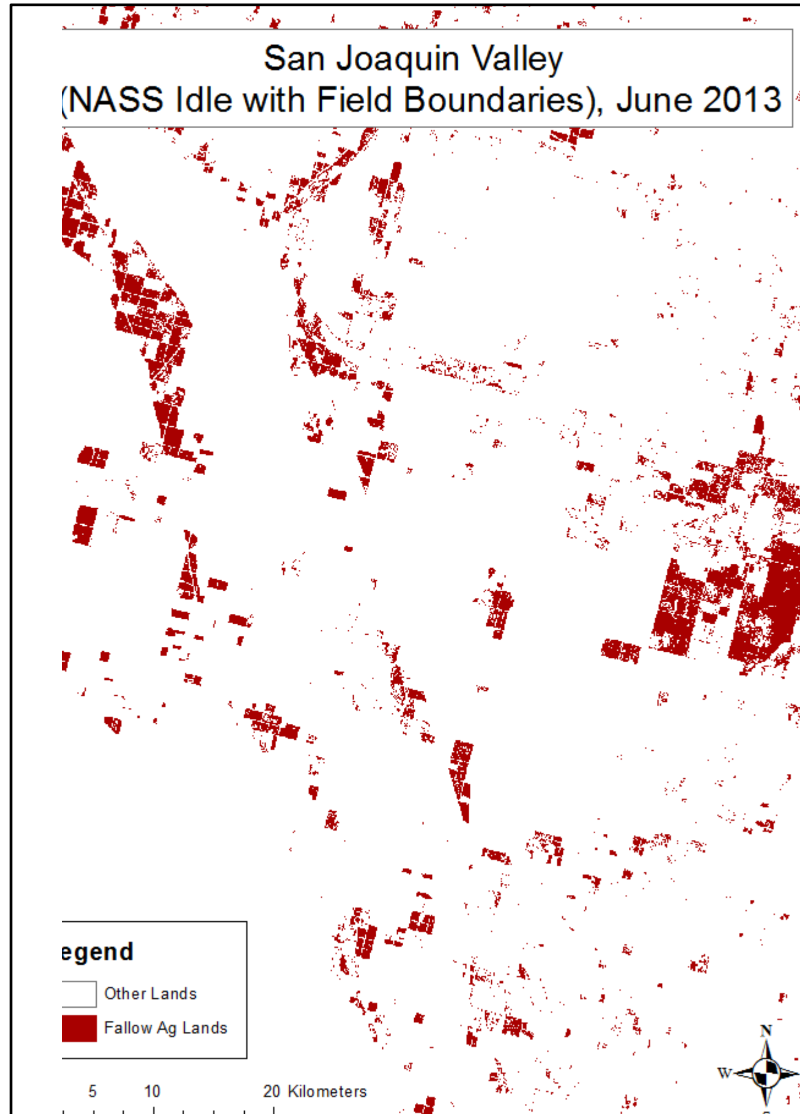




Early Season Classification Output

Generally good agreement between June USDA NASS and NASA products, though differences exist





Groundtruth transects:

Central California

April-June, 2012; Sept-Oct, 2012; Mar-June, 2013

Figure 1. Survey transects, from April-May and May-June 2012. ~2000 fields total.

Early Season Accuracy Assessment

ACCURACY TABLE (excluding perennials)	FAM March 2013 (n = 99)		FAM April 2013 (n = 99)		FAM May 2013 (n = 99)	
	Crop	*Non-Crop*	*Crop*	*Non-Crop*	*Crop*	*Non-Crop*
Producers Accuracy	60%	84%	50%	100%	33%	100%
Users Accuracy	30%	95%	100%	96%	100%	94%
Overall	82% correct		96% correct		94% correct	

- Accuracy statistics derived from comparisons against field survey data collected in 2013
- Statistics focus on crop/non-crop classification
- Majority of discrepancies explained by issues with recent harvest, emergent crops, and field boundary issues → use of seasonal summaries to reduce apparent uncertainty

USGS Enterprise Science Processing Architecture

- USDA NASS estimates will be supported by NASS as part of the Cropland Data Layer program
- Evaluating options for March – June estimates
  - Option 1: Algorithms / processing workflows to be transferred to CDWR
  - Option 2: Implemented on EROS Enterprise Science Processing Architecture (ESPA)
- The ESPA Framework has been created to support Terrestrial Monitoring applications at USGS/EROS
- The EROS/Enterprise Science Processing Architecture is designed to enable science users to bring their algorithms to the archive to better and more quickly serve their needs

Next Steps

- Need to finalize definition(s) of ‘fallow’
  - Short vs long-term: ‘idle’ and ‘fallow’ may not be the same thing
  - Cropping patterns and single vs double-cropping
  - Seasonal vs annual summaries

- Establish baseline and reference periods
  - Processing data for 2000 to 2013 to provide historical baseline
  - Select reference years with average / above average precip (e.g., 2010-2012)

- Refine algorithms for early-season classification
  - Continued accuracy assessment and improvement
  - Confusion with weeds / grass and low yield cereals
  - Refinements to address unique signals of some crops

Questions?