

Sediment sources and transport in the Santa Clara River watershed

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And: Yantao Cui, John Wooster, and many more

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Oxnard, CA
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Photo taken by the Coastal Conservancy, Jan 2005



Stillwater Sciences

GEOGRAPHY

Santa Cruz Island

- Tectonics
- Climate
- Geology
- Topography
- Wildfire
- Land cover/use

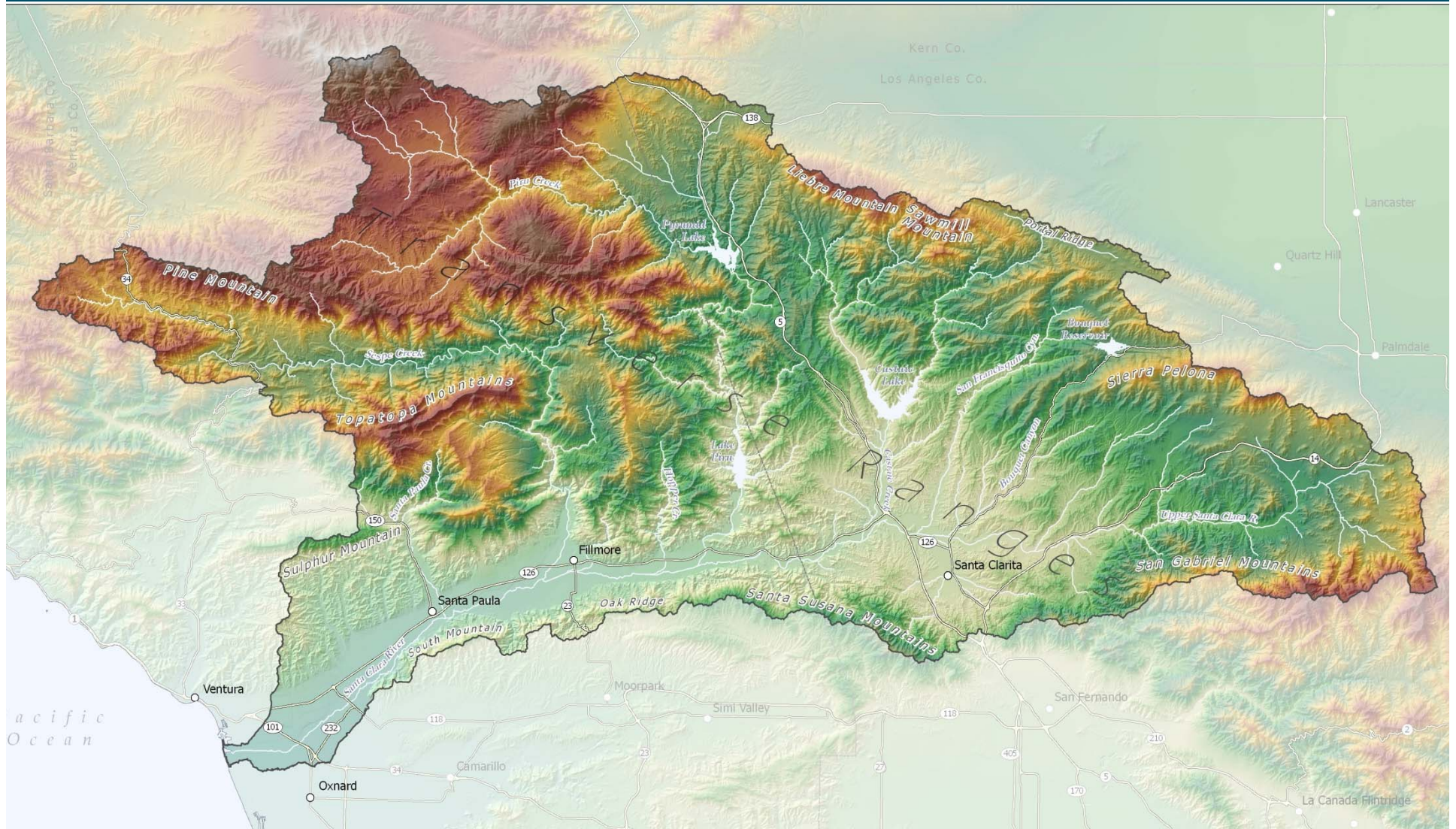
Santa Paula Creek

Santa Clara River

Sespe Creek

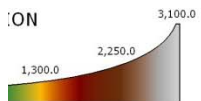


SEDIMENT SOURCES?



Mountain ranges and elevations in the SCR watershed and vicinity

Santa Clara River Watershed, Ventura Co. and Los Angeles Co.

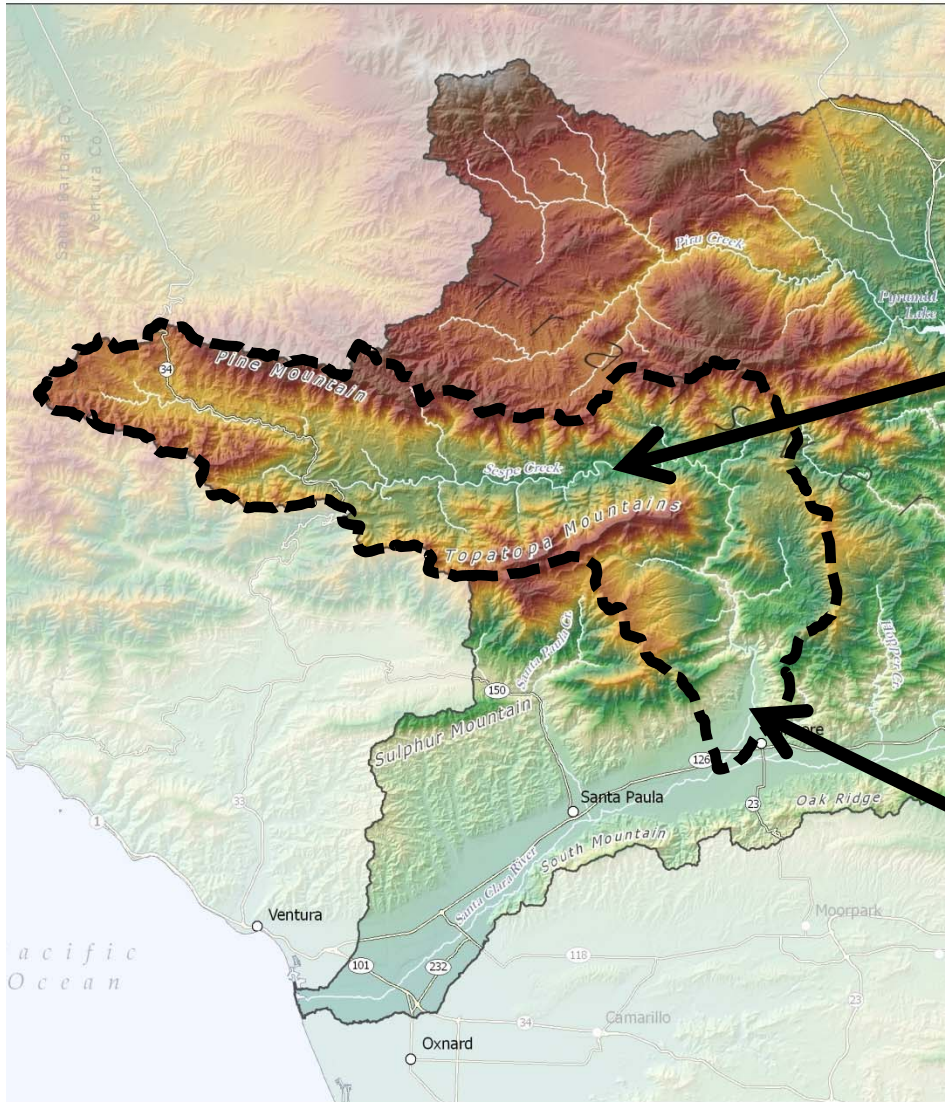


Source data:
 Hillshade: 30m DEM; Roads: ESRI 2008
 Streams and lakes: NHD; Counties: CaSIL
 Santa Clara R. watershed: Stillwater Sciences
 Elevation: 10m DEM

