

An introduction to the source-to-sink sediment system of the Western Transverse Ranges

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NASA ESS Fellowship
USGS Mendenhall
USGS Coastal and Marine
SCCWRP

*Santa Clara River mouth,
January 1995*



California

(from MODIS Terra)



N



100 km

Eel

San
Francisco
Bay

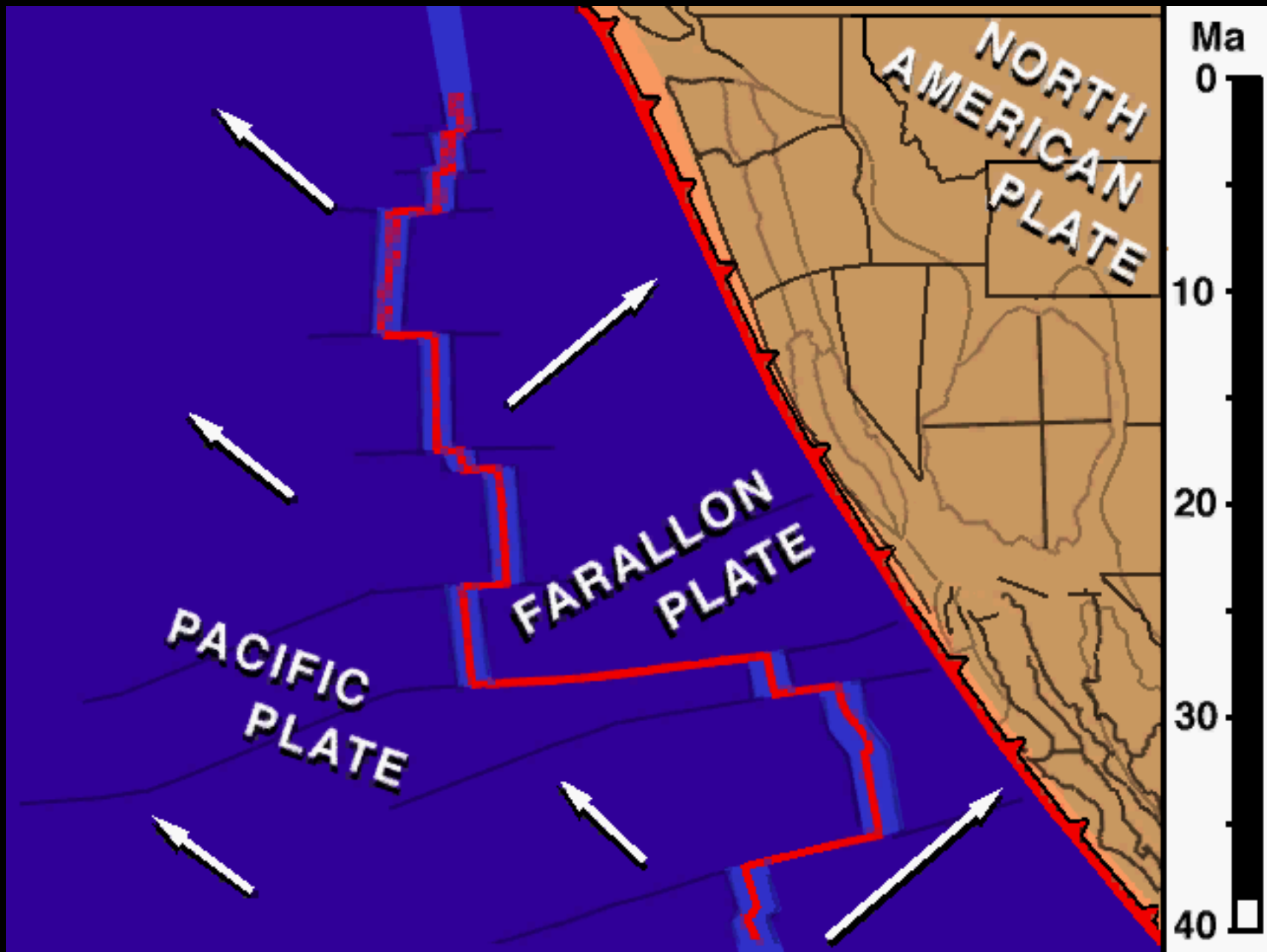
Western Transverse
Ranges

SAF

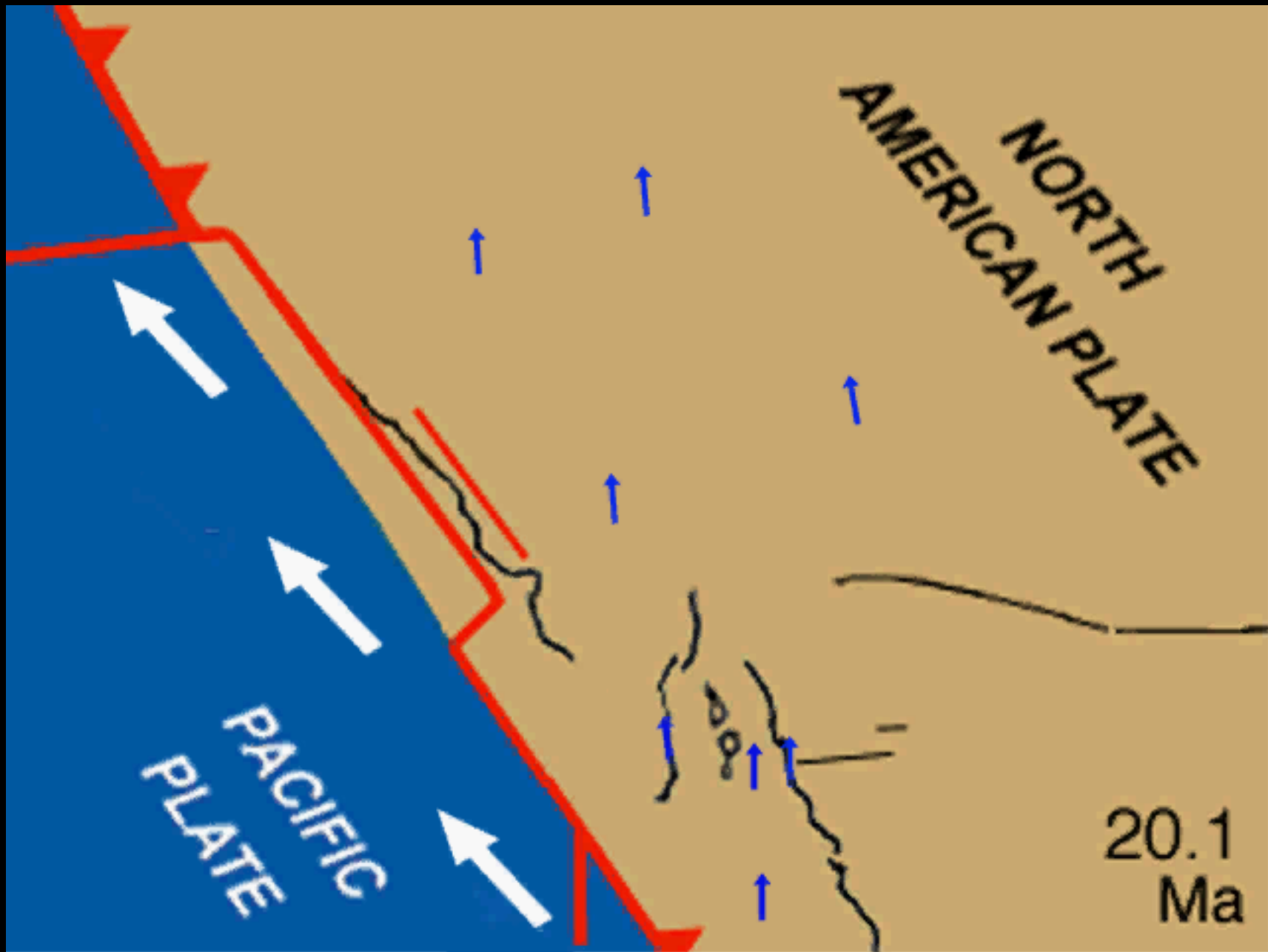
~20 million
people

California
Borderland

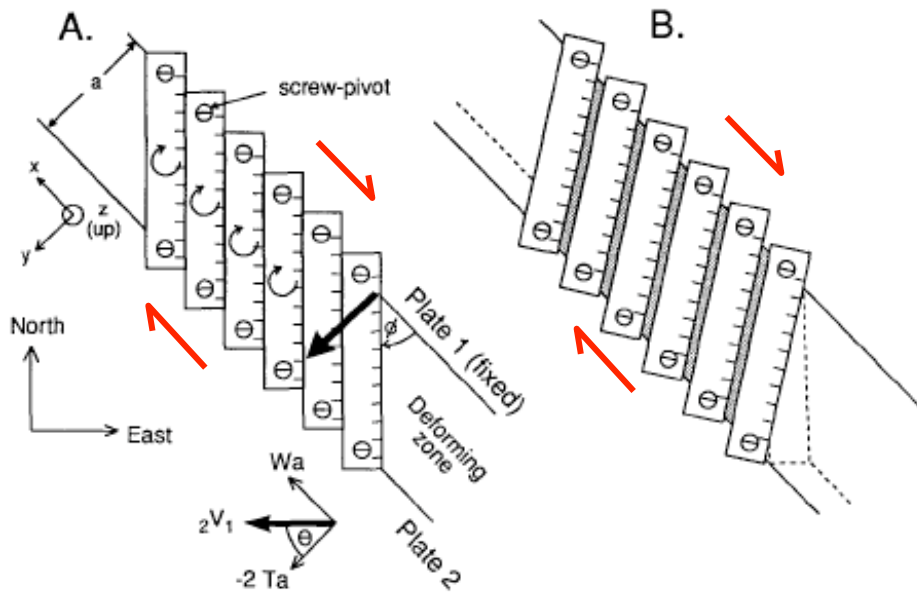
Drawn and animated by Tanya Atwater (UCSB)



