Mapping Drought Impacts on Agricultural Production in California's Central Valley

James Verdin, USGS

Project Team

James Verdin (PI), Prasad Thenkabail, John Dwyer, Cynthia Wallace, USGS

Rick Mueller and Audra Zakzeski, USDA NASS

Forrest Melton, Lee Johnson, Alberto Guzman, Carolyn Rosevelt, Sean Windell, Aimee Teaby, David Hamblin, John Urness, Kirk Post, NASA ARC-CREST / CSU Monterey Bay

Rama Nemani, NASA Ames Research Center

Jeanine Jones, California Department of Water Resources

Support from the NASA Applied Sciences Program and NOAA NIDIS Program Office

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(s)

- **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 proclamations of emergency pursuant to the California Emergency Services Act and allocation of drought relief funding
- State priorities for providing assistance with and processing of local water transfer requests
- Assessment of economic impacts of drought

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

Project Partners and Stakeholders

Project Partners

CA Department of Water Resources

USDA National Agricultural Statistics Service

USGS

NASA / CSU Monterey Bay

Project Stakeholders

CA Governor's Drought Task Force

CA Department of Water Resources

CA Department of Food and Agriculture

CA Social Services Agencies and Food Banks

CA State Water Resources Control Board (water rights admin.)

Nature Conservancy (solar development planning)

California Farm Bureau

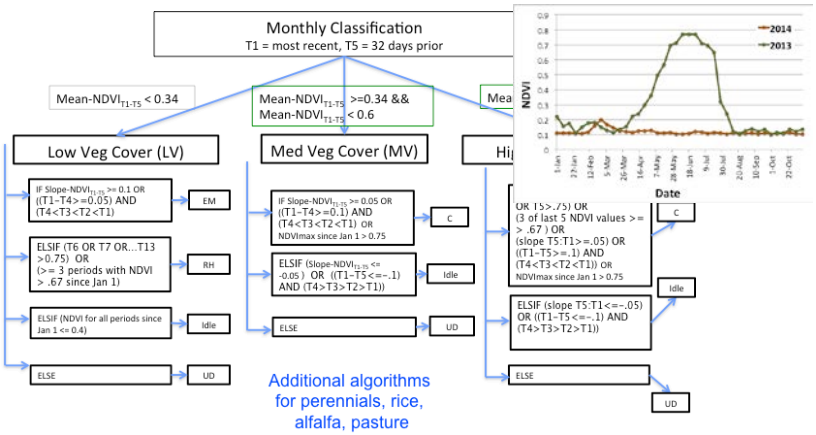
Approach

Satellite Data

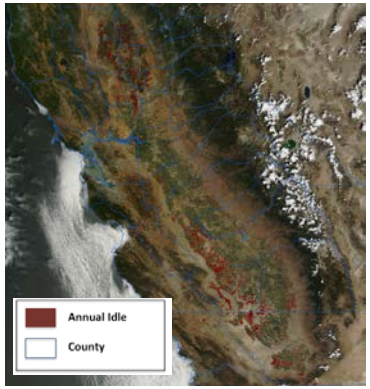
Landsat (TM / ETM+ / OLI)
+SPOT, DMC, Sentinel-2(?)

Terra / Aqua (MODIS)
250m / 15.5 acre
Daily overpass

Decision Tree Algorithms



Outputs: Maps and Summary Tables

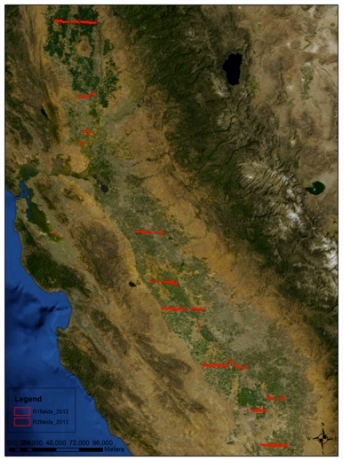


Central Valley, Total Idle Acreage (through September 22)		
Year	Summer Idle (idle Jun 1 – Sept 30)	Annual Idle (idle since Jan 1)
2014	1,713,838	1,201,472
2013	1,671,611	971,094
2011	1,213,682	321,865
2014 – 2011 (change)	**500,156**	**879,607**