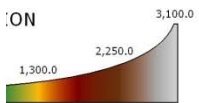


Sierra

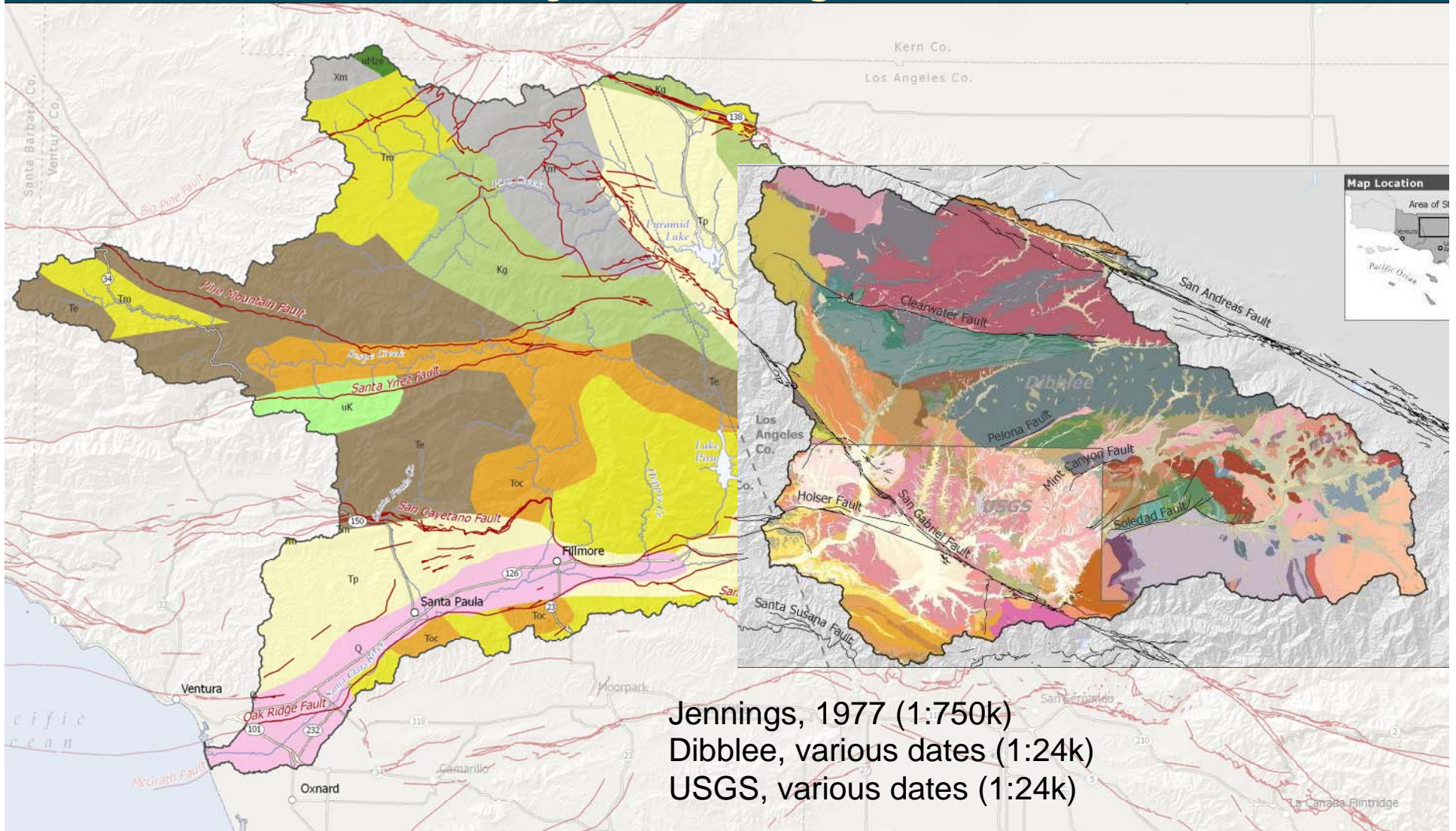
SEDIMENT SOURCES?



Elevation ranges and elevations in the SCR watershed and vicinity



GEOLOGY: Diversity of lithologic units



Jennings, 1977 (1:750k)
 Dibblee, various dates (1:24k)
 USGS, various dates (1:24k)

Geologic map showing major rock units and fault traces in the SCR watershed

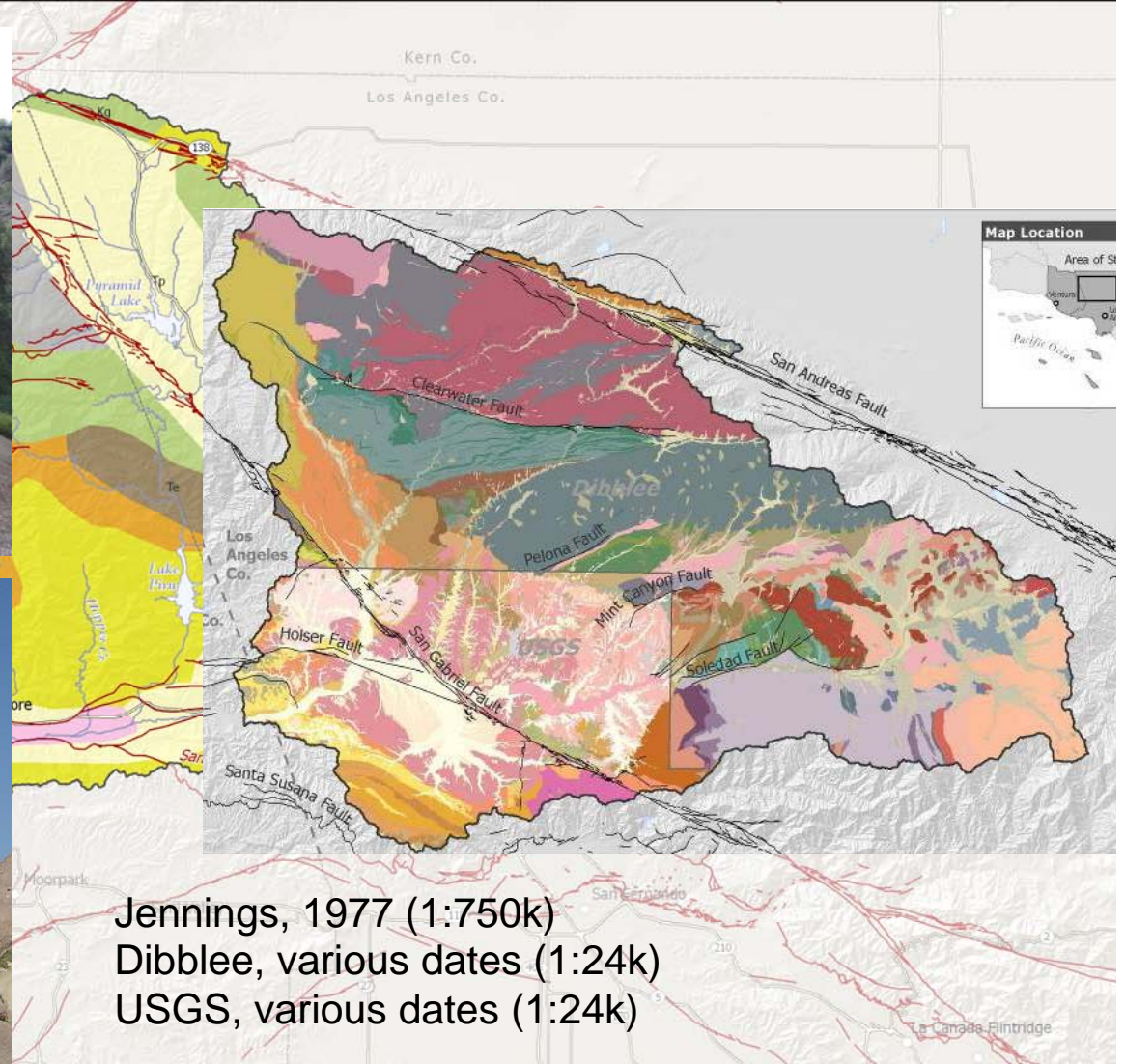
- | | | | |
|-----------------------------|--------------------------------------|--|-------------------------|
| Quaternary alluvium | Te: Eocene marine deposits | uMze: Upper Mesozoic eugeosynclinal deposits | — Fault lines (approx.) |
| Eocene marine deposits | ITV: Lower Tertiary volcanics | Pzg3: Upper Paleozoic granitic | |
| Eocene marine deposits | uK: Upper Cretaceous marine deposits | Xm: Precambrian metamorphic | |
| Eocene continental deposits | Kg: Cretaceous granitic | Ya: Precambrian anorthosite | |

Santa Clara River Watershed, Ventura Co. and Los Angeles Co.