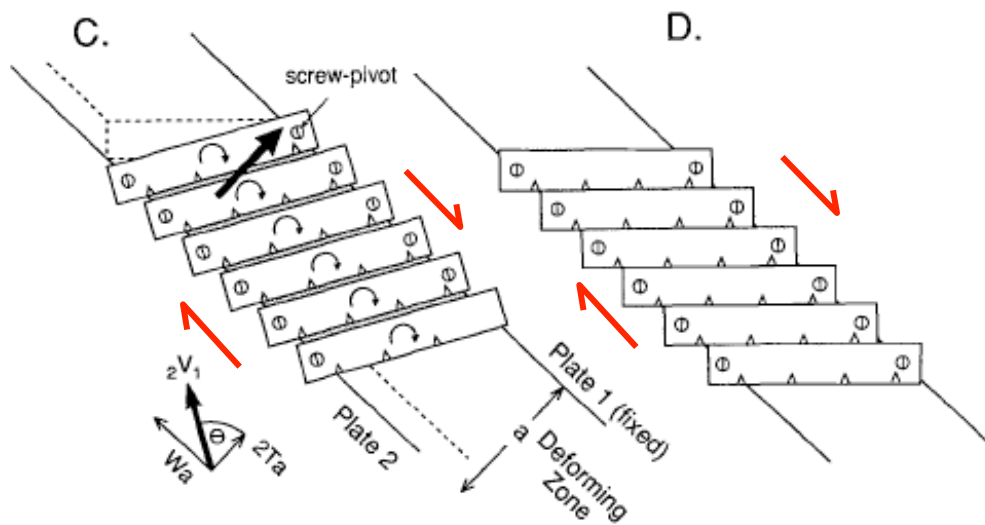
Drawn and animated by Tanya Atwater (UCSB)



MIDDLE MIOCENE
TRANSTENSION



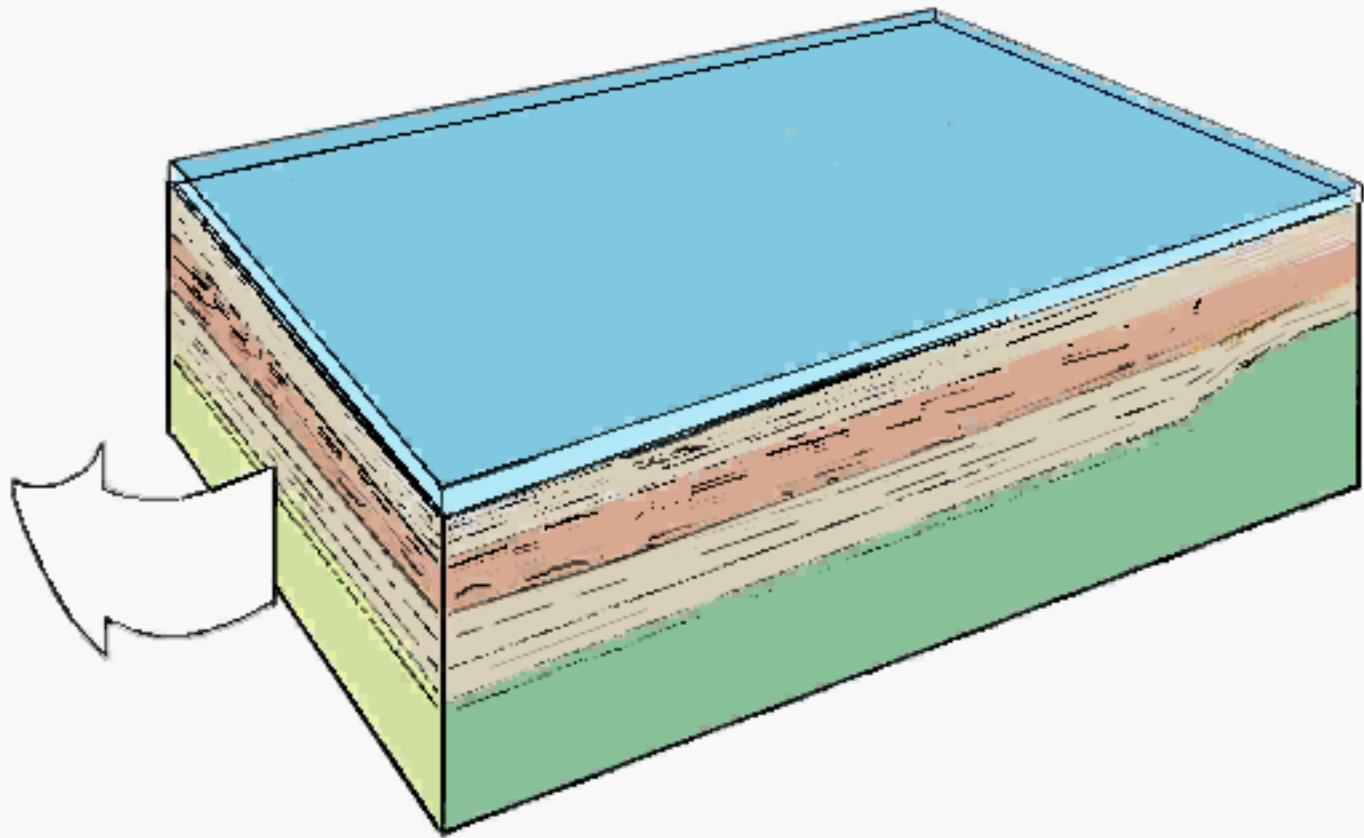
PLIOCENE/QUATERNARY
TRANSPRESSION



After Luyendyk (2001) **GSAB**

Miocene

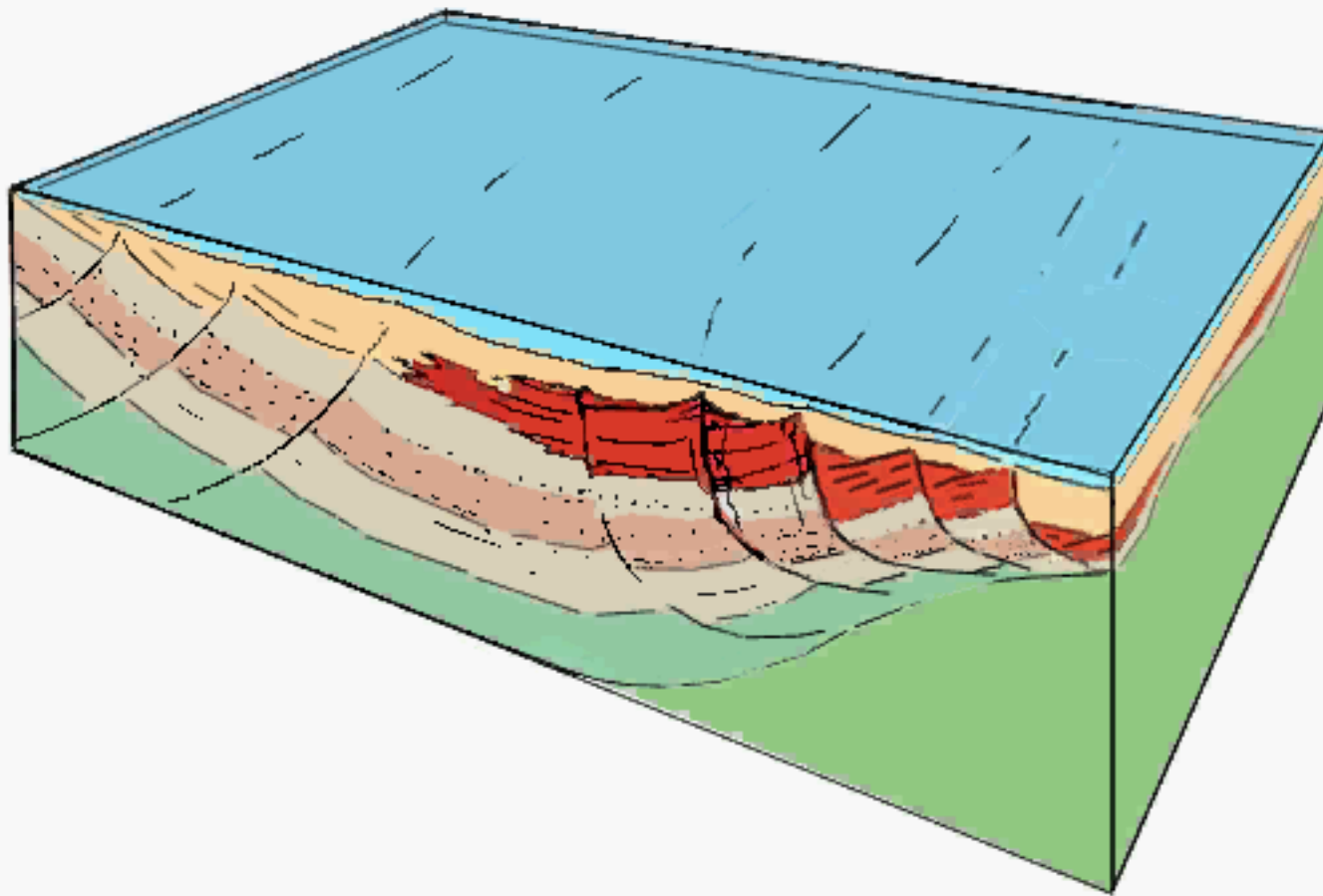
Rifting and rotation, volcanism, crustal upwelling and deposition in marine basins



Drawn and animated by Tanya Atwater (UCSB)

Plio-Pleistocene

Oblique Shortening against the "Big Bend"



Drawn and animated by Tanya Atwater (UCSB)



