California Drought 2011-2015

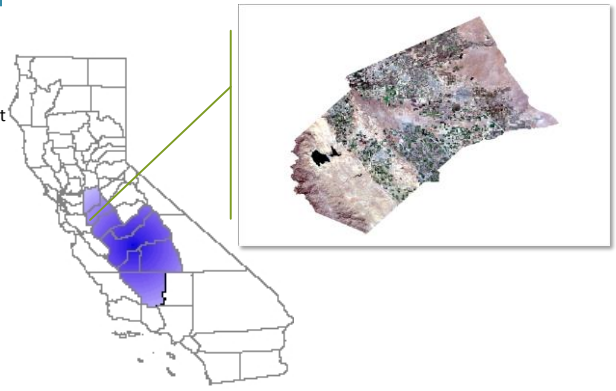
SAN JOAQUIN VALLEY – A LOOK AT MERCED COUNTY AND SURROUNDING AREA

Objective and Methods

Objective

To document land cover changes between 2011 and 2015 within the San Joaquin Valley region, specifically Merced County, as a result of one of the worst recorded droughts in California history.

Merced County was chosen as a result of the varying, and noticeable, land cover changes over the 4 year period due to both abiotic conditions and subsequent biotic interactions.



Data used:

Data was obtained from the USGS Global Visualization Viewer

- Landsat 5 TM with 10% cloud cover – September 2011
- Landsat 8 OLI with 10% cloud cover – September 2015
- Though the drought still persists through 2016, El Nino helped to replenish reservoirs in the Spring of 2016. As a result, the data selected from 2011-2015 highlights the height of the drought.

Software used:

- ERDAS Imagine 2015
- ArcGIS 10.2

Objective and Methods (cont.)

Supervised classification

- Post-classification land-cover change detection
- Created separate training samples for both 2011 and 2015
- 6 classes: agriculture, water, developed land, unassociated vegetation, barren, forest
- Highlight agriculture from/to
- Classification change to Water

Unsupervised classification

- Layer stacking -10 band composite of Landsat 5 and 8 imagery
- Used to highlight water loss
  - San Luis Reservoir, Don Pedro Reservoir, New Melones Lake, Total Water Loss in Merced County

Examples of ArcGIS Functions Used

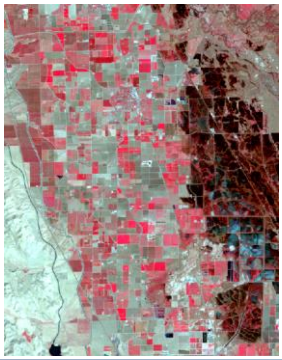
- Raster processing
  - Clip, Composite Bands
- Calculate Statistics
- Map Algebra
- Extract by Attributes
- Combine
- Reclassify

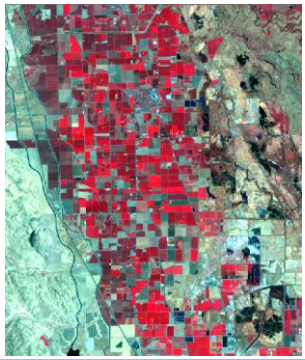
Agricultural Impact and Human Response

Agriculture

Biotic interactions (Human impact-farm economy) reacting to abiotic conditions (drought)

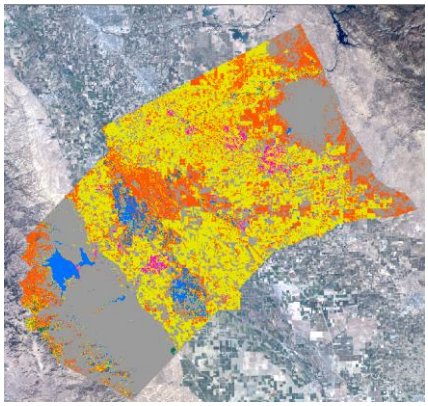
- Humans shaped the environment as a result of the drought over the 4 year period.
- Farming and agriculture actually flourished in certain areas (patches) for high priced crops (almonds, walnuts, pistachios) due to human controlled water dispersion.
- Naturally those areas (wheat, corn) not tended to by humans experienced loss.
- Certain plants were also grown around the wildlife refuges to account for the loss in vegetation.
- Visible agricultural patch differences between Landsat 2011 and 2015 data are evident.





