Land Subsidence along the Delta-Mendota Canal in the Northern Part of the San Joaquin Valley, California

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Summary

► 1,200 mi² area subsided ½-11 inches/year during 2008-10; surveys indicate these rates have continued through 2013
► Adversely affecting water conveyances and other infrastructure
  ► Delta-Mendota Canal, California Aqueduct, Eastside Bypass, San Joaquin River, local canals
► Subsidence is largely permanent
► Subsidence occurred when groundwater levels declined to historically low levels as a result of pumping
► Recent subsidence has shifted about 25 mi northeast from historical (1926-70) maximum
► Long-term monitoring of water levels and subsidence is needed to detect and track groundwater conditions for decision support
Subsidence Damages Natural Resources and Infrastructure

► Flood Protection and Infrastructure
  - Damage to water conveyance systems and other infrastructure
    - Reduced conveyance capacity and freeboard, panel damage; water surface and liner misalignment; erosion/deposition in unlined channels
    - Roads, rails, bridges, pipelines, wells, etc.

► Natural resources
  - Reduces aquifer-system storage capacity
  - Impacts to wetland, riparian, and aquatic ecosystems
  - Restricted land uses
Impact on Infrastructure

Canal photos courtesy of Chris White, Central California Irrigation District
Measuring Subsidence

Bench Mark

Spirit Leveling

GPS

InSAR

ERS-1, ERS-2

Extensometer*

*measures part of land subsidence
Extensive withdrawal of groundwater caused widespread subsidence (1920s-1970)

Surface-water deliveries caused widespread recovery and slowing or cessation of subsidence, except when deliveries were curtailed and groundwater pumping increased to meet demand.

Galloway and others, 1999; USGS Circular 1182
Recent Subsidence

- Renewed subsidence concern during 2007-09 drought, and now, the current drought
  - Reduced surface water importation
  - More reliance on the groundwater resources
  - As it turns out...this is not just a problem during droughts for some areas with little or no surface-water access

P304 data from UNAVCO; 2004-10 water-level data from Luhdorff and Scalmanini Consulting Engineers
Federal, State, and Local Water Infrastructure in the Impacted Area

Modified from Faunt, 2009
Detected Edges of Subsiding Area

**InSAR Subsidence Measurements**

Max of about 3 inches (2007-10)

Max of about 6 inches (2003-08)
Max of at least 21 inches (2008-10)
Highest Impact: Adjacent to San Joaquin River and Eastside Bypass
Subsidence along the DMC

Explaination:
- 1: Check station and number

Vertical displacement in millimeters:
- 12/24/2007-7/26/2010
- 7/3/2003-3/24/2005

2007-10
2003-08
Water levels in the Shallow and Deep Systems Declined 2007-10

Clayey lenses
Unconfined aquifer system
Confined aquifer system
Corcoran Clay (confining layer)

River

Fresh-water recharge
Sierra Nevada

Bedrock

Old saline water

Year
Groundwater Levels Continue to Decline

13S-15E-31J6 (near Mendota)
GPS Subsidence Measurements

- Rate increases during droughts
- Subsidence only during droughts
Historical Subsidence
Current Activity: Extensometers

- Oro Loma (16H2)
- Panoche (11D6)
- DWR Yard (33A1)
- Rasta (6D1)

Hourly measurements of aquifer-system compaction and groundwater levels
Subsidence near Stockton
What Can Be Done About It?

► Focus on maintaining groundwater levels above historical low levels
  - Reduction of groundwater withdrawal
    - Decreasing groundwater demand
    - Limiting/redistributing groundwater use
    - Increasing supplemental water supply
  - Enhanced groundwater recharge
    - Artificial recharge: direct well injection or surface infiltration
    - Natural recharge: source protection

► Long-term monitoring of water levels and subsidence is needed to detect and track groundwater conditions for decision support
Thanks!