Oak Ridge
Santa Clara
River

Ventura Avenue
Anticline

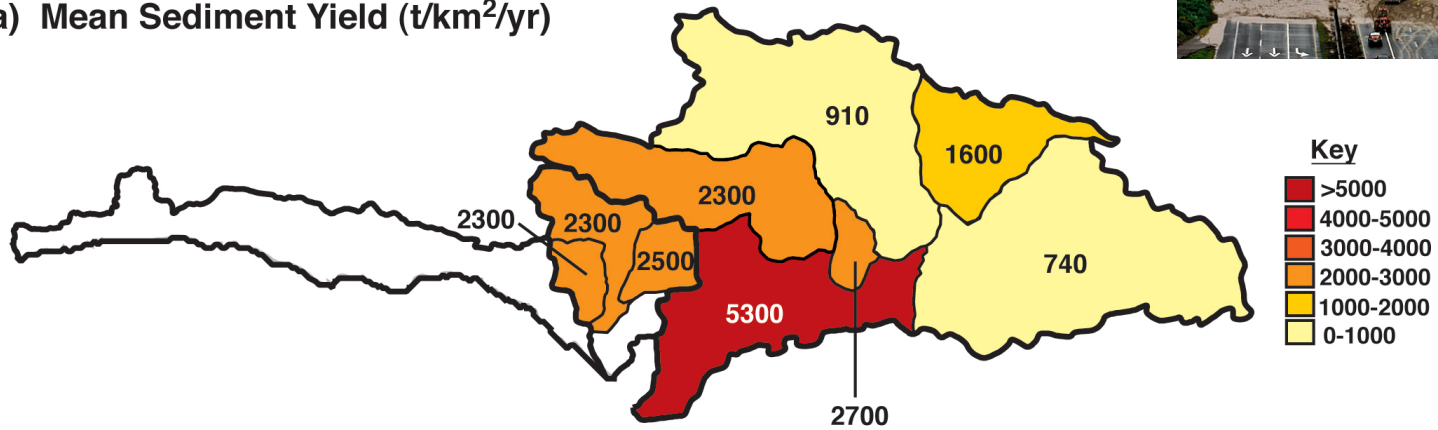
Sespe Creek



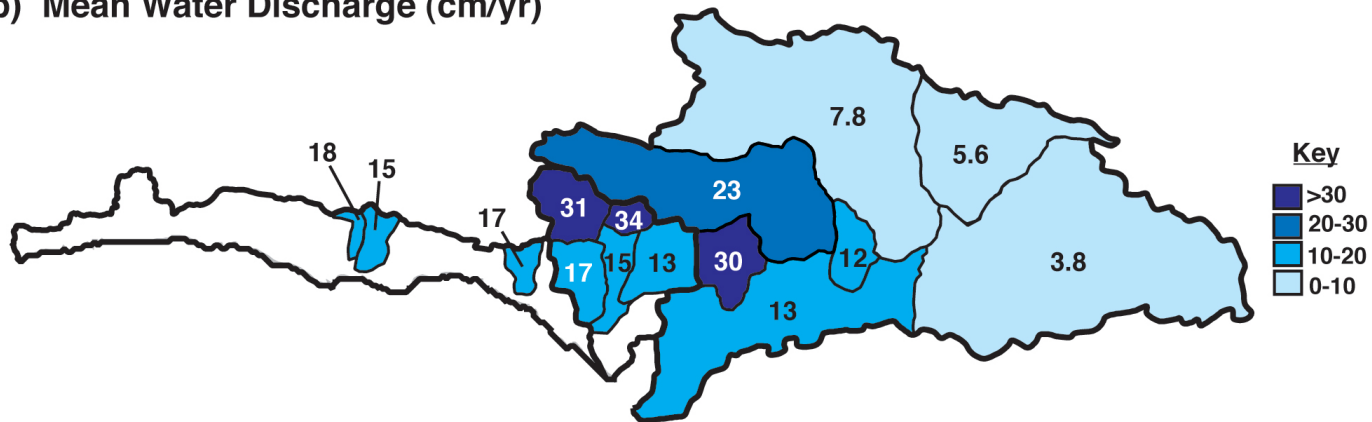
Western Transverse Range Watersheds (1969-1999)



(a) Mean Sediment Yield ($t/km^2/yr$)

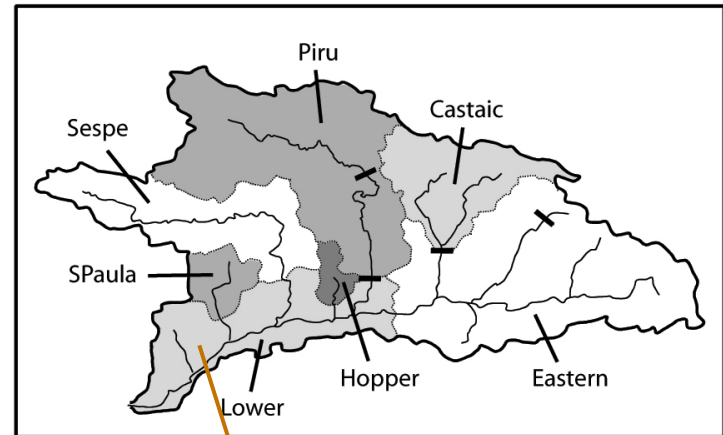
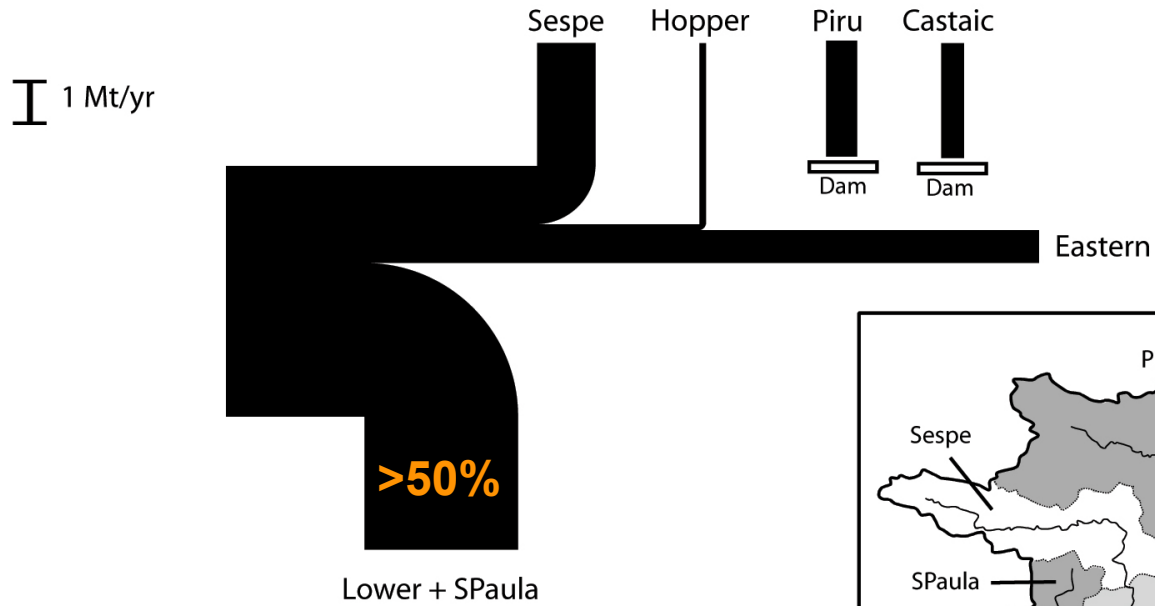


(b) Mean Water Discharge (cm/yr)