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 Geology and faults: USGS



GEOLOGY: Diversity of lithologic units



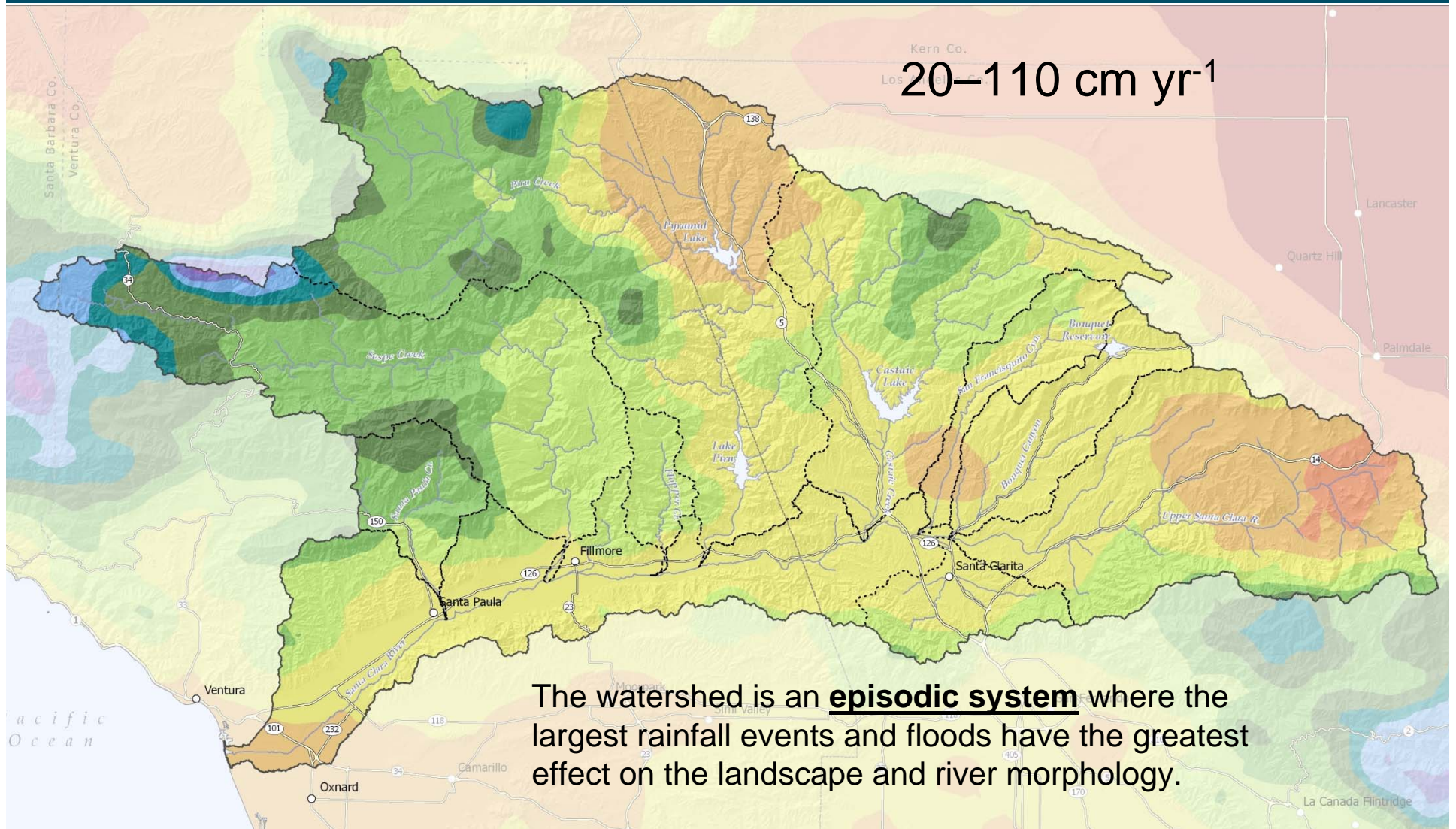
Santa Clara River Watershed, Ventura Co. and Los A

Source data:
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 Streams and lakes: NHD; Counties: CA-SIL
 Santa Clara R. watershed: Stillwater Sciences
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0 5 10 Miles

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CLIMATE: Semi-arid → Episodic system



20–110 cm yr⁻¹

The watershed is an **episodic system** where the largest rainfall events and floods have the greatest effect on the landscape and river morphology.

Distribution of average annual precipitation across the SCR watershed based on data from the period 1971–2000

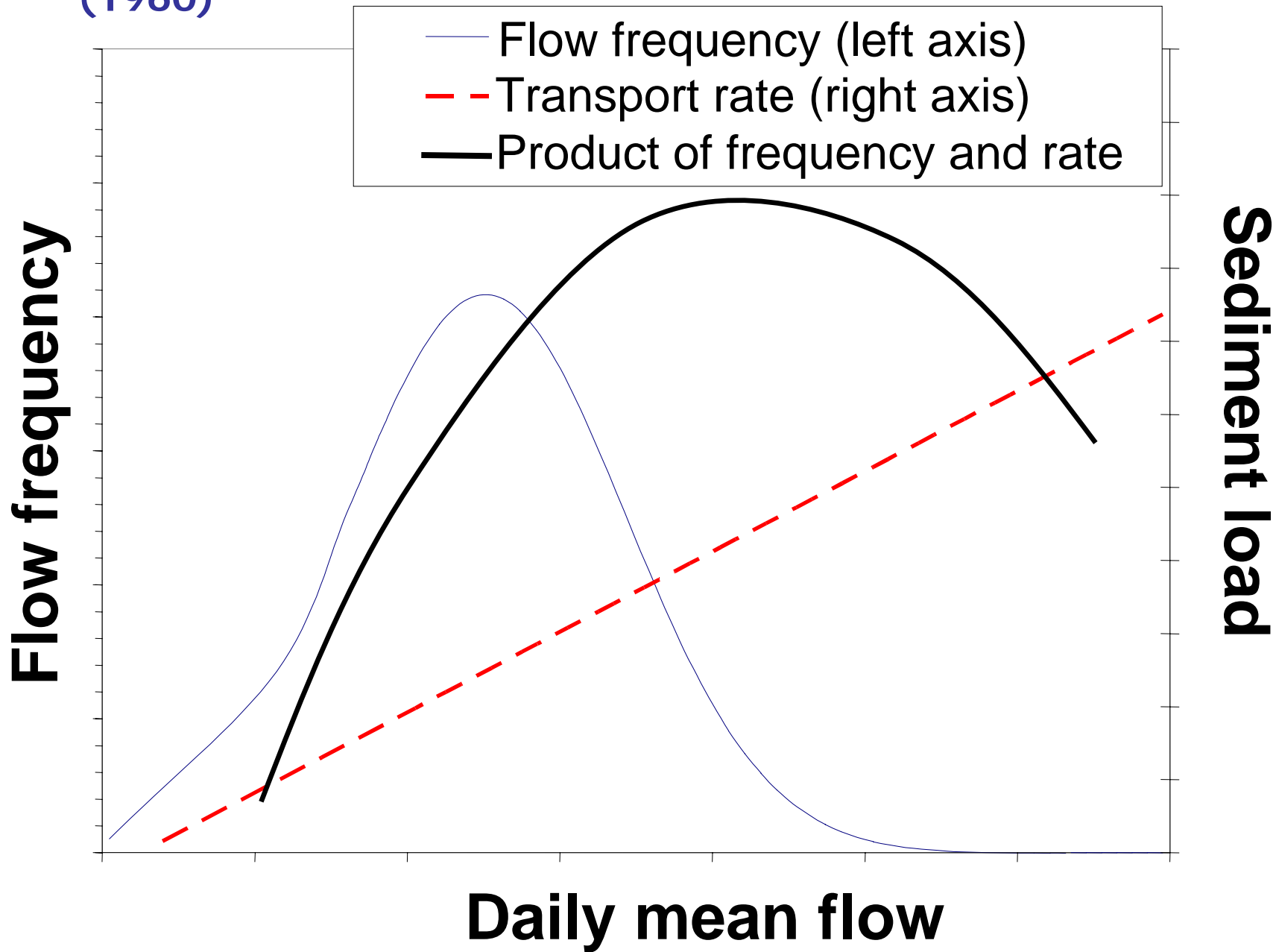
Santa Clara River Watershed, Ventura Co. and Los Angeles Co.