Agricultural Impact and Human Response

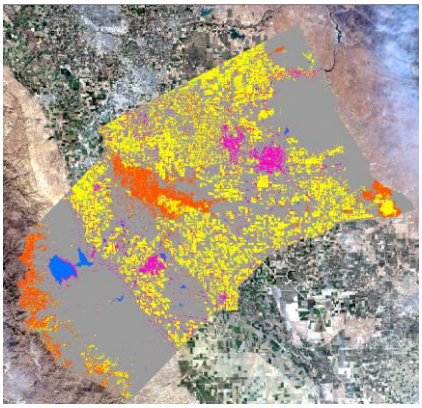
Supervised Classification of Merced County



Sept 2011 - Sept 2015

Class Name

- Agriculture
- Water
- Developed Land
- Barren
- Unassociated Vegetation
- Forest



Agricultural Impact and Human Response

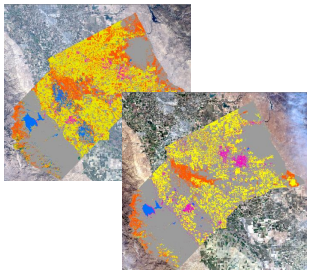
Supervised Classification of Merced County – Total Changes from 2011 – 2015

Sep-2011	Sep-2015	Pixel Count	Meters Square	Acres
Agriculture	Barren	1108343	997508700	246,489.55
Agriculture	Agriculture	818993	737093700	182,139.66
Agriculture	Developed Land	111490	100341000	24,794.78
Agriculture	Unassociated Vegetation	66508	59857200	14,791.02
Agriculture	Forest	7024	6321600	1,562.10
Agriculture	Water	2812	2530800	625.37
Barren	Barren	1866321	1679688900	415,059.80
Barren	Agriculture	133750	120375000	29,745.28
Barren	Unassociated Vegetation	61690	55521000	13,719.53
Barren	Developed Land	33113	29801700	7,364.15
Barren	Water	139	125100	30.91
Barren	Forest	677	609300	150.56
Developed	Barren	37078	33370200	8,245.95
Developed	Developed Land	66876	60188400	14,872.86
Developed	Agriculture	3640	3276000	809.52
Developed	Unassociated Vegetation	602	541800	133.88
Developed	Water	495	445500	110.09
Forest	Barren	8475	7627500	1,884.79
Forest	Developed Land	410	369000	91.16
Forest	Agriculture	3672	3304800	816.63
Forest	Unassociated Vegetation	6049	5444100	1,345.27
Forest	Forest	4112	3700800	914.49
Forest	Water	319	287100	70.94
Unassociated Vegetation	Barren	598813	538931700	133,172.81
Unassociated Vegetation	Unassociated Vegetation	245877	221289300	54,681.73
Unassociated Vegetation	Agriculture	249164	224247600	55,412.74
Unassociated Vegetation	Developed Land	12277	11049300	2,730.34
Unassociated Vegetation	Forest	5586	5027400	1,242.30
Unassociated Vegetation	Water	777	699300	172.80
Water	Barren	133200	119880000	29,622.97
Water	Agriculture	19300	17370000	4,292.22
Water	Developed Land	15591	14031900	3,467.35
Water	Water	54852	49366800	12,198.79
Water	Unassociated Vegetation	13510	12159000	3,004.55
Water	Forest	676	608400	150.34

Agriculture understandably experienced the biggest change with the largest patches moving to a Barren classification.

Even with the decrease in total acreage planted, however, agricultural land gained area that was previously Barren due to site-specific farming. Global supply and demand helped to drive up the prices of cash crops and increase farming revenue.

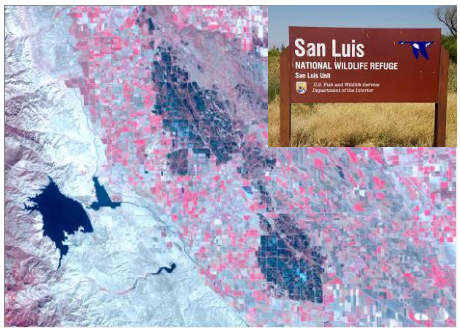
A great deal of the vegetation around the wildlife refuges was lost and therefore human interaction and restoration efforts were needed.