Santa Clara River

(a) Mean Annual Suspended Sediment Budget

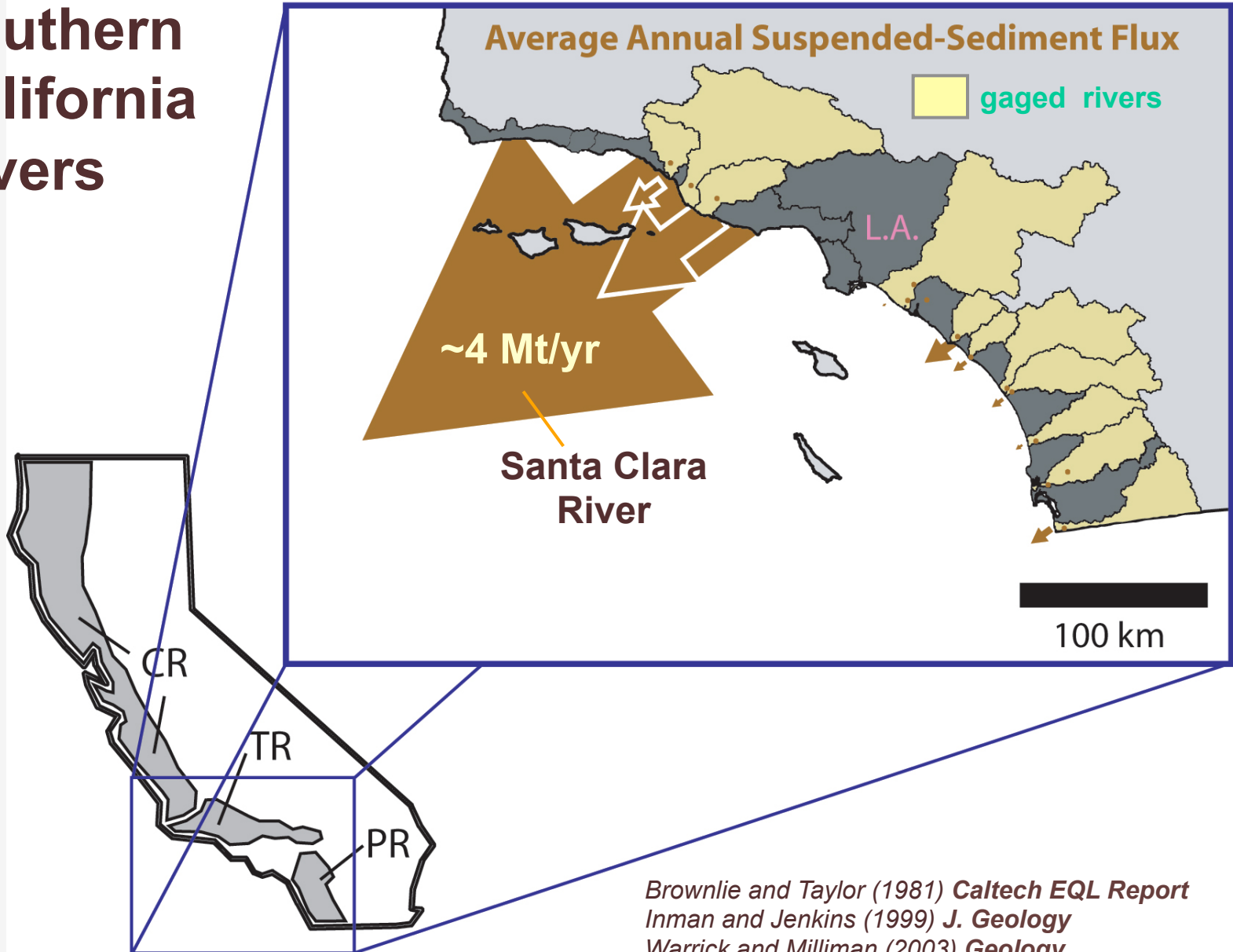


~10%



Warrick and Mertes (2009) **GSAB**

Southern California Rivers

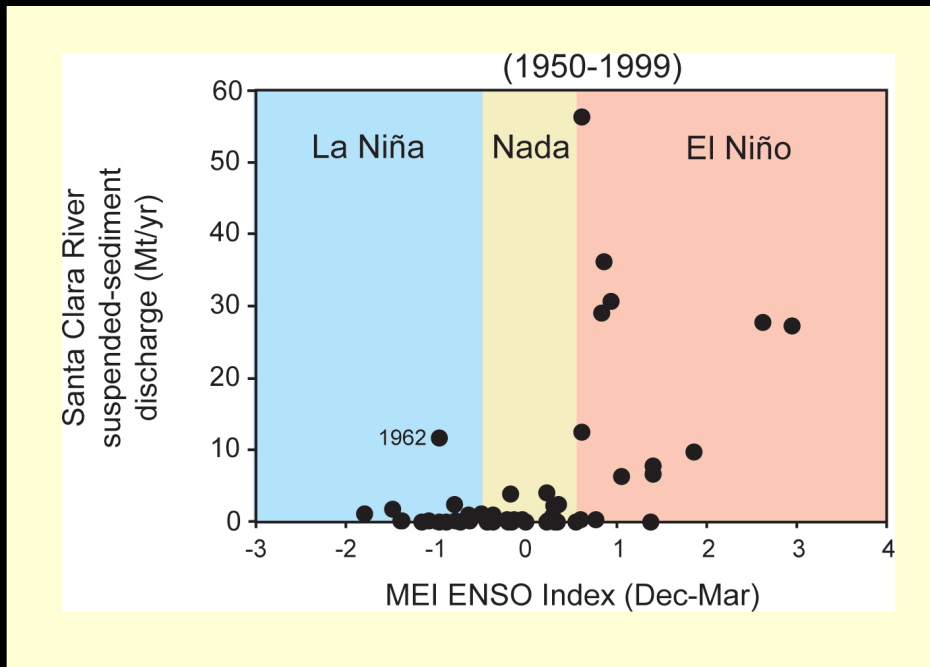
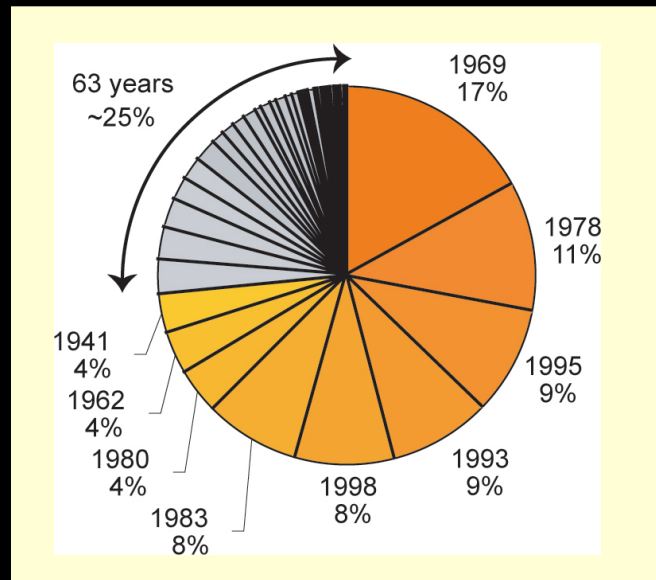


Brownlie and Taylor (1981) *Caltech EQL Report*
Inman and Jenkins (1999) *J. Geology*
Warrick and Milliman (2003) *Geology*
Farnsworth and Warrick (2007) *USGS SIR*



Santa Clara River sediment discharge (1928-1999)

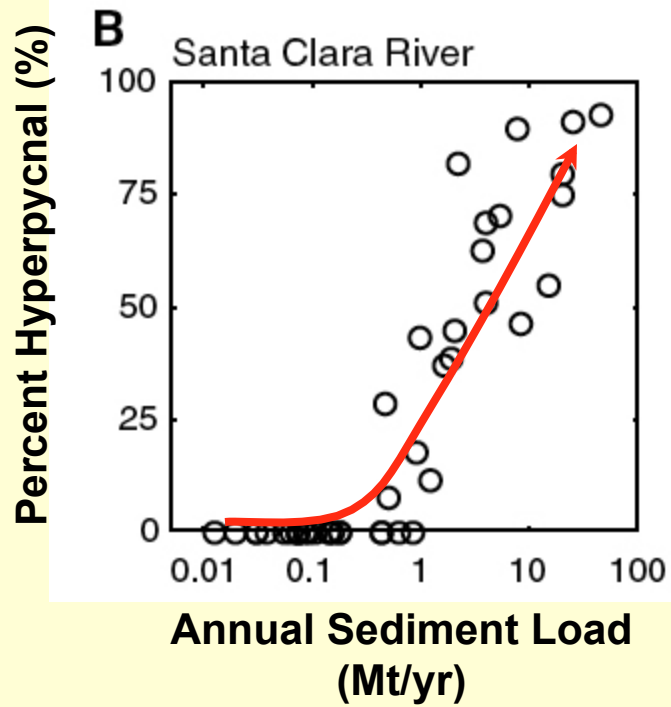
Interannual variation...



*Brownlie and Taylor (1981) Caltech EQL Report
Inman and Jenkins (1999) J. Geology
Warrick and Milliman (2003) Geology
Farnsworth and Warrick (2007) USGS SIR*

Hyperpycnal Discharge.

Using 40 g/l Threshold...



A 1998 flood ...



Coastal Dispersal of River Sediment

Photo courtesy of the
California Coastal Conservancy, taken in 2005

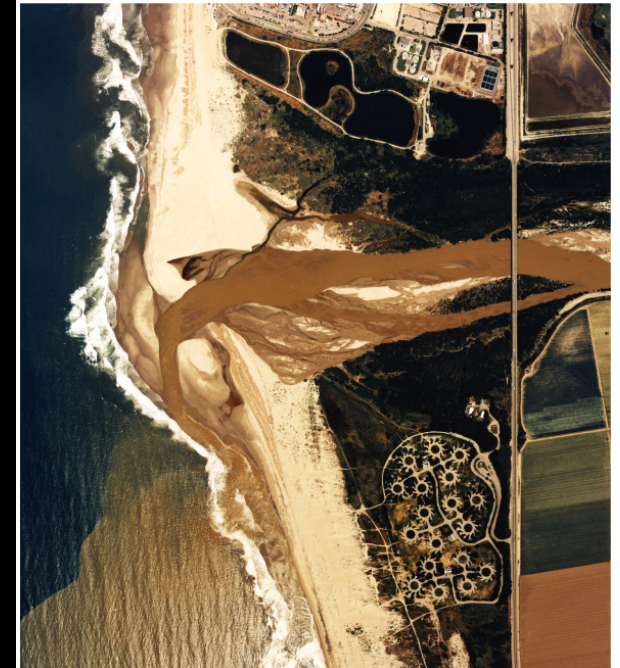
Barnard and Warrick (2009)
Marine Geology



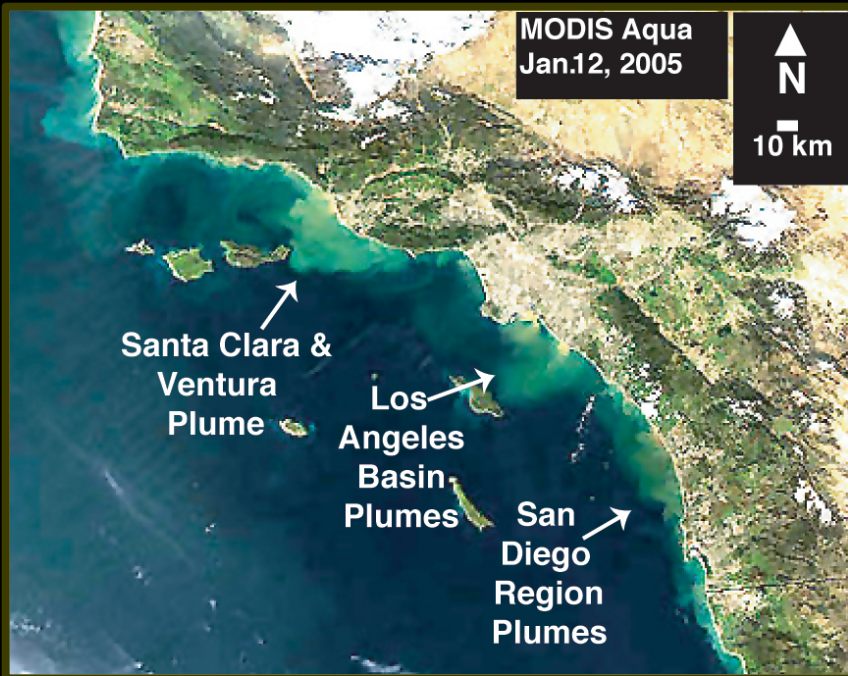
(a) March 17, 1987



(b) April 14, 1993

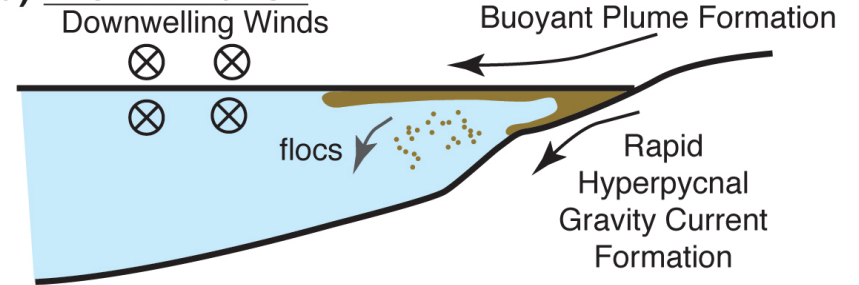


Hyperpycnal plumes

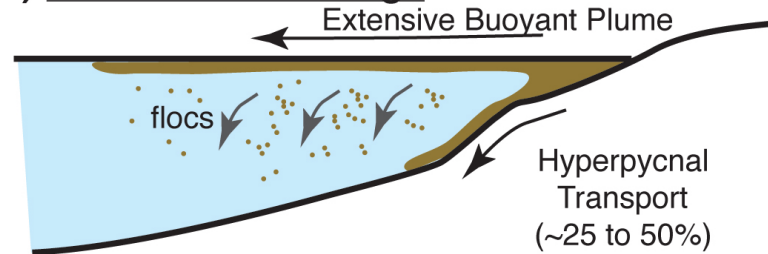


Warrick et al. (2007) **Continental Shelf Research**
Warrick et al. (2008) **Continental Shelf Research**