Subwatershed

Source data:
 Hillshade: 30m DEM; Roads: ESRI 2008
 Streams and lakes: NHD; Counties: CaSIL
 Santa Clara R. watershed: Stillwater Sciences
 Precipitation: PRISM data

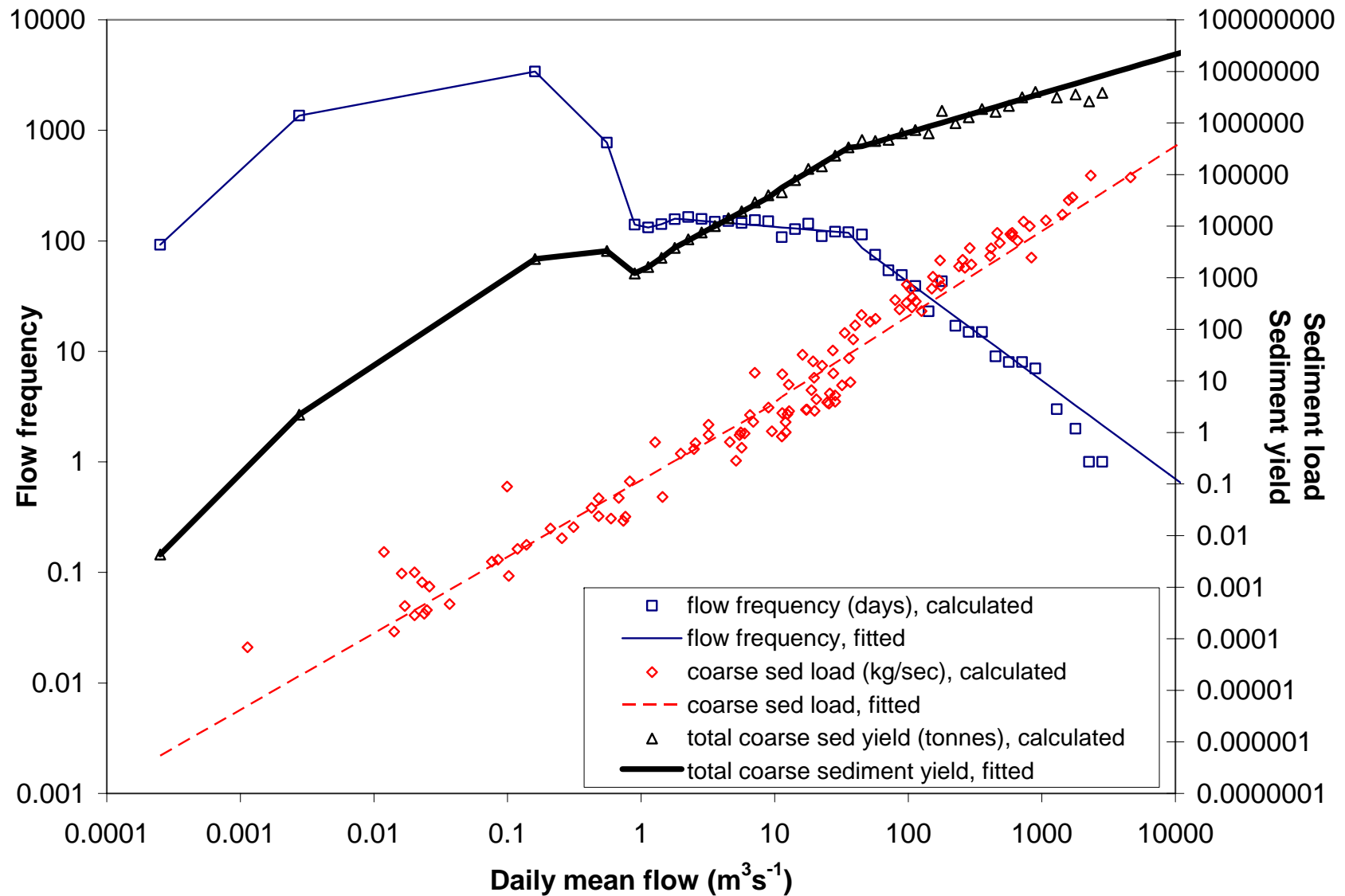
Conceptual, dominant discharge model of Wolman and Miller (1960)



Episodic system:

Lower Santa Clara River (Montalvo stream gauge)

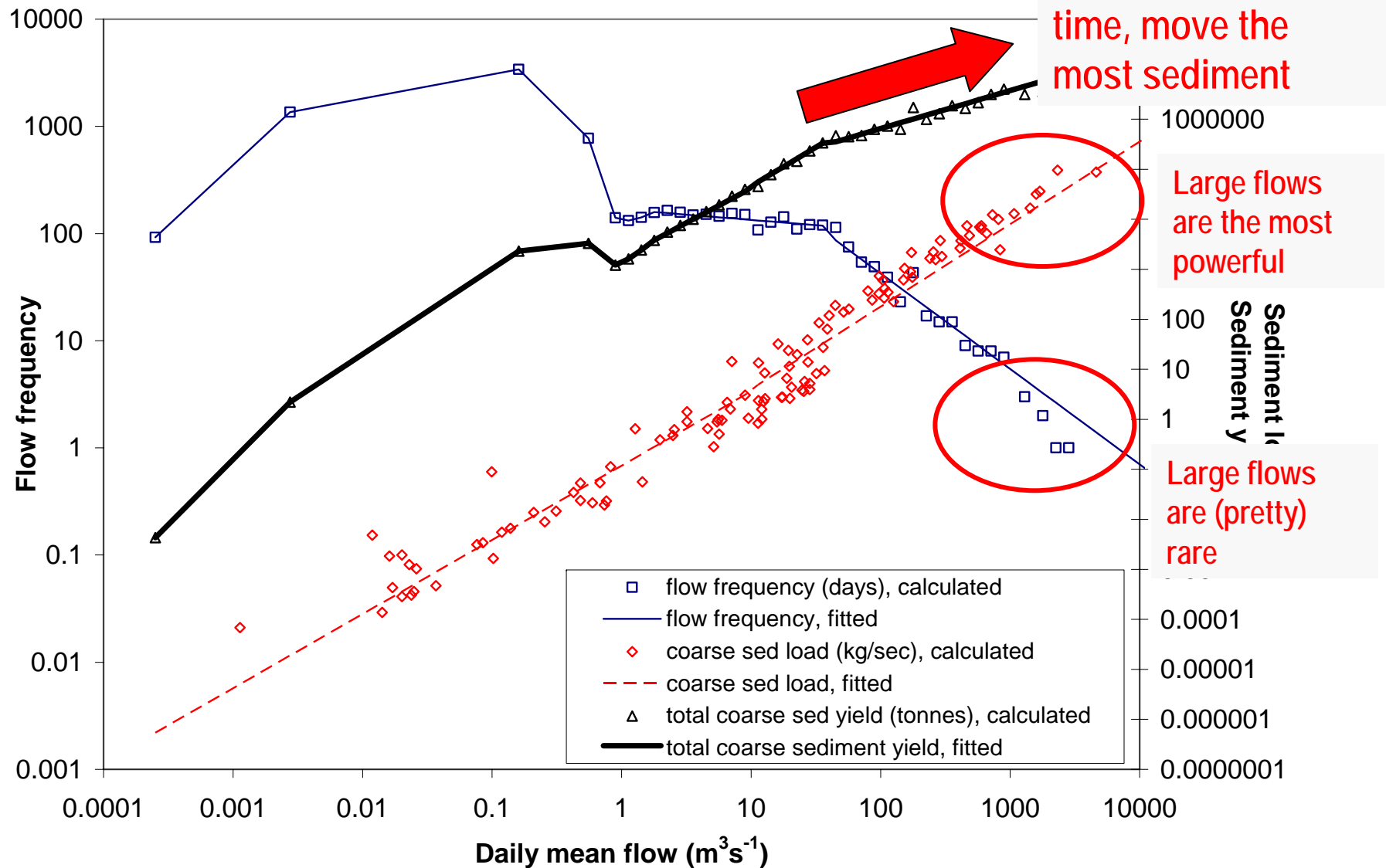
The majority of sediment transport occurs during very short periods of time.