- Annual idle mapping from USDA NASS
- Early season + summer mapping from NASA
- Comparisons against baseline period

Validation

Via FSA Data and Field Surveys



Highlights

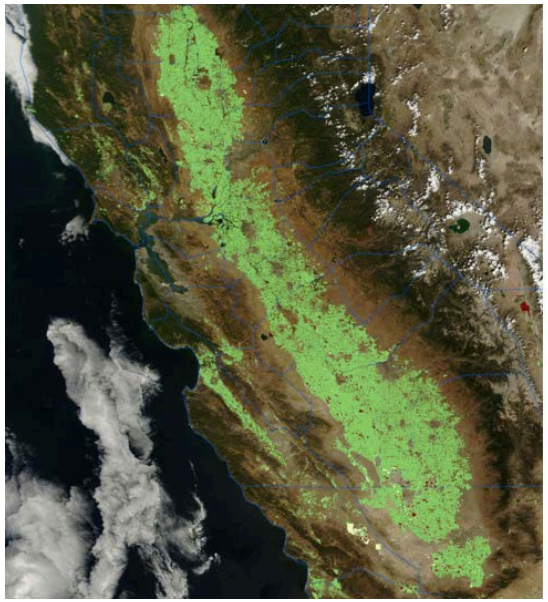
- Collaborative, interagency effort between USGS, NASA, USDA, and CA DWR → responds to request from CA Dept. of Water Resources

- Successfully demonstrated capability for within season mapping of idle acreage (advanced delivery of information >10 months).

- Monthly estimates generated by the project team for March – September, 2014 and delivered to DWR within two weeks of end of month.

- Overall accuracy has been approx. +/- 15% or better in all months.

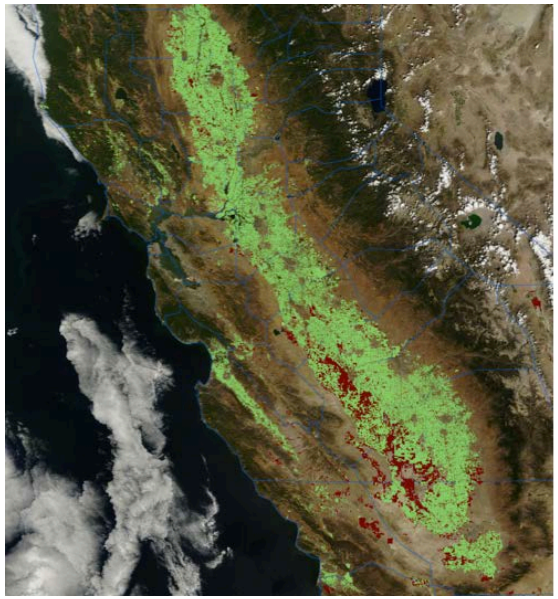
- Good agreement between USDA/NASA year-to-date idle



August 27, 2011
Year to Date
Conditions
Central Valley

Annual Idle
Cultivated
Emergent
County Bndry

Data source: USDA NASS. Map derived from data from Landsat 7, Landsat 8, and DMC satellites. Pixel-based classification for entire state.

