Earthquake Risk to Water Distribution Systems

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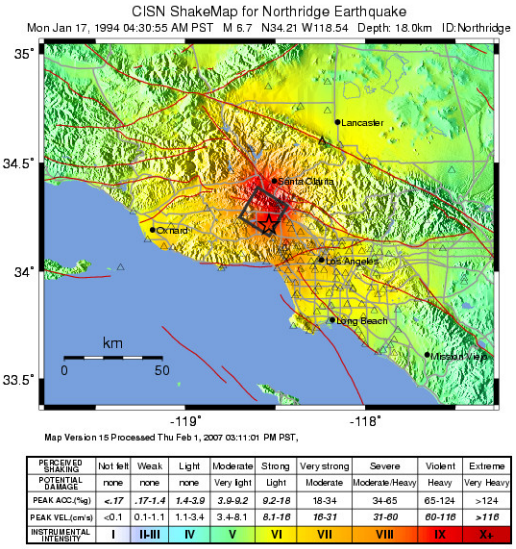
Outline

- Northridge earthquake
- Water system damage in Northridge earthquake
- Water distribution earthquake risk today

1994 M_w 6.7 Northridge Earthquake

Blind thrust fault

No surface rupture



Source: http://earthquake.usgs.gov/earthquakes/shakemap/sc/shake/Northridge/

1994 M_w 6.7 Northridge Earthquake

Blind thrust fault

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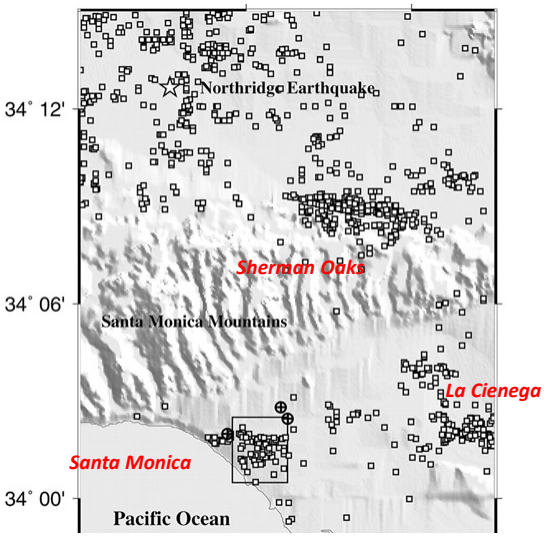
Clustering of damage to buildings



Source: Davis et al., 2000: Science.

1994 M_w 6.7 Northridge Earthquake

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Clustering of damage to buildings

Impacted building types:

1. Tuck-under parking
2. URMs
3. Nonductile concrete

Source: LA Times

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http://www.ngdc.noaa.gov/hazardimages/event/show/18

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Photo: M. Celebi, USGS

1994 M_w 6.7 Northridge Earthquake

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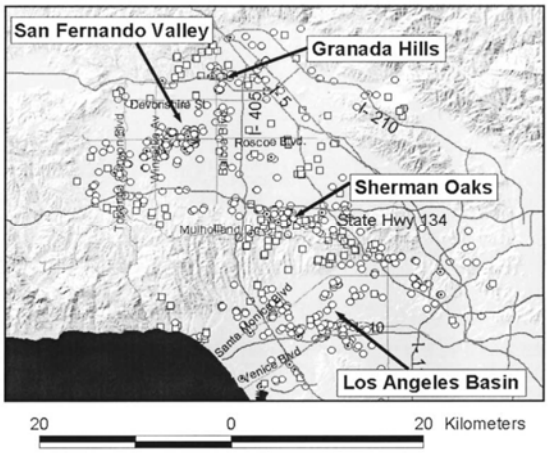
Impacted building types:

Disruption of water distribution system



Source: Jeon and O'Rourke, 2005

1994 M_w 6.7 Northridge Earthquake

Blind thrust fault

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Clustering of damage to buildings

Impacted building types:

Disruption of water distribution system

- Balboa Blvd
- Due to aging pipes, can expect similar losses in future earthquakes

Outline

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- Water system damage in Northridge earthquake
- **Water distribution earthquake risk today**

Three aqueducts supply southern California:

- LA Aqueduct
- Colorado R. Aqueduct
- California Aqueduct

All cross San Andreas fault

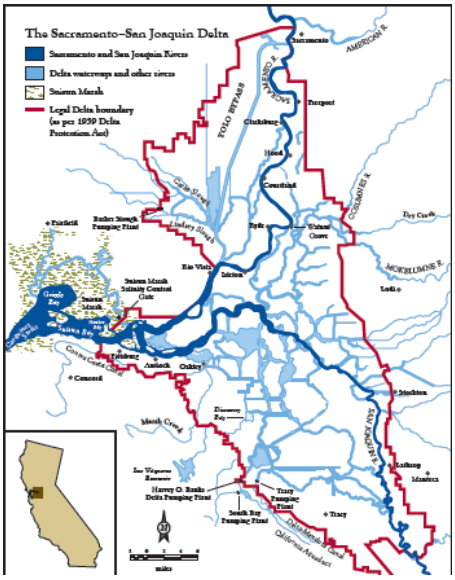
Temporary local supply south of fault

California Aqueduct:

- Intake in Delta
- 40% of supply, but impact is greater
- Greatest risk is local earthquakes in Delta region

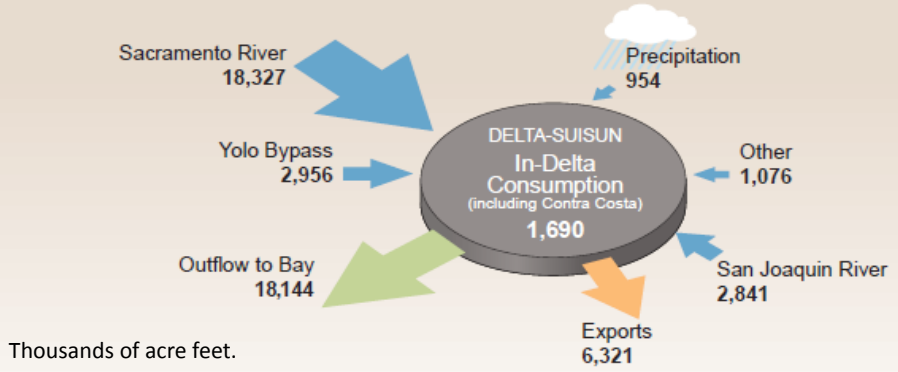
Source: Wikipedia

The Delta



Lund et al. (2007).

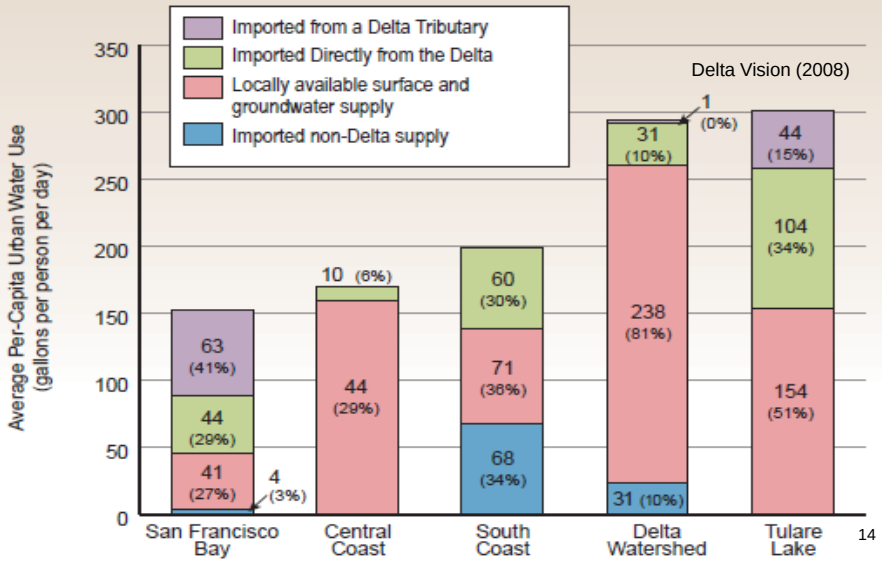
The Delta



Thousands of acre feet.

Delta Vision (2008)

The Delta



Delta Vision (2008)

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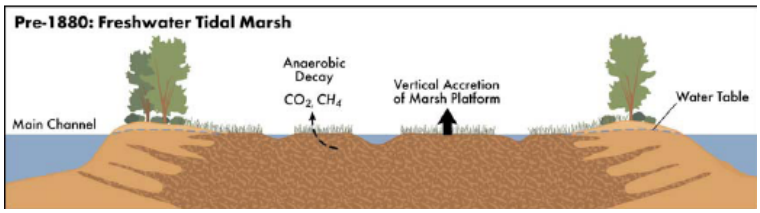
Pre-European Delta



Mount and Twiss (2005)

Delta Reclamation (1850-1930)