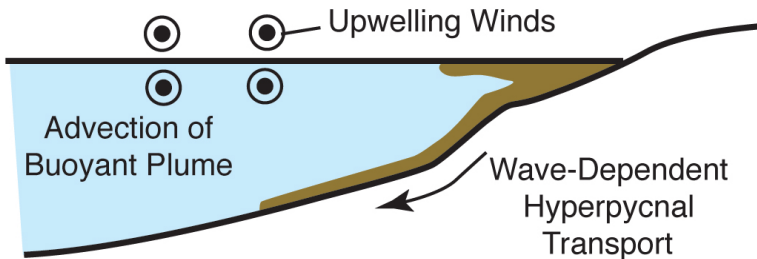
(a) Event Initiation



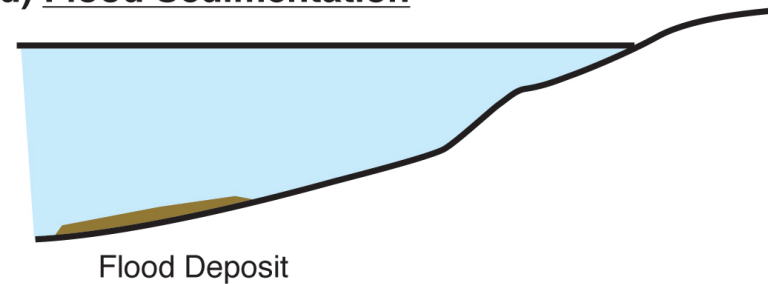
(b) Peak River Discharge



(c) Post-Event Dynamics

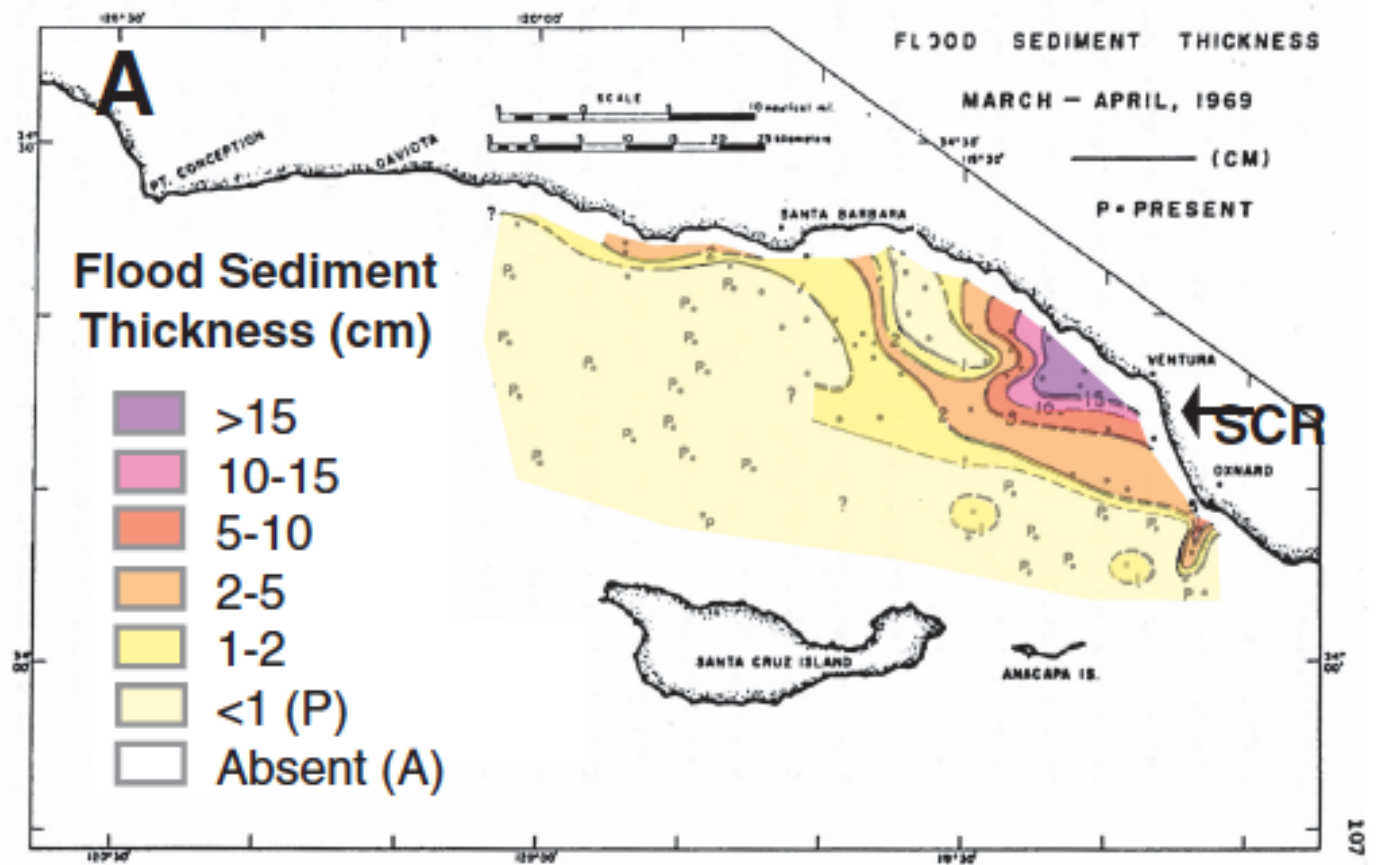


(d) Flood Sedimentation



Post-Flood Mud Deposition

Drake (1972)





science for a changing world



USGS Mendenhall Postdoctoral
Research Fellowship Program

Thank You.

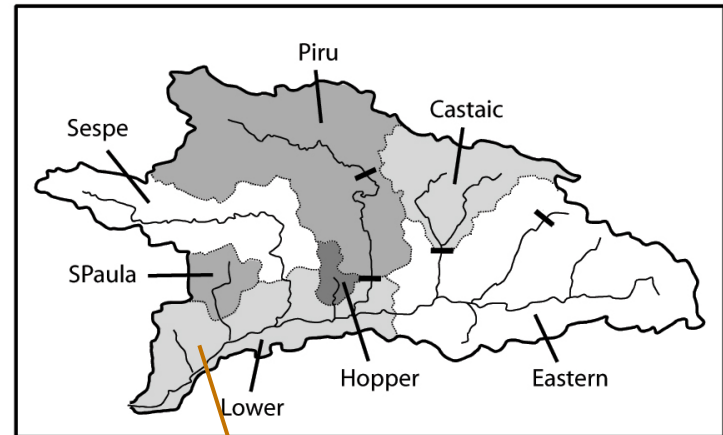
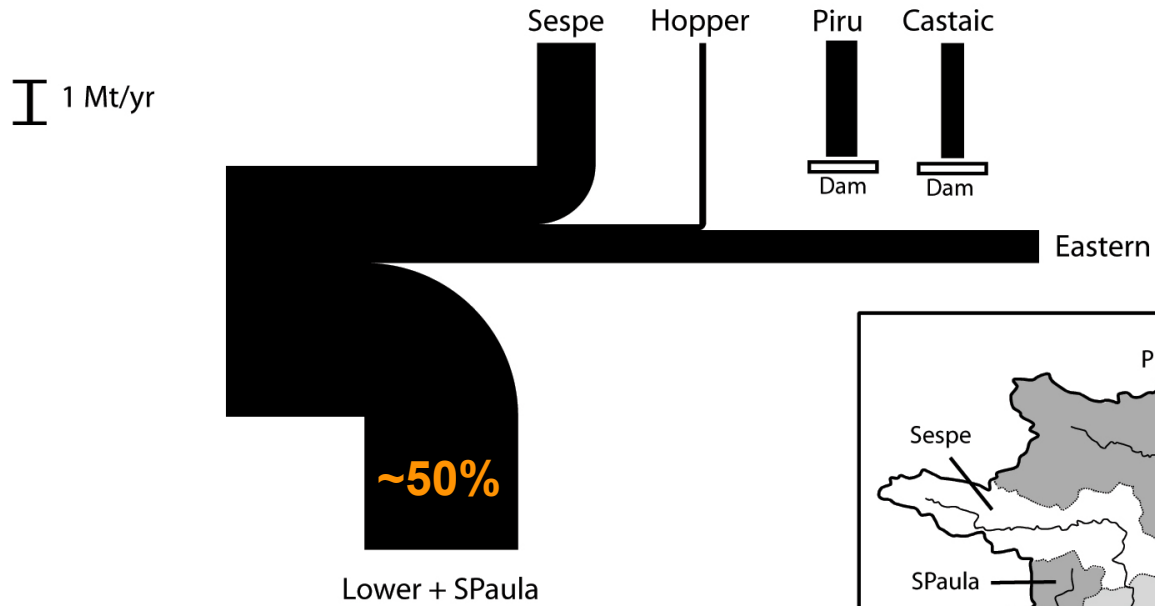
For More Info:

jwarrick@usgs.gov



Santa Clara River

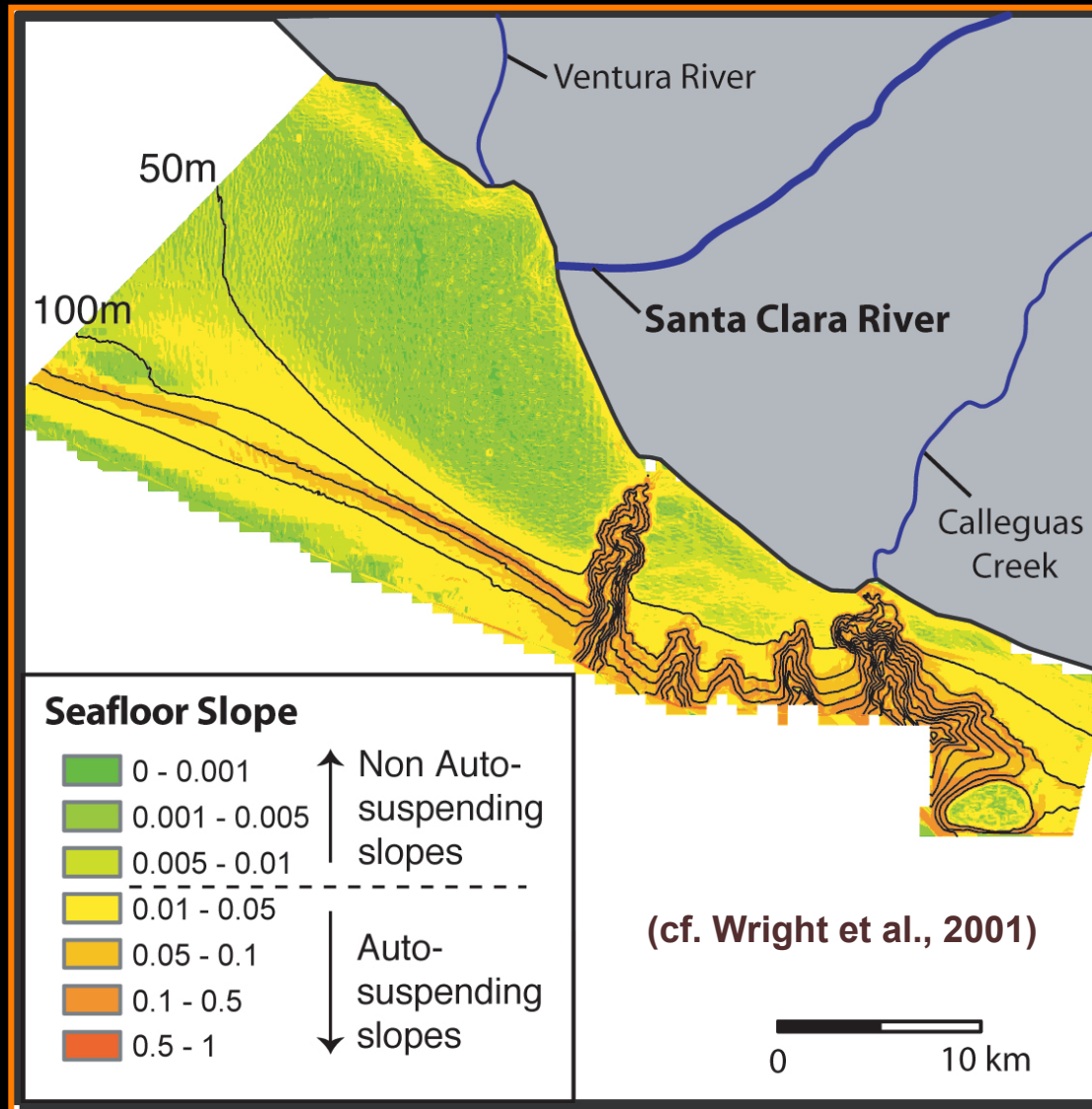
(a) Mean Annual Suspended Sediment Budget



~10%

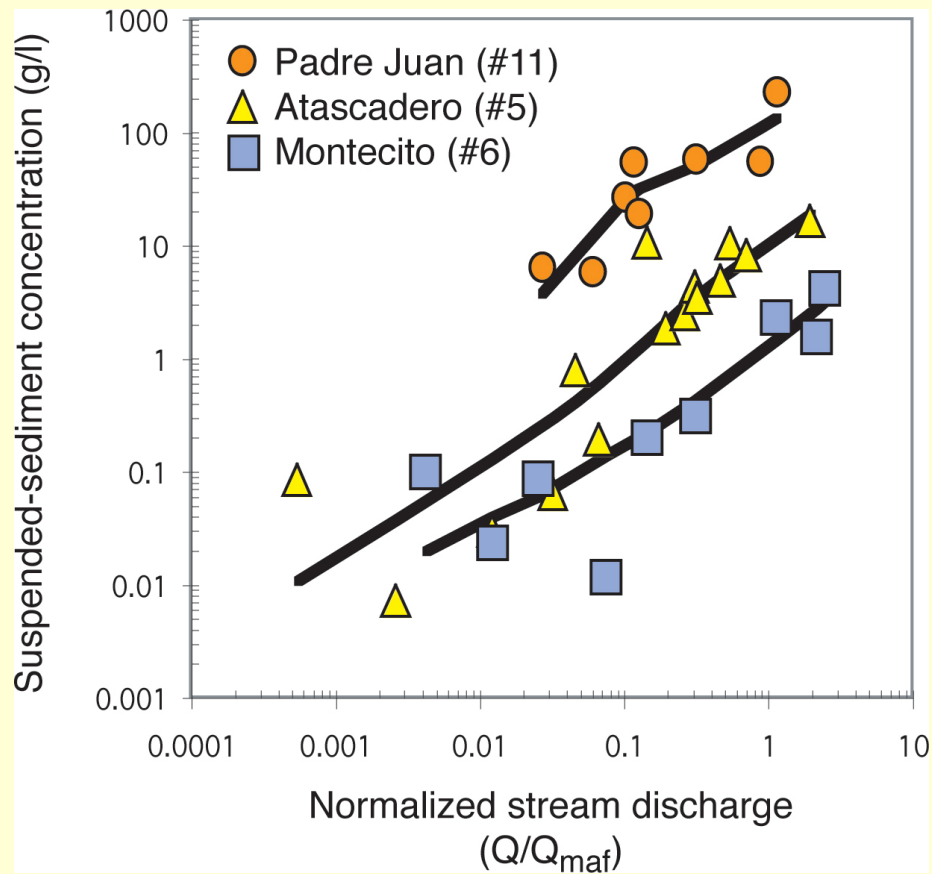
Warrick and Mertes (2009)





**Santa Clara River sediment gravity currents
cannot be auto-suspending.**

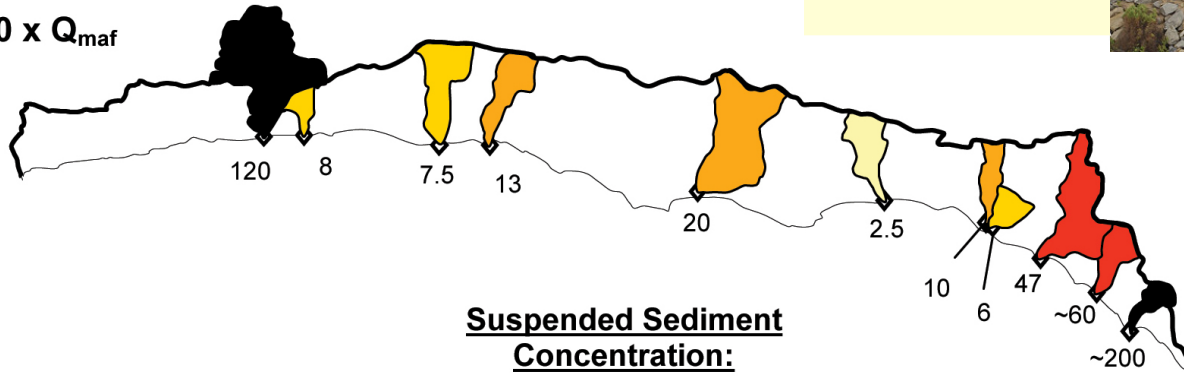
Santa Ynez Mountain Watersheds (1997-2000)



Warrick and Mertes (in press)

Santa Ynez Mountain Watersheds (1997-2000)