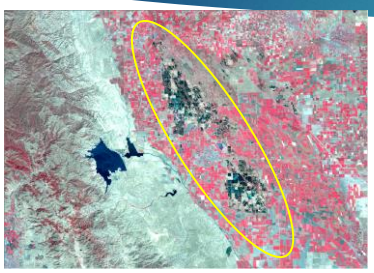
San Luis NWR Complex: An Overview

Merced County is home to the San Luis National Wildlife Refuge Complex, which is comprised of the San Luis, Merced, and San Joaquin River National Wildlife Refuges as well as the Grasslands Wildlife Management Area. These protected lands are maintained throughout the year: drained in the Spring, irrigated throughout the Summer, and flooded in the late Summer/early Fall.

- Accompanied with the lack of rainwater, water conservation and delays in water delivery to the Central Valley attributed to dire situations for many of the refuges covered under the Central Valley Project Improvement Act (CVPIA).
- The CVPIA was enacted in 1992 to allocate enough water resources for each of the refuges in order to support ecological needs.
- With the refuges only receiving a fraction of their water requirements at the height of the drought = changes from Wetland to Upland classes.
- Results: overpopulation, disease, and a subsequent drop in certain wildlife.

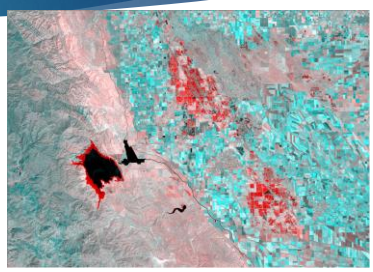


Drought and Water Loss – San Luis NWR Complex



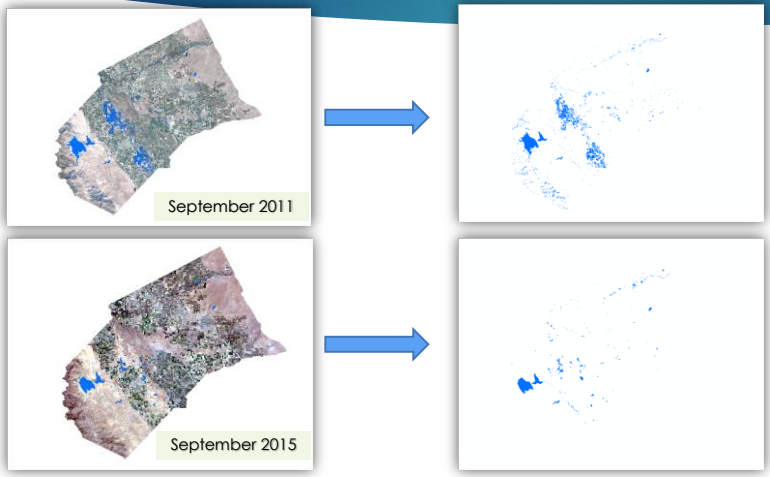
In the yellow circle pictured above, the San Luis NWR begins its yearly flooding of the seasonal wetlands in September 2011. This is to promote annual bird migration and nesting. Flooding begins in late Summer-September/October. These wetlands are then drained in the Spring and maintained throughout the Summer to help plant growth in the area.

The San Luis NWR pictured in September 2015. Due to water constraints and issues with water delivery, the refuges were only able to flood a fraction of the ecologically important seasonal wetlands.



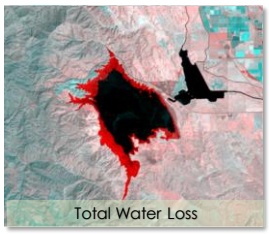
Here, the areas of water loss between 2011 and 2015 are highlighted in red. Not only did the wildlife refuges experience significant effects of the drought, but reservoirs and lakes in the Central Valley did as well.