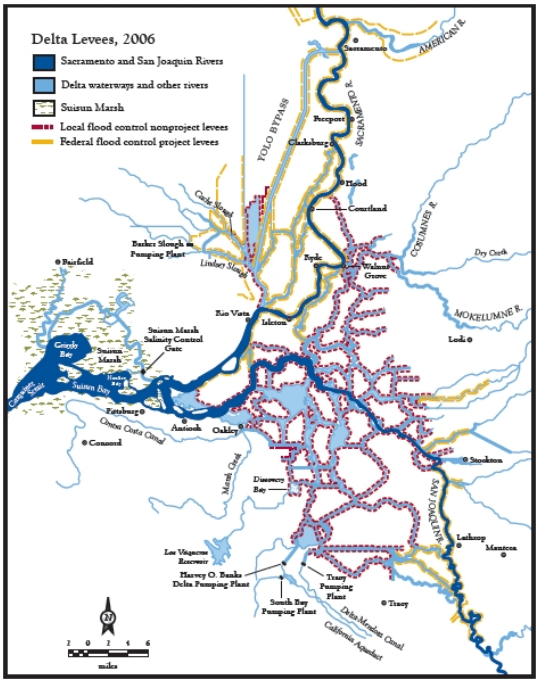
Delta Today

Multiple owners

1100 miles of levees; many marginally stable

Upper Jones Tract Failure 2004: $100 million repair

1900-2000: > 150 failures (non-seismic)



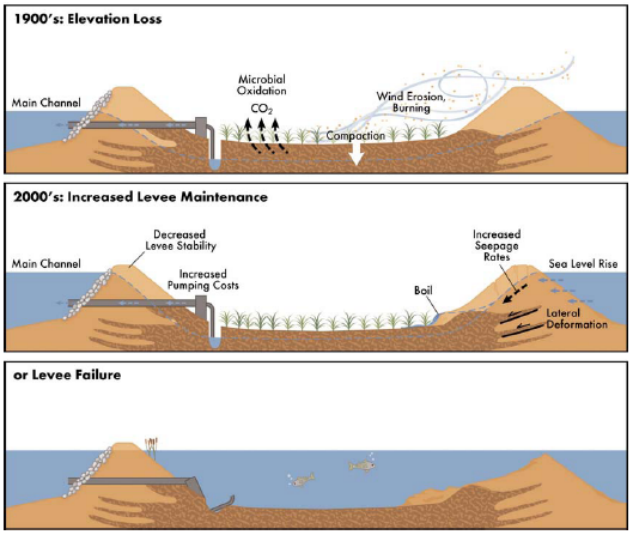
California Water Project

Requires fresh water at intake

Maintained in Delta waterways only by adequate outflow to push back the saline bay waters

For over 70 years, a fresh water Delta has been maintained by controlling the amount of outflow

Land Subsidence



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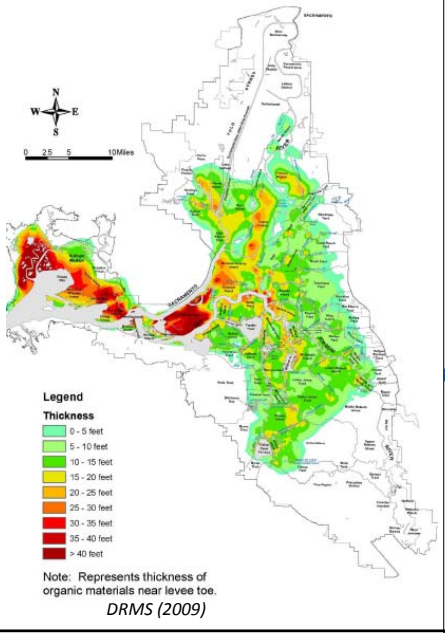
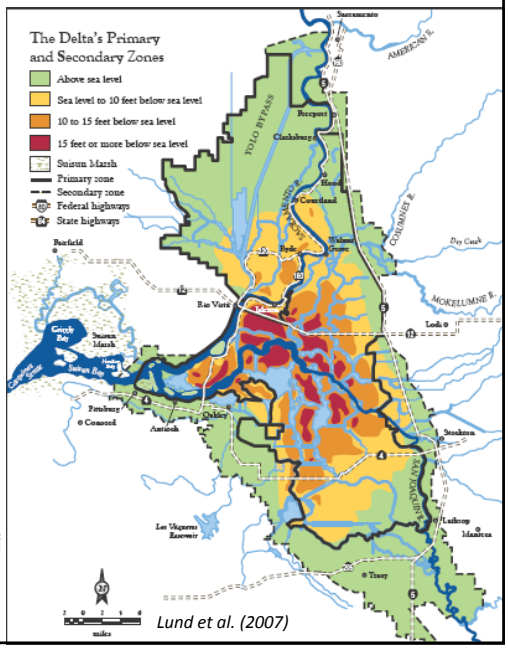
Land Subsidence