e) $2.0 \times Q_{maf}$

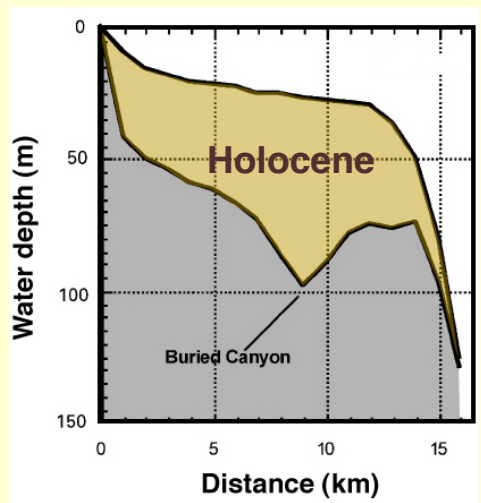
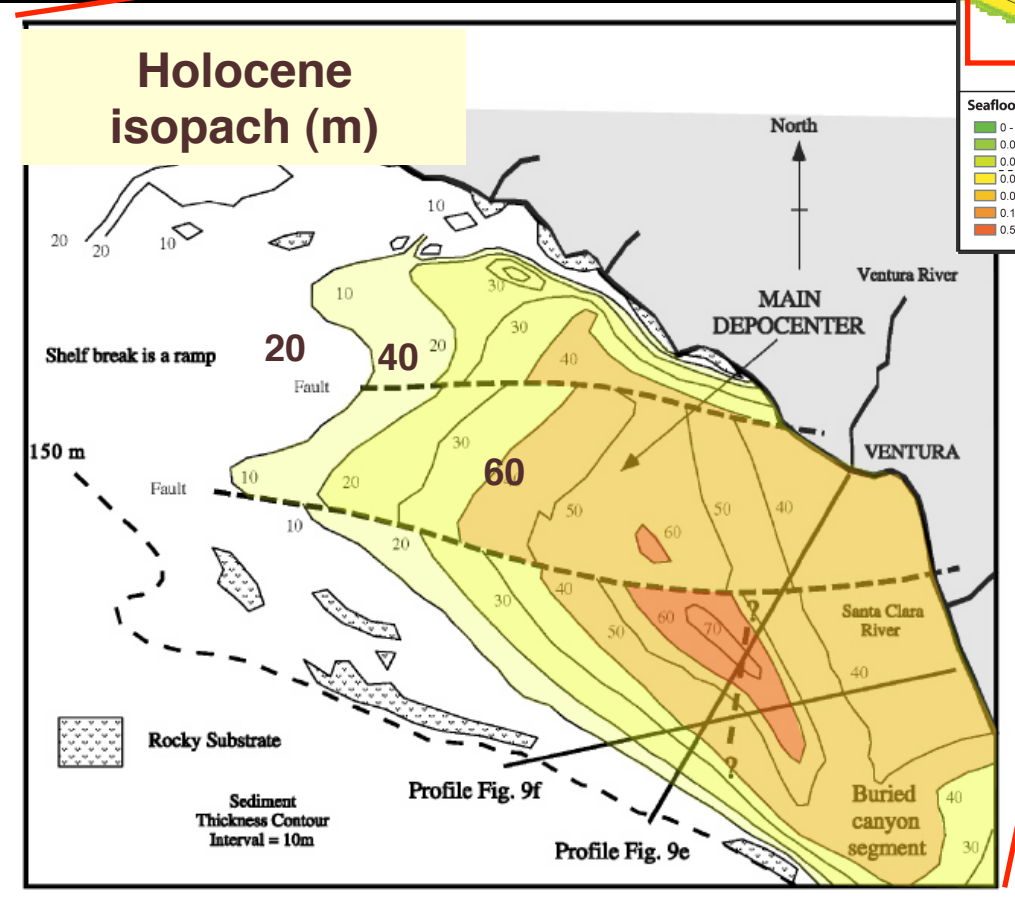
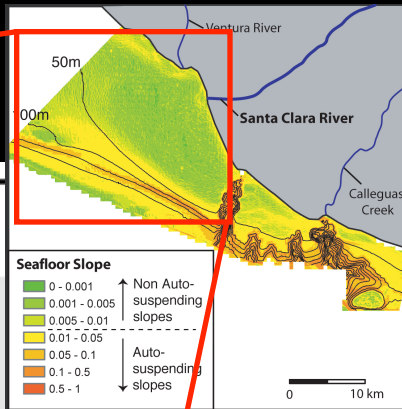


Suspended Sediment Concentration:

10 km



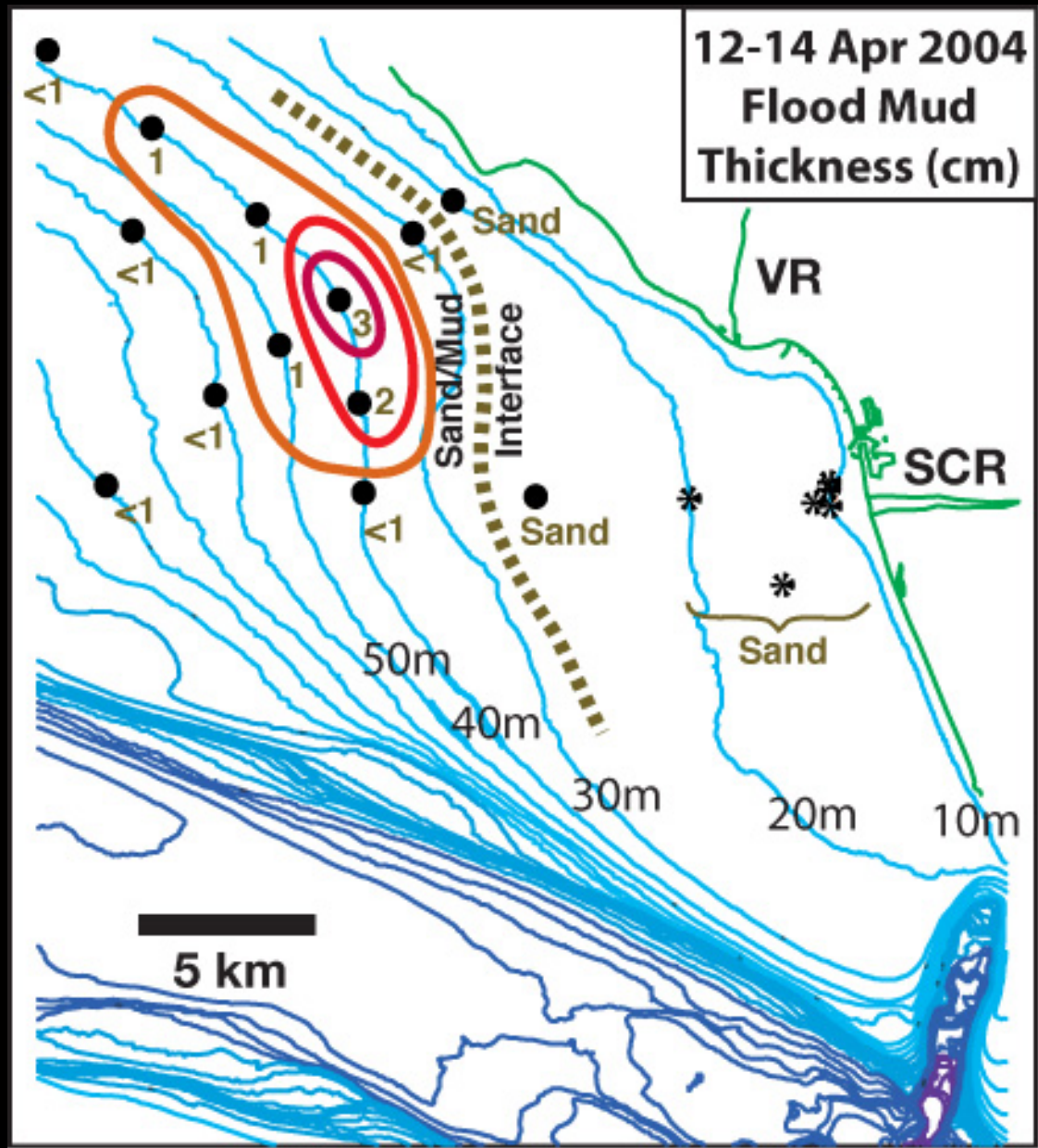
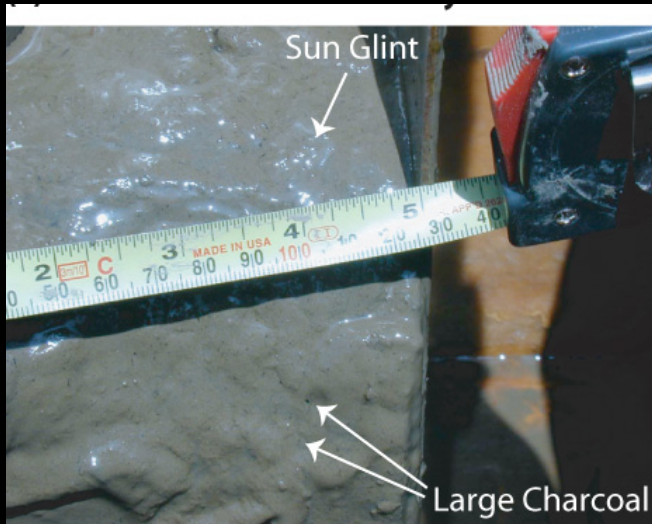
Warrick and Mertes (in press)



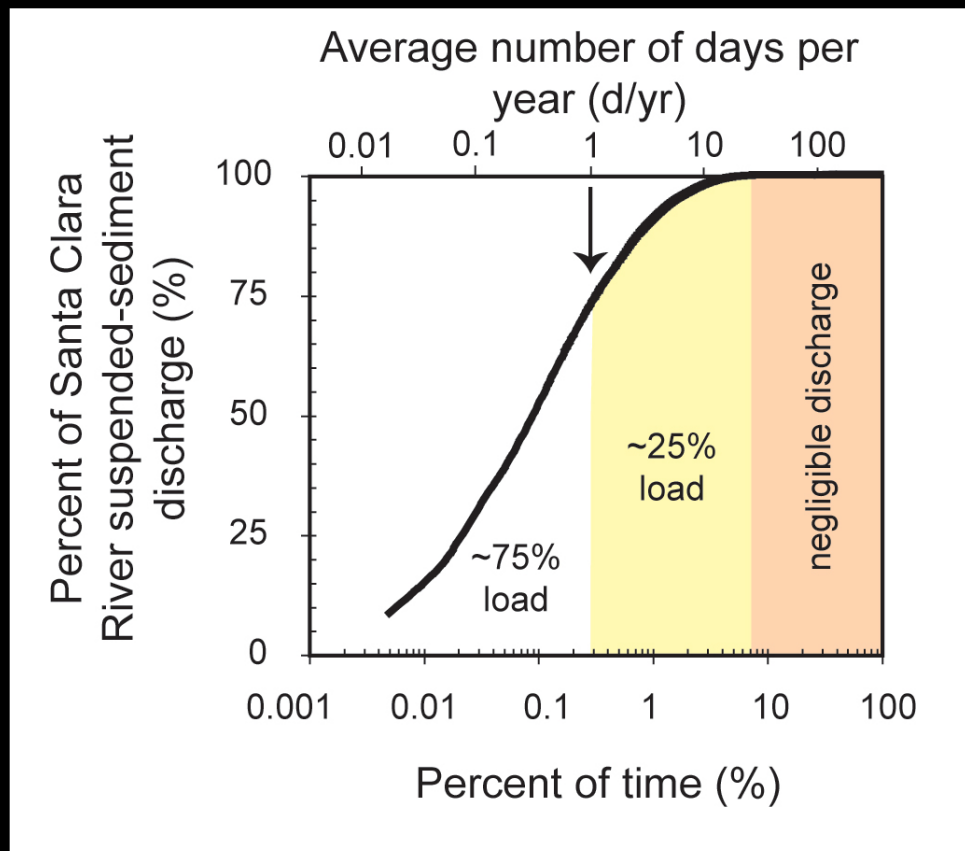
Slater et al. (2002)

Slater et al. (2002)

2004 FLOOD SEDIMENT DEPOSIT



Infrequent Events are Important.