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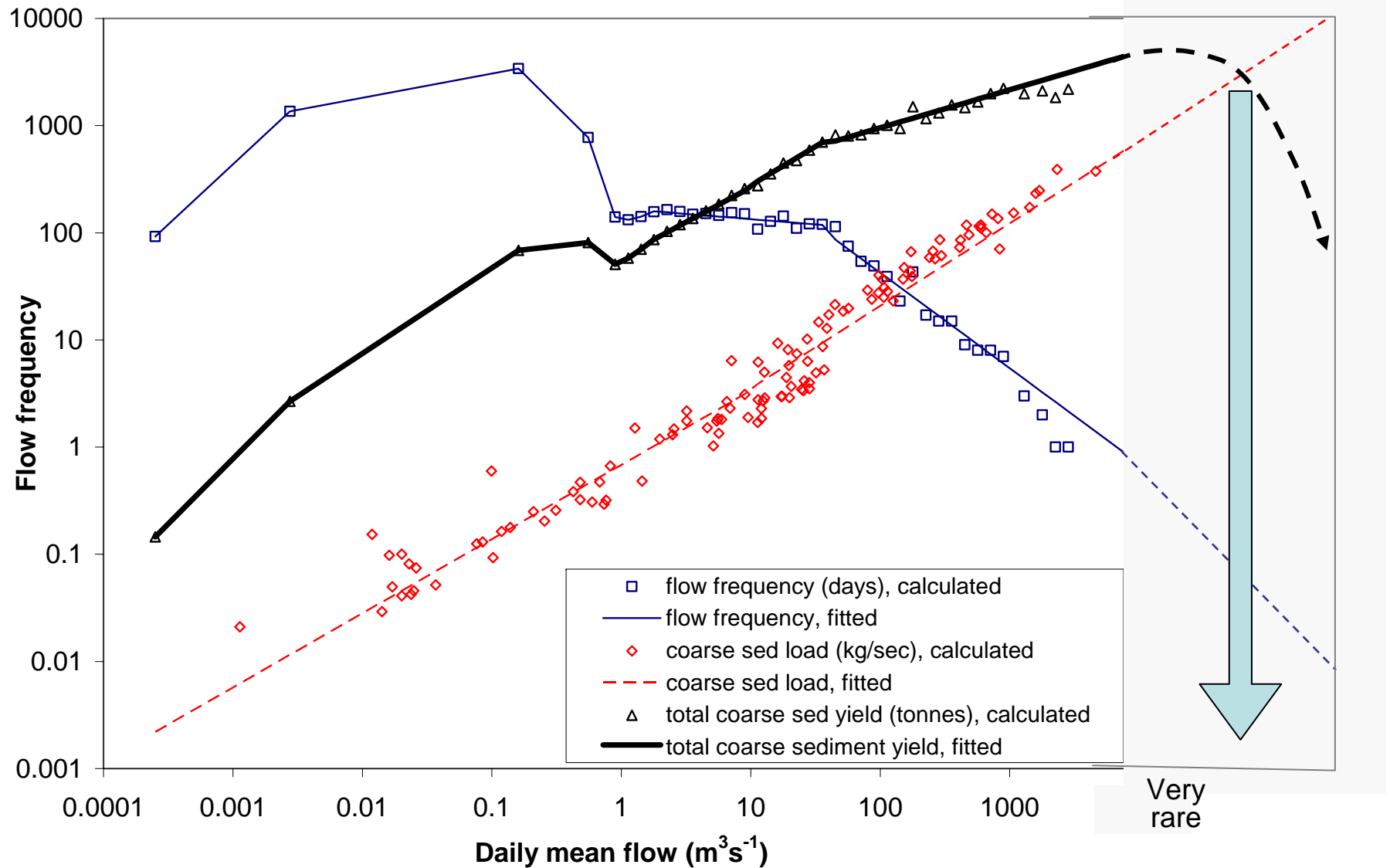
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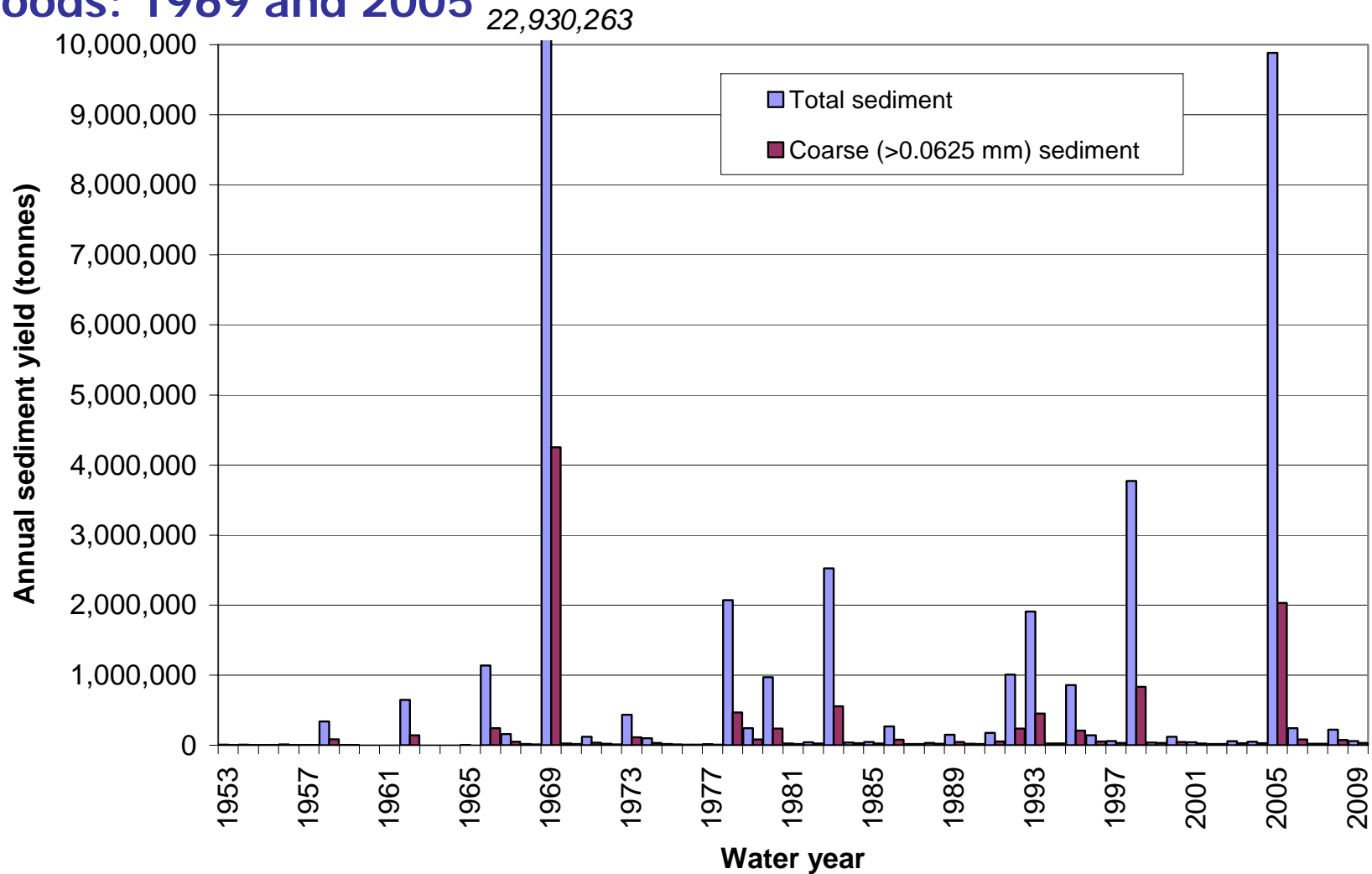
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Episodic system:

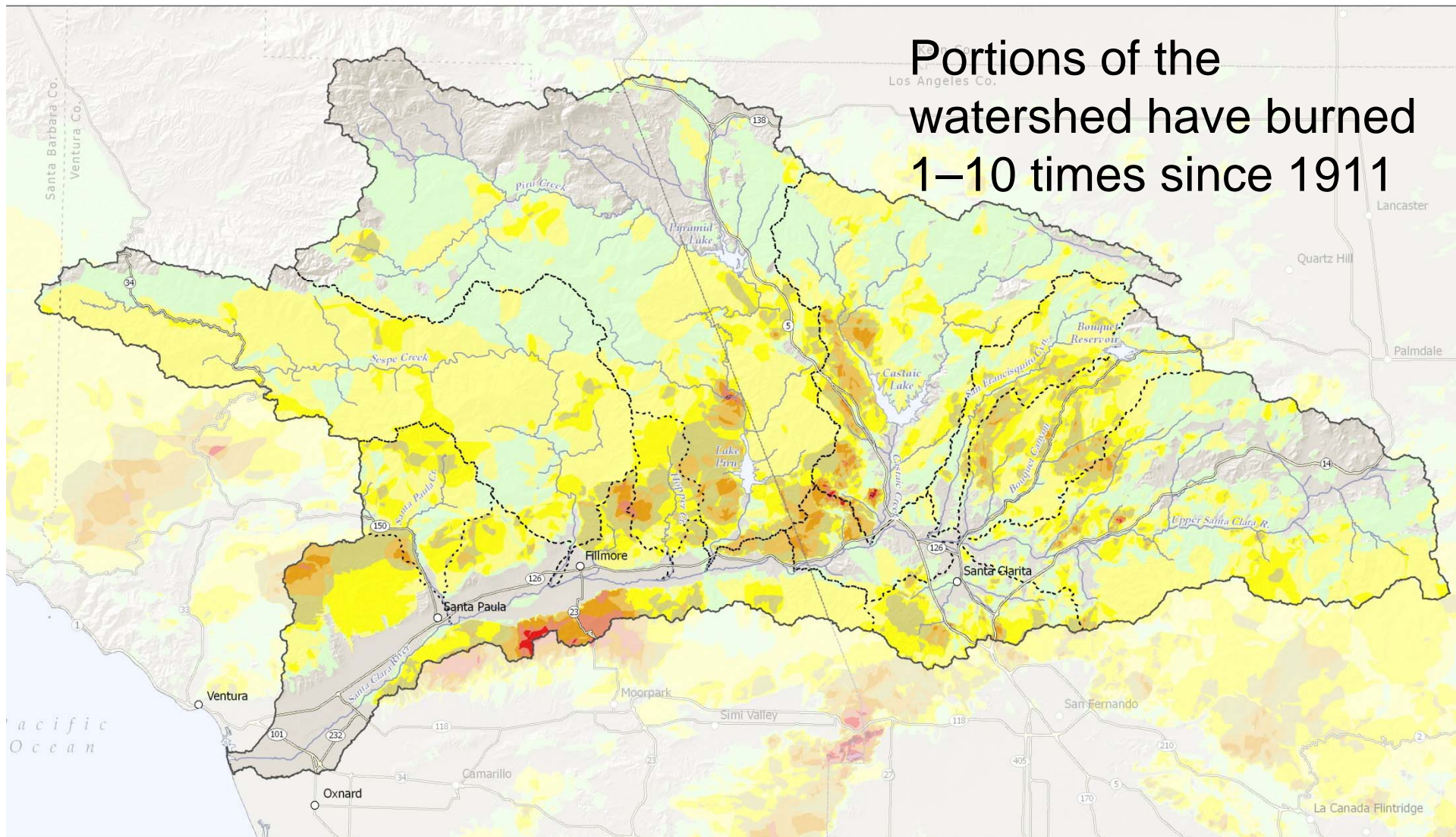
Dominant discharge in SCR is the one that transports most of the total sediment load

At the County line, more than half of the total sediment yield out of the USCR between 1953-2009 occurred during two largest floods: 1969 and 2005



WILDFIRE:

Portions of the watershed have burned 1–10 times since 1911



cy of burn events in the SCR watershed (1878-2009)

Santa Clara River Watershed, Ventura Co. and Los

of times burned



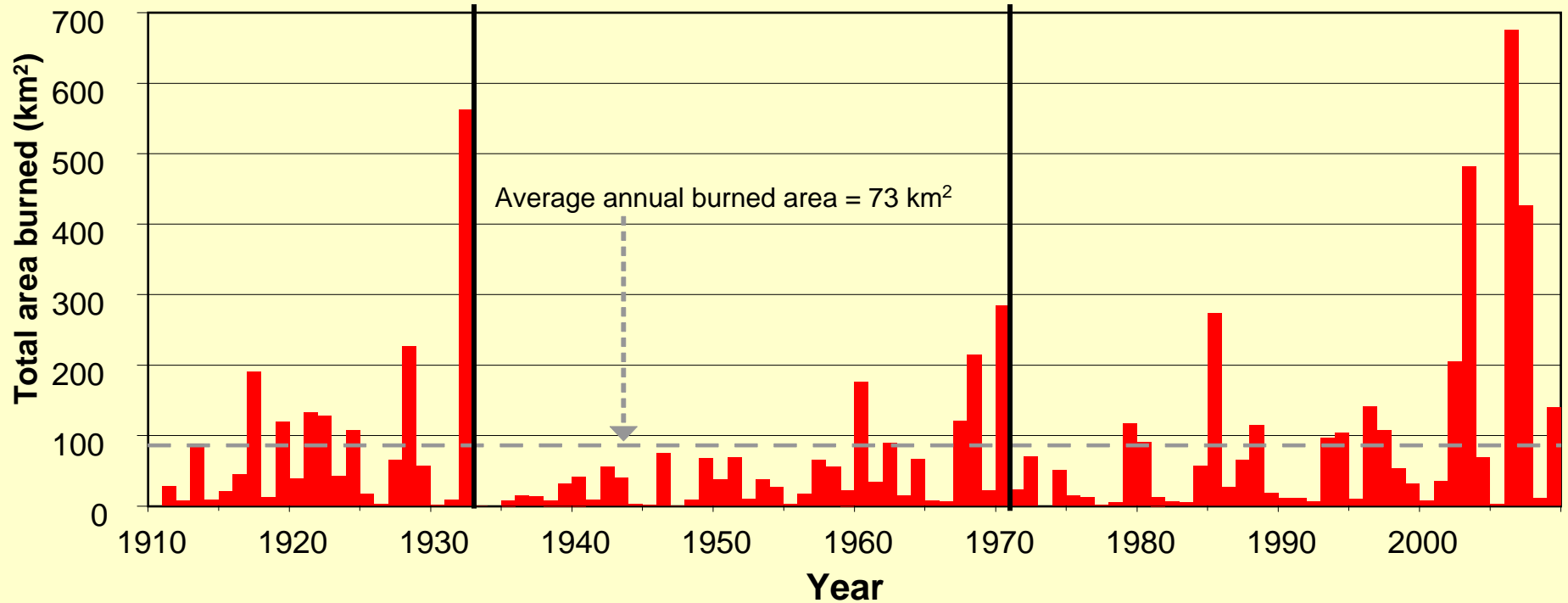
Selected subwatersheds

Source data:
Hillshade: 30m DEM; Roads: ESRI 2008
Streams and lakes: NHD; Counties: CaSIL
Santa Clara R. watershed: Stillwater Sciences
Fire frequency: Cal FRAP 2009 and Stillwater Sciences

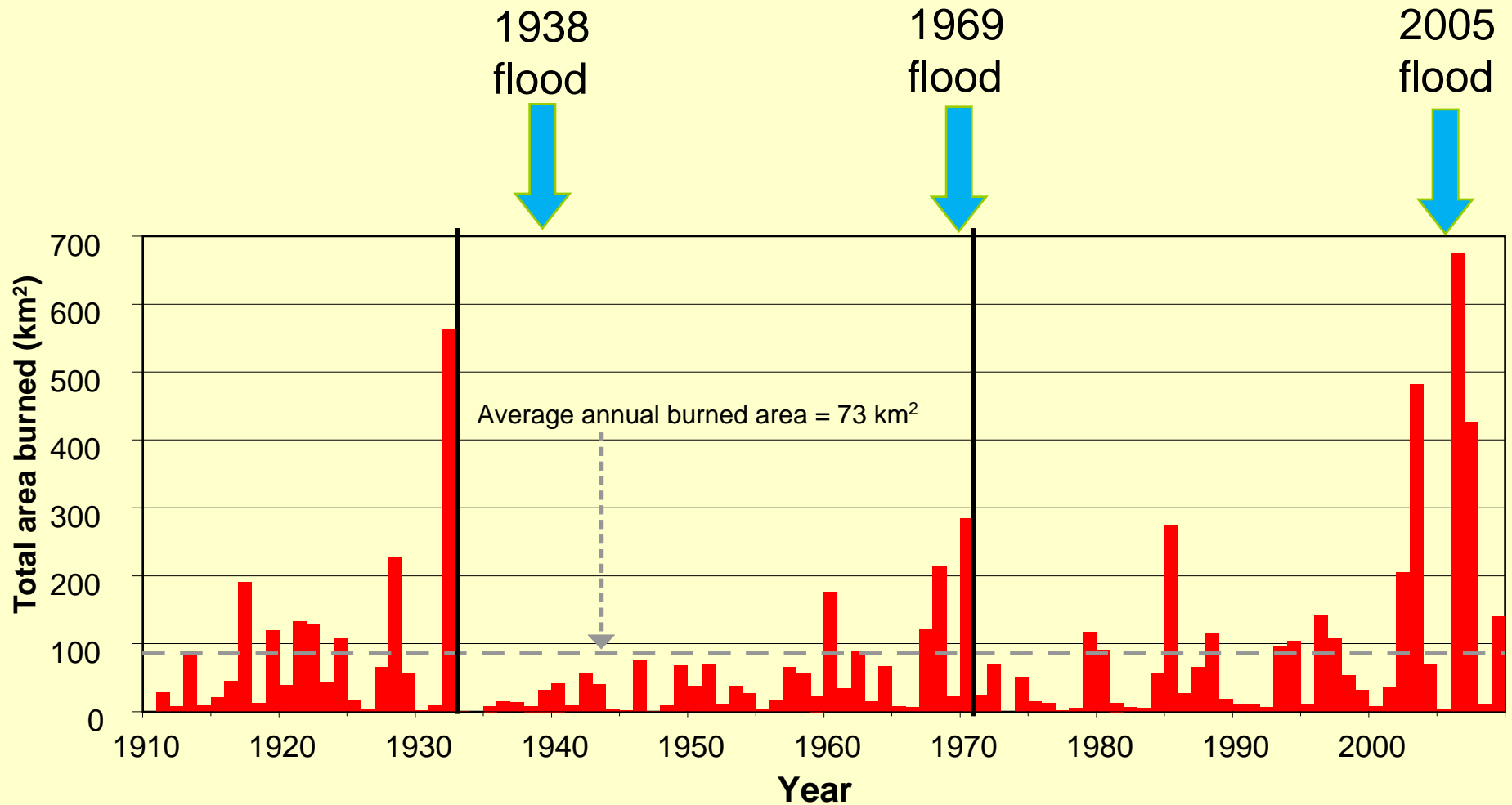


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WILDFIRE: Periodicity of large wildfires