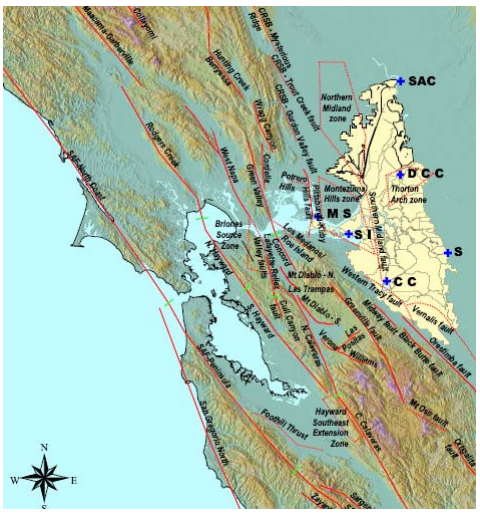


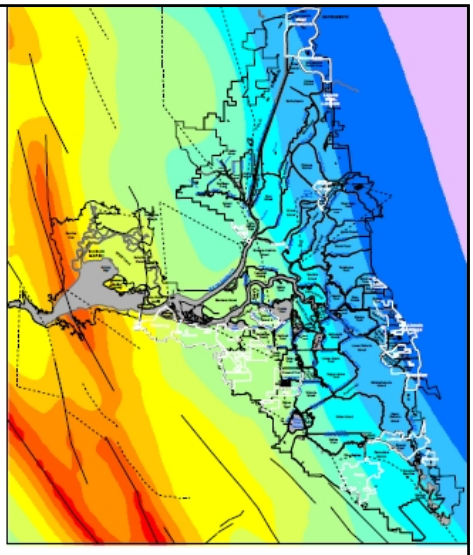
DRMS (2009)



Lund et al. (2007)

Seismic Hazard





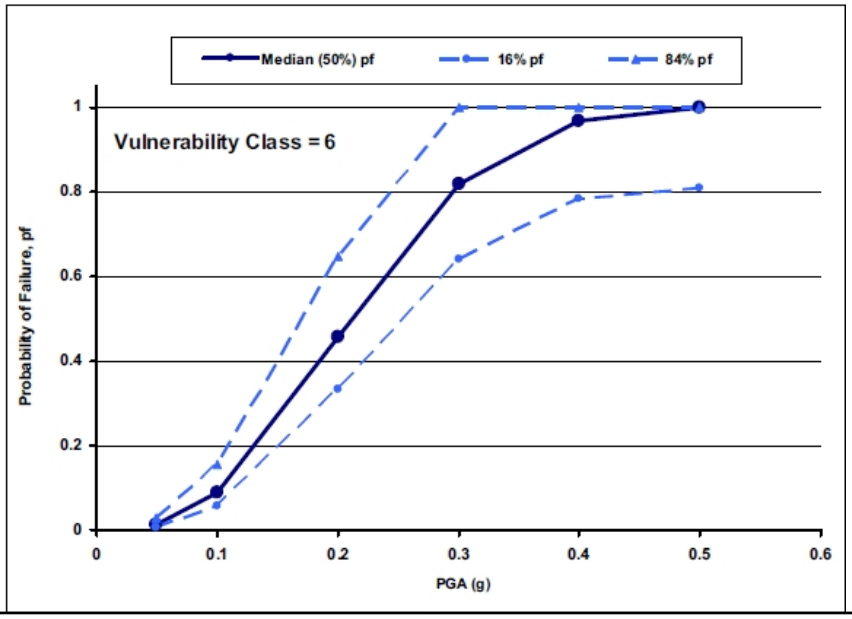
Legend

Mapped Faults
Surficial faults used in the hazard analysis
Blind Faults
Blind faults used in the hazard analysis
Legal Delta and Suisun March Boundary

PGA, 600 Year Return Period
0.00 - 0.10
0.11 - 0.15
0.16 - 0.20
0.21 - 0.25
0.26 - 0.30
0.31 - 0.35
0.36 - 0.40
0.41 - 0.45
0.46 - 0.50
0.51 - 0.55
0.56 - 0.60
0.61 - 0.65
0.66 - 0.70

Seismic Hazard

Delta Risk Management Strategy, 2009



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Video courtesy MWD and Curt Schmutte

Summary

- Northridge demonstrated water distribution system vulnerability to modest earthquake in urban LA
- Bigger threat is water supply from major aqueducts.
- Of the major aqueducts, CWP is most vulnerable.
- Huge impact for California if this occurs.