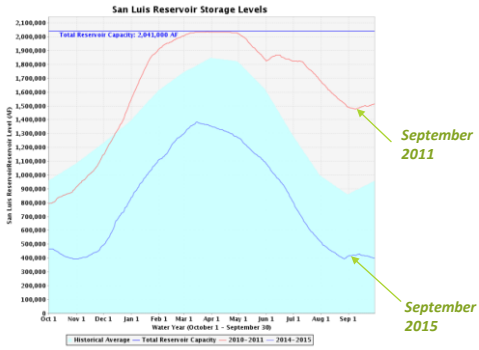
Water Loss – Merced County (Total)



- According to the Supervised Classification, there were 237,129 30m Water class pixels in 2011 for Merced County. That number dropped to 59,394 pixels in 2015.
- Speaking in terms of measurements, there were roughly **82 square miles of water in 2011** and **21 square miles in 2015** within the same area. This is a decrease of **~74%** of the total Water class designation within the 4 year period for Merced County.

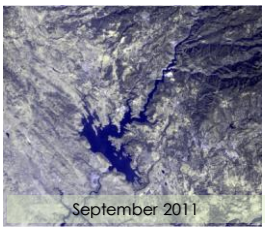
Water Loss – San Luis Reservoir

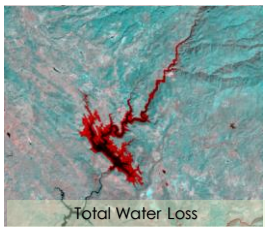


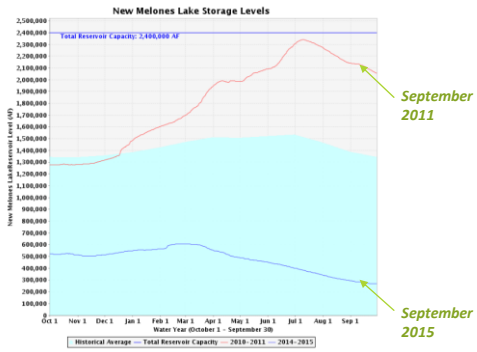


- October 2011 ~ 1,500,000 acre feet (AF)
- September 2015 ~ 400,000 AF
- 73% water loss

Water Loss – New Melones Lake

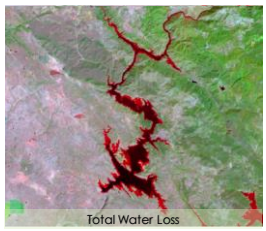


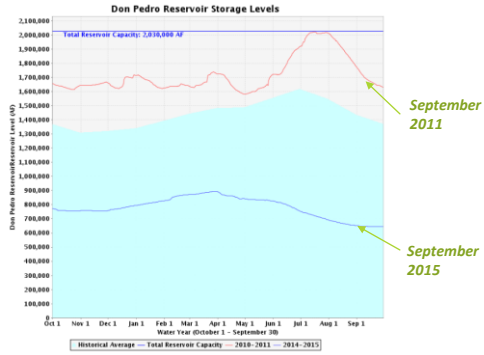




- September 2011 ~ 2,100,000 acre feet (AF)
- September 2015 ~ 300,000 AF
- 86% water loss

Water Loss – Don Pedro Reservoir





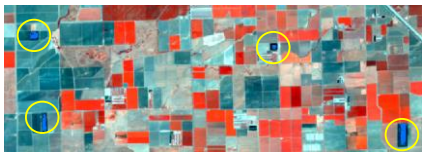
- September 2011 ~ 1,650,000 acre feet (AF)
- September 2015 ~ 650,000 AF
- 60% water loss

Water…Gain?

A possible explanation:

- "Pop-up wetlands"
  - Farmers rented rice fields to Nature Conservancy.
  - Farmers are paid to keep land flooded.
  - Flooded land in order to create wetland habitat for migratory birds.
  - In direct relation to the San Luis NWR'S inability to fully establish its seasonal wetlands.

Sep-2011	Sep-2015	Pixel Count	Meters Squared	Acres
Agriculture	Water	2812	2530800	625.37
Barren	Water	139	125100	30.91



Areas experiencing water gain are depicted above.

Conclusion and Discussion

Even without reservoir storage levels or total land cover changes, Landsat imagery has given us the ability to document historical pattern change when faced with an extreme natural disturbance, such as persistent drought. We've learned that humans can shape the environment and make adjustments to abiotic conditions which can then further affect other processes within an ecosystem.

Sources include:

- USGS
- US Fish & Wildlife Service
- California Dept. of Conservation
- ESRI
- Think Progress
- High Country News
- News Deeply