How the Current Drought is Increasing Future Flooding
Subsidence Impacts on the San Joaquin River

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Credits

• NASA (JPL/CalTech) – Subsidence in the Central Valley
  Tom Farr, Cathleen Jones, Zhen Liu, 2015 Progress Report

• DWR – DIRWM South Central Region Office:
  Alexis Phillips-Dowell, 2014 CWEFM

• USBR – SJRRP:
  Michael Mitchener, 2013 FMA Sacramento

• USGS – Land Subsidence along the Delta-Mendota Canal:
  Michelle Sneed and Mike Solt 2013

• USGS – San Joaquin Valley, Largest human alteration of
  the earth’s surface: Devin Galloway and Francis Riley, 1999
Timeline of San Joaquin Valley Subsidence

- Improved deep well turbine pump
- Threat of Jan Joaquin Valley subsidence recognized
- New surface water for agricultural interests
- USGS Study: Largest human alteration of the Earth's surface
- DWR had data indicating subsidence had resumed
- USGS Study of 2003 to 2010 showing renewed subsidence
- Sustainable Groundwater Management Act
- Groundwater Sustainability Plans in place
- Achieve sustainability goals
1999 Study Made it Look Like the Situation was Under Control

SAN JOAQUIN VALLEY, CALIFORNIA

Largest human alteration of the Earth's surface.

Mining groundwater for agriculture has enabled the San Joaquin Valley of California to become one of the world's most productive agricultural regions. While onsite recharge is not fully contributing to the overall recharge of the valley, the groundwater is being replenished by a combination of flood storage, evapotranspiration, and direct injection. The San Joaquin Valley Basin is the largest groundwater basin in the United States, covering approximately 1,000 square miles. The valley has a long history of groundwater pumping, with most of the water pumped from the unconfined portion of the San Joaquin aquifer. The valley is divided into three major subbasins: the North Valley, the Central Valley, and the South Valley. The North Valley is the largest subbasin, accounting for about 60% of the valley's groundwater storage. The Central Valley is the second largest subbasin, accounting for about 30% of the valley's groundwater storage. The South Valley is the smallest subbasin, accounting for about 10% of the valley's groundwater storage.

Depth to water (feet below land surface)

During the droughts of 1976-77 and 1987-91, deliveries of imported water to the west side of the San Joaquin Valley were cut back. More ground water was pumped to meet the demand, resulting in a drop in the water table and consequent compaction.

Compaction (inches)

Some elastic expansion of the aquifer system has occurred, but the compacted materials can never return to their pre-compacted thickness.

(Modified from Swanson, 1998)
What had Occurred before 1999

In the major subsiding areas, subsidence has continued except for a slight leveling off in the mid 1970s.

Over 16 Billion cubic yards of displacement
Since 1974, land subsidence has been greatly slowed or largely arrested but remains poised to resume.

When the costs of lost property value due to condemnation, regrading irrigated land, and replacement of irrigation pipelines and wells in subsiding areas are included, the annual costs of subsidence in the San Joaquin Valley soar to $180 million per year in 1993 dollars (G. Bertoldi and S. Leake, USGS, written communication, March 30, 1993).
Back in 2010, DWR Identified that Subsidence had Resumed
It Made the Paper in 2013

November 22, 2013
Land Sinking almost 1 foot per year
2013 USGS Study Focused on Period from 2003 to 2010

- 1926 to 1970: locally up to 28 feet
- Subsidence slowed with surface water deliveries
- Renewed subsidence with increased groundwater pumping; Climatic drought & “Regulatory drought”
Subsidence made the Front Page in 2015!

Valley sinking fast in drought, study says

August 20, 2015
May 2014 to January 2015 ➔ 13+ inches
Extent of Upper San Joaquin River System Subsidence from 2008 to 2011

From San Joaquin River to Mariposa Bypass – Most severe near Ash Slough
2006 survey control issues impact comparison to 2008
2011 Calibration Profile
2011 High Water Marks, 2008 Model Topo

Area of maximum subsidence downstream from Ash Slough

Impacts of subsidence on high water marks
Subsidence along Eastside and Chowchilla Bypasses 2008 to 2013
Subsidence along Eastside and Chowchilla Bypasses 2008 to 2013
System Design Capacity

General Profile Plot - Velocities

- Ash Slough
- Berenda Slough
- Fresno River
- San Joaquin River

Legend:
- Q Total PP 1
Near maximum subsidence

Downstream flatter reach
2008 Conditions at Design Discharge

Area of Maximum Subsidence
Results from Shifting Model to 2013
2018 Conditions Based on Continued Subsidence
Change in Freeboard due to Subsidence

![Graph showing change in freeboard due to subsidence over different river stations. The graph compares data from 2008 to 2013 and 2008 to 2018.](image)
Capacity Change from 2008 to 2016 from DWR Presentation

Diagram showing capacity changes with measurements of approximately 3,000 cfs and 2,500 cfs. Key features include Sand Slough Connector, Bifurcation Control Structure, Sack Dam, and Mendota Pool & Dam. The map also includes a legend with key features, river miles, project levees, and SJR restoration reach subreach delineations.
Conclusions

• Where subsidence causes lower channel slope, depth increases & capacity is reduced
• Impact of subsidence has been limited to date because most severe conditions have been centered on steep reach
• Significance will increase with recent and future subsidence
Questions?

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