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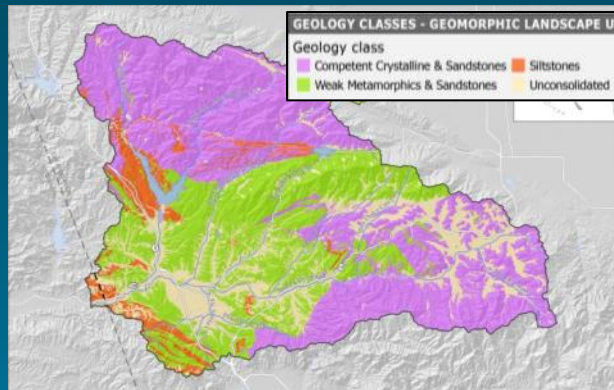
HILLSLOPE SEDIMENT PRODUCTION

- The watershed hosts a diverse patchwork of landscape types
- Dominant erosion processes: dry ravel, soil creep, and sheet wash

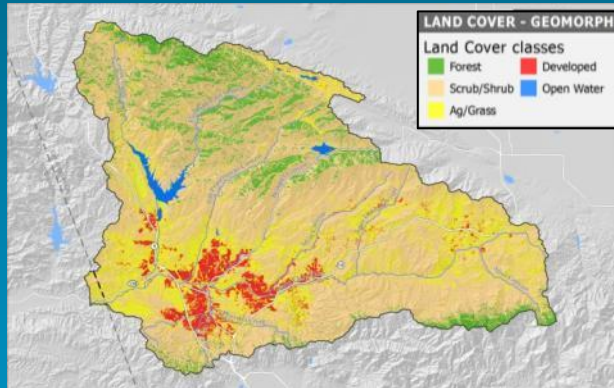


Estimate of Sediment Production Rates

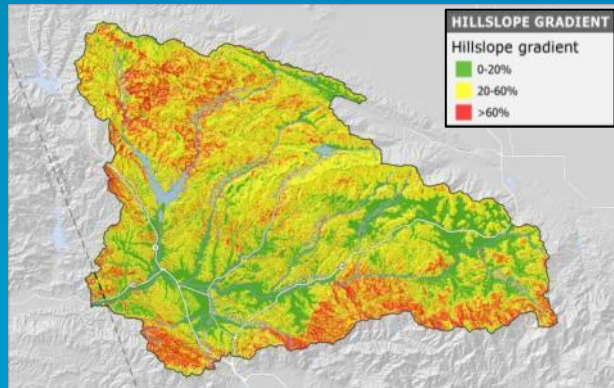
Geomorphic Landscape Units - GLUs



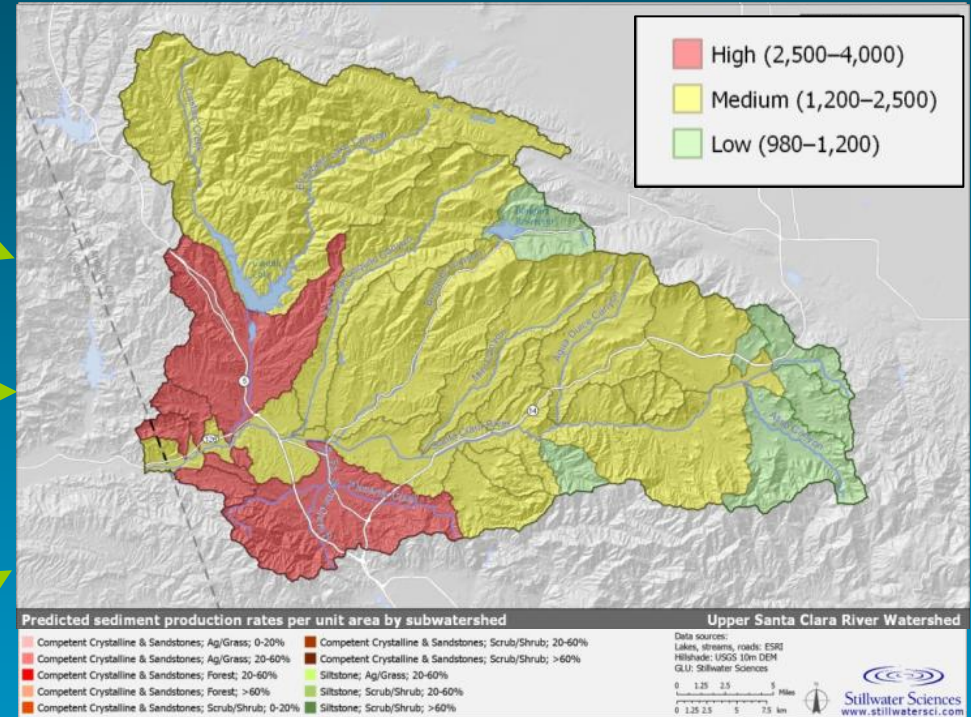
Geology



Land Cover



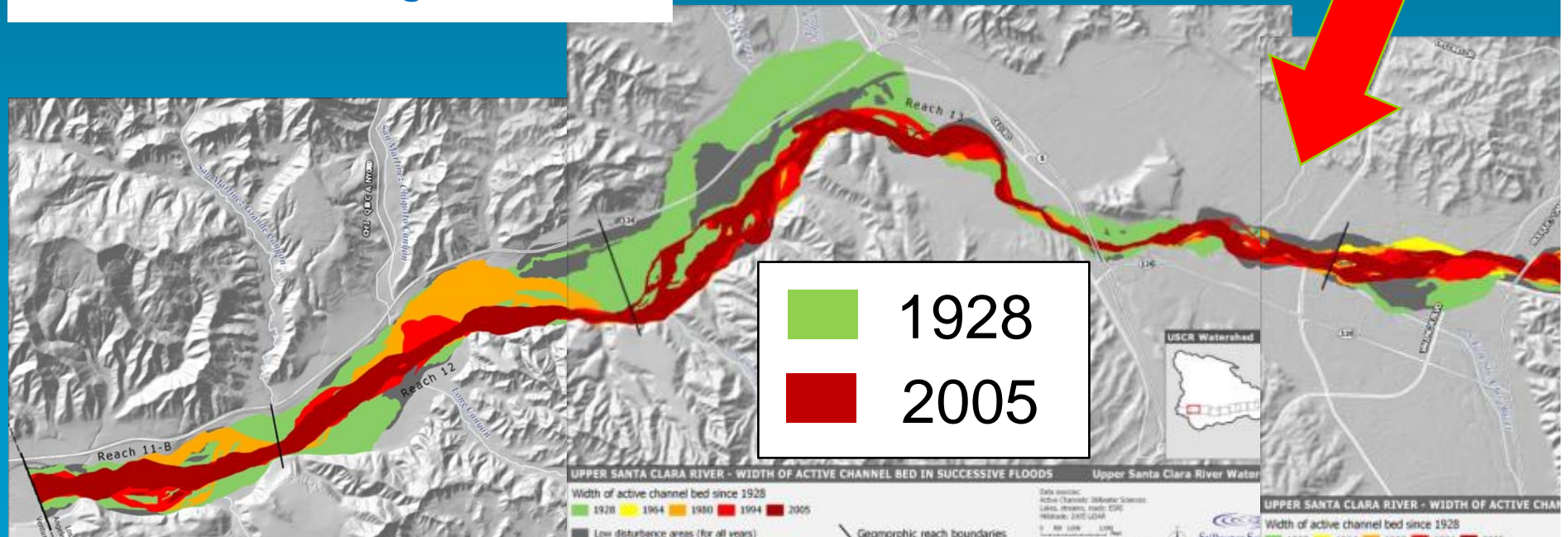
Hillslope Gradient



- Quantified rates from sedimentation records
- Validated with other estimates: stream gauge, uplift, and sediment dating