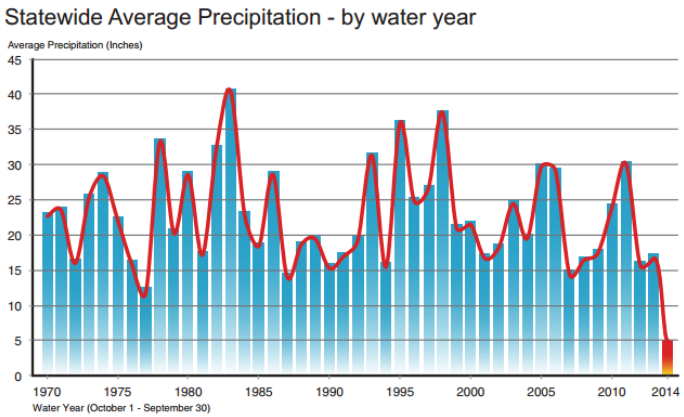


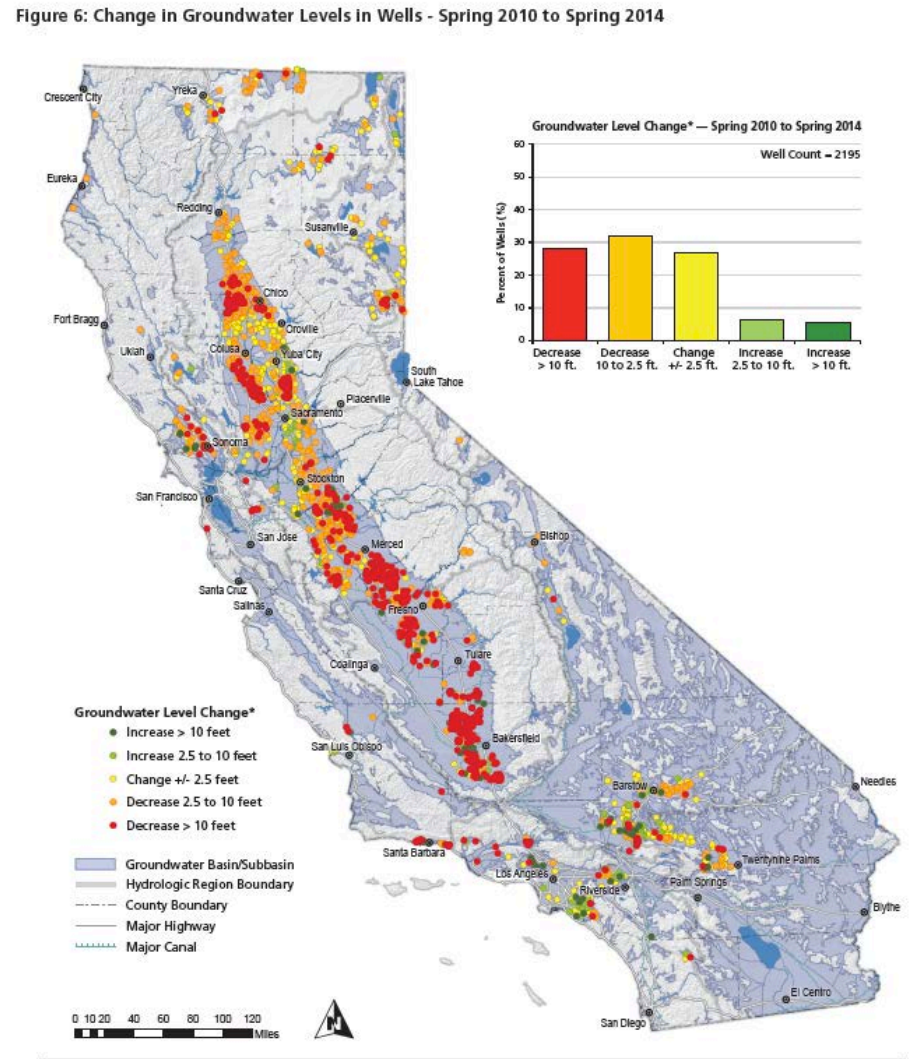
August 27, 2014
Year to Date
Conditions
Central Valley

Annual Idle
Cultivated
Emergent
County Bndry

Data source: NASA / CSU Monterey Bay. Map derived from data from Landsat 7, Landsat 8, Terra and Aqua satellites. Satellite observations for ~200,000 fields obtained every 8 days.