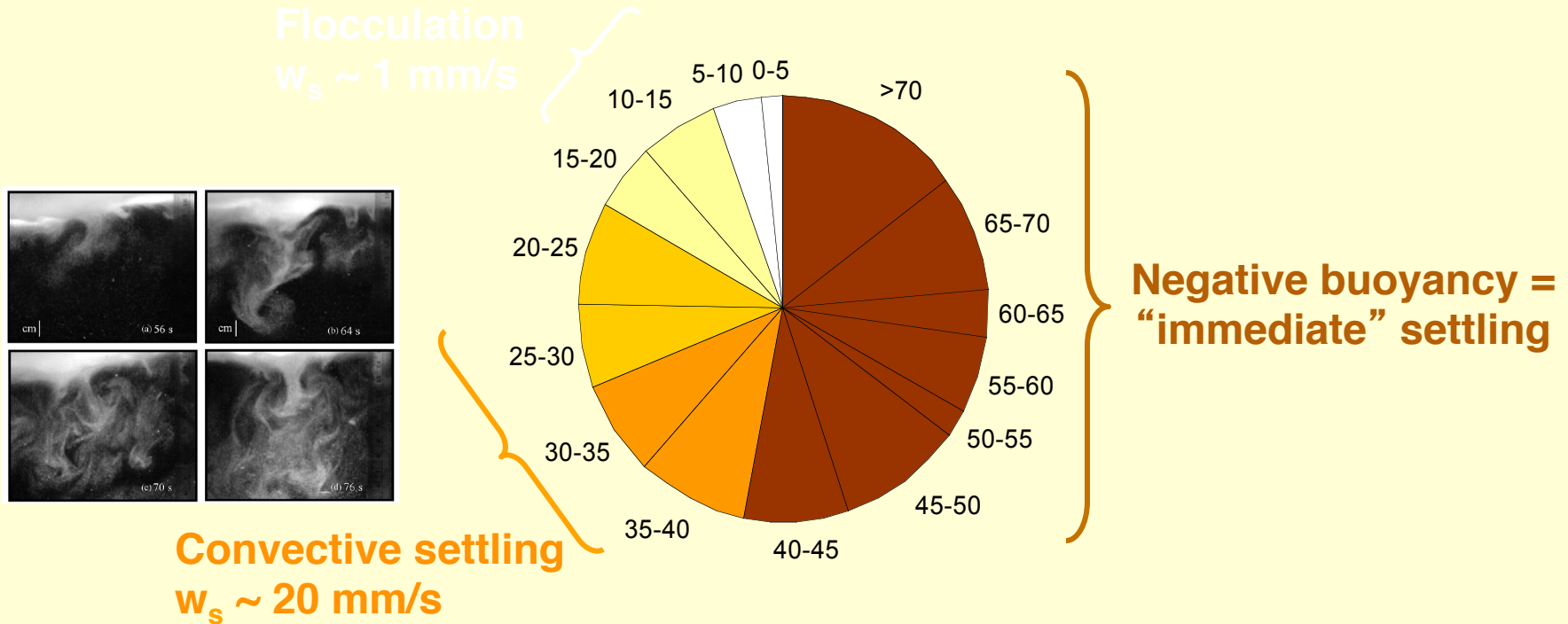
Warrick and Milliman (2003)
Farnsworth and Warrick (2007)



Landscape photos



Suspended-Sediment Concentration (g/l) of Santa Clara River Sediment Load

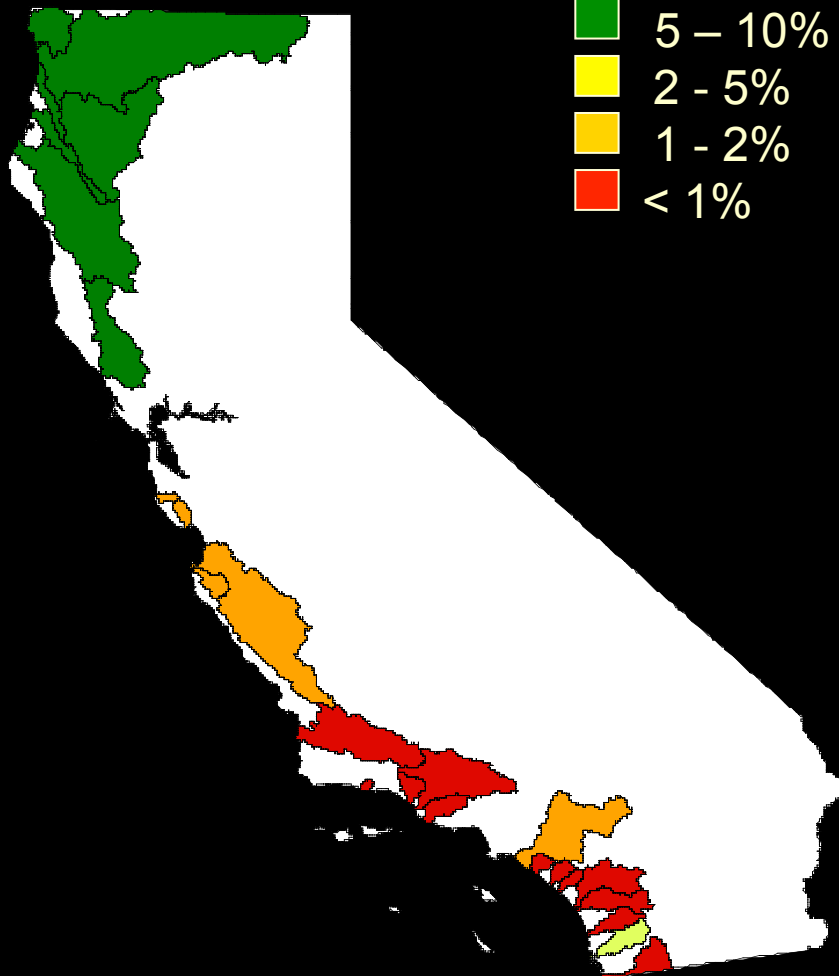
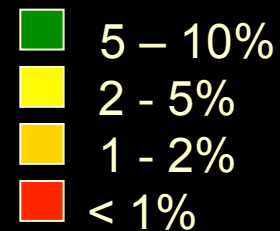


Bates (1953)
Mulder and Syvitski (1995)
Hill et al. (2000)
Warrick and Milliman (2003)
McCool and Parsons (2004)



River Events for California

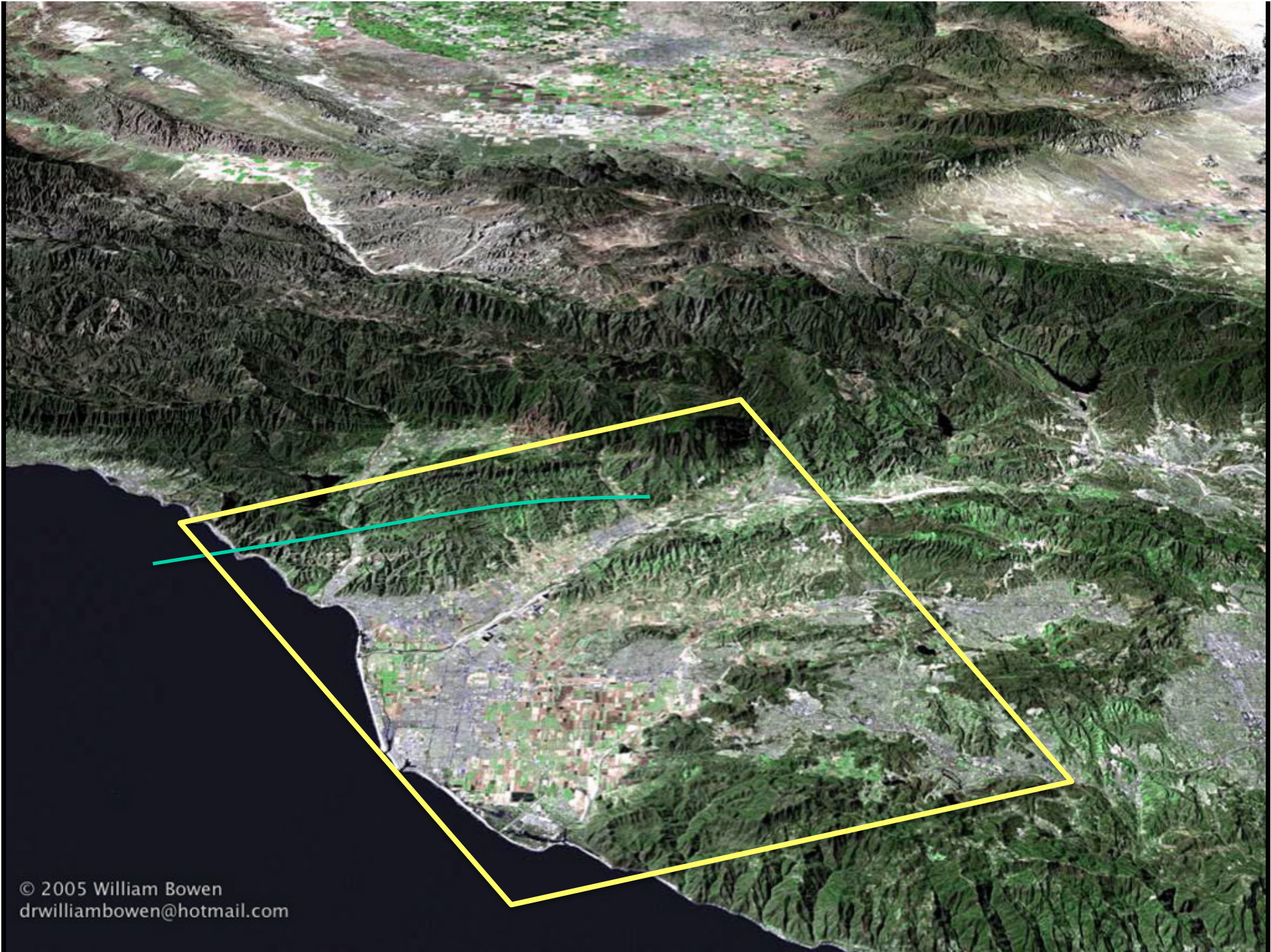
Percent of time to deliver **90%** of total sediment load



Farnsworth and Warrick (2007)
Warrick and Milliman (2003)



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