2014 California Drought

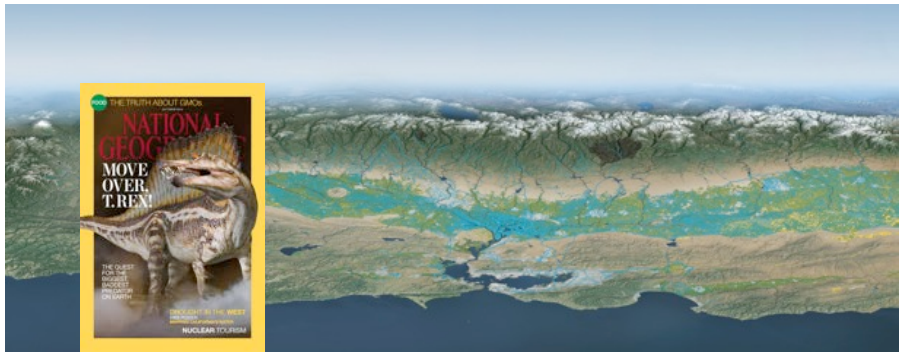




- **2013 driest calendar year on record**
- **2014 was 4th driest Water Year on record**
- **In 2014, many growers had surface water allocations <10% of full allocation**
- **2014 fallow up 40% (500,000 acres) compared to 2011**
- **2015 not much better**
  - **Precip is 86% of avg for CY, but only 46% of avg for WY**
  - **Snowpack just 21% of normal**
  - **Reservoirs at 67% of avg statewide**

Impacts

- Data presented to Governor's Drought Task Force by CA DWR (August 2014)
- Data used by CDFA in modeling of economic impacts of drought on agriculture
- Data used in allocation of emergency drought relief funds to food banks in impacted counties (July 2014)
- Data featured in 5-page poster in National Geographic issue on Drought in the West (Oct 2014)
- Data highlighted in CDWR 2014 Public Update for Drought Response (Nov 2014)
- NASA Earth Observatory Image of the Day (1/30/2015)



Transition Strategy

- USDA NASS mapping 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 and/or public cloud or Google Earth Engine
  - Option 2: Implemented on EROS Enterprise Science Processing Architecture (ESPA)

- The ESPA Framework has been created to support Terrestrial Monitoring applications at USGS/EROS and is designed to enable science users to bring their algorithms to the archive to better and more quickly serve their needs.

- Currently preparing report for CA DWR on options for transition.

Lessons Learned

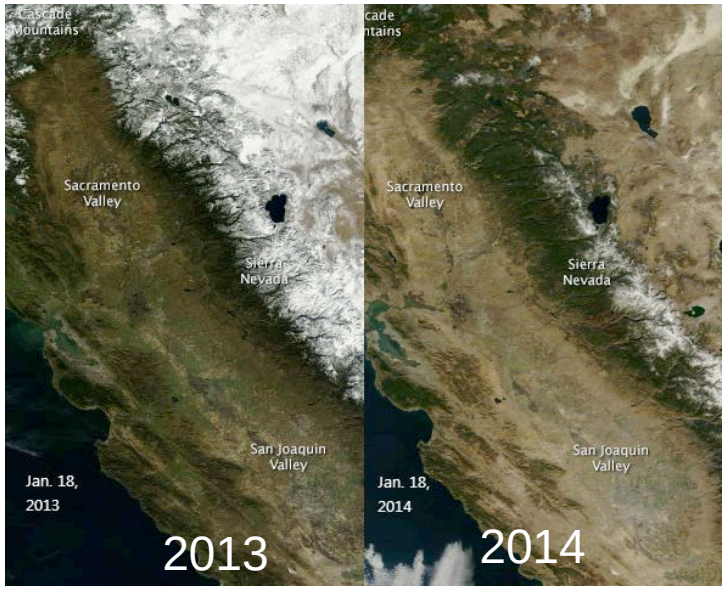
1) Communication, communication, communication

2) Quantifying accuracy increases utility for decision makers

3) Policy-makers prefer maps; also useful for public communication and outreach

4) There are many definitions of “fallow” → buy-in to technical definitions used is key

5) Looking to be another busy year



Questions?

https://c3.nasa.gov/water/projects/5/

USGS
science for a changing world

USDA

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

NASA