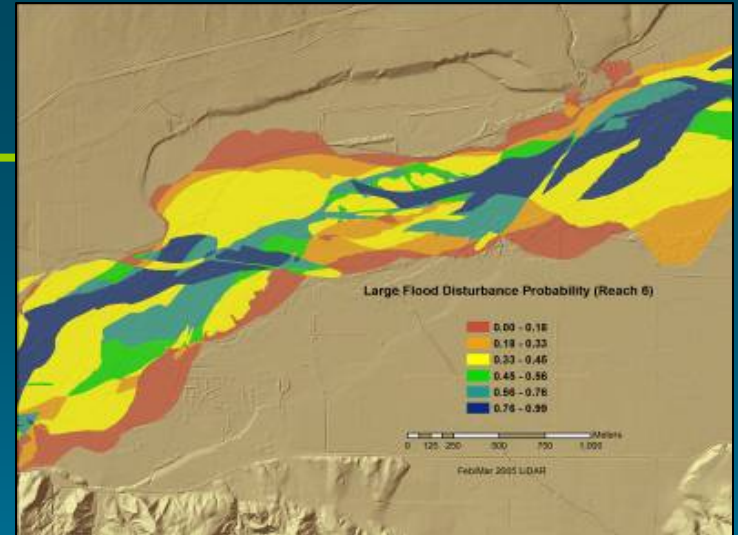
Channel Morphology: ST. FRANCIS DAM FAILURE OF 1928

- Peak flow between dam and Co-line: ~10,000–30,000 cms (Begnudelli and Sanders 2007)
 - 8–15 times greater than any subsequent peak flow
- **Most recent and significant “channel-forming” flow**



Channel Morphology

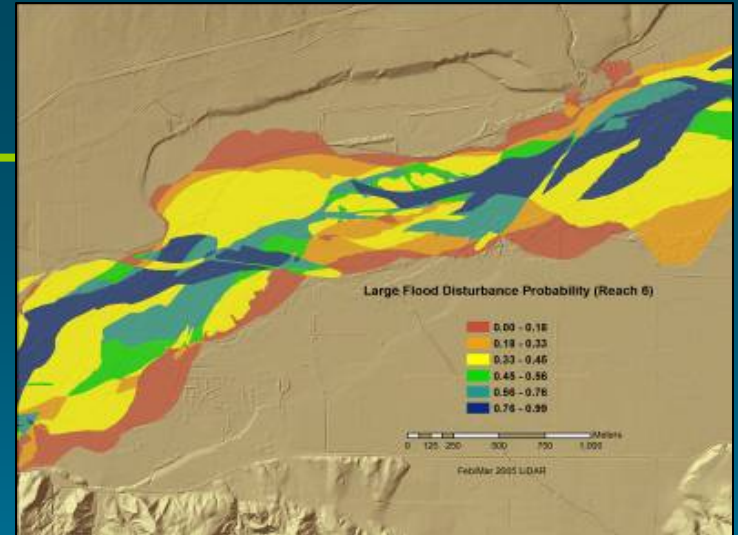
Highly dynamic mainstem



■ ■ ■ ■ Summer baseflow channel (June 2002)

Channel Morphology

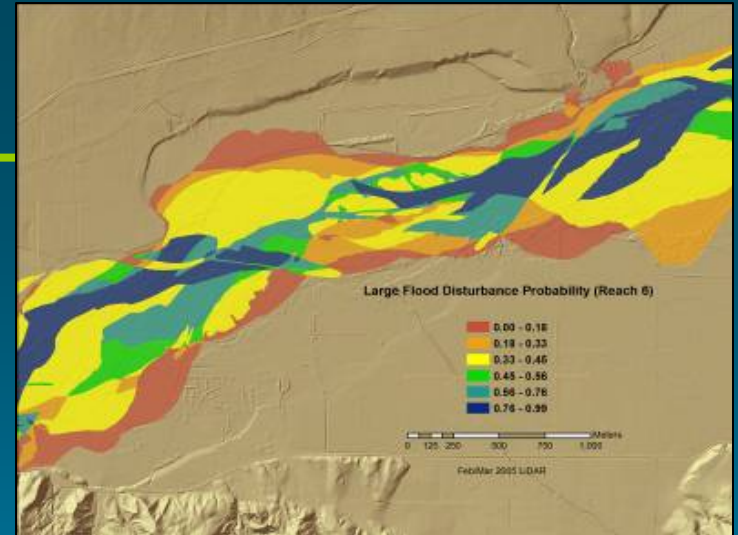
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Channel Morphology

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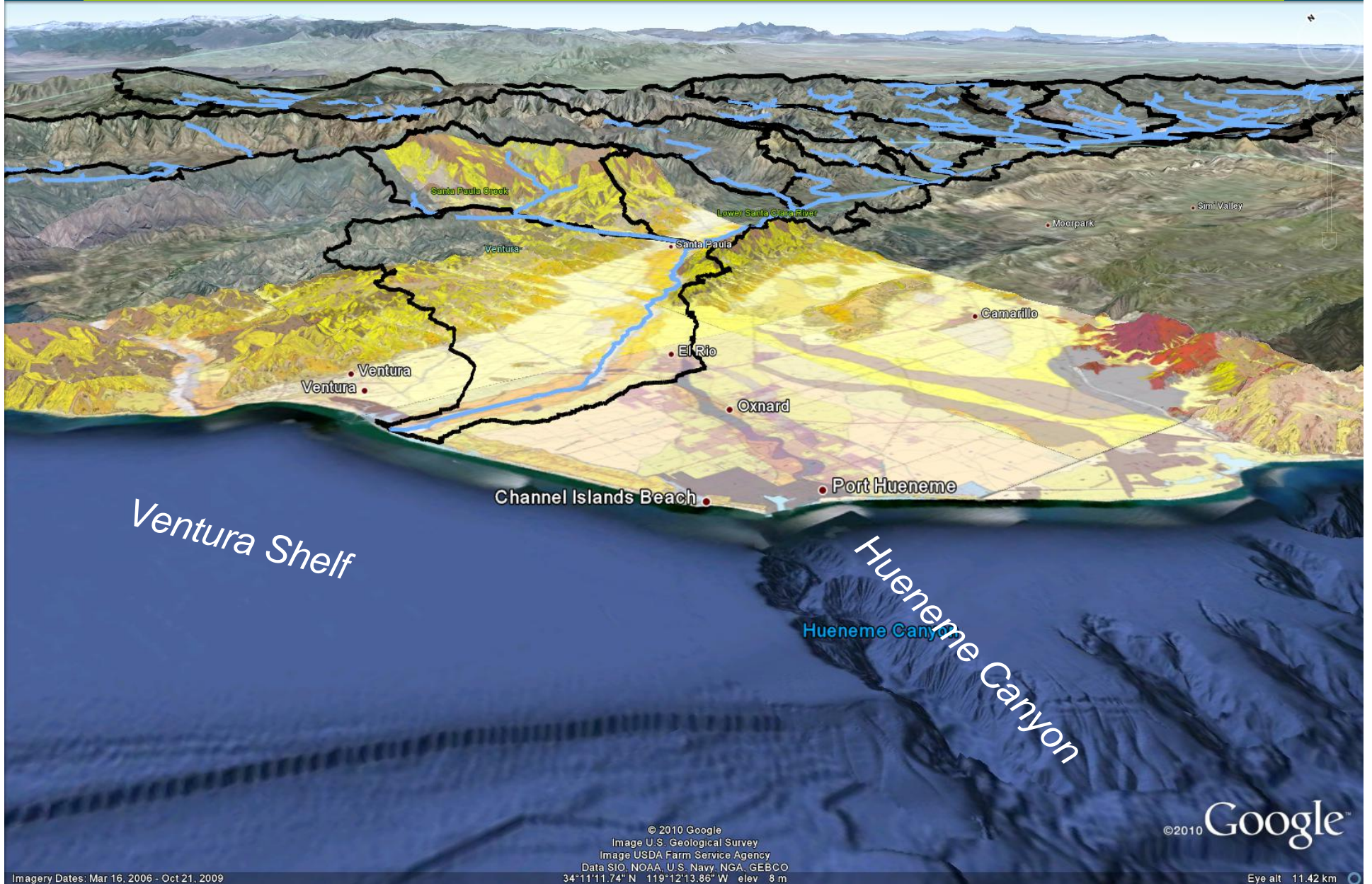


Channel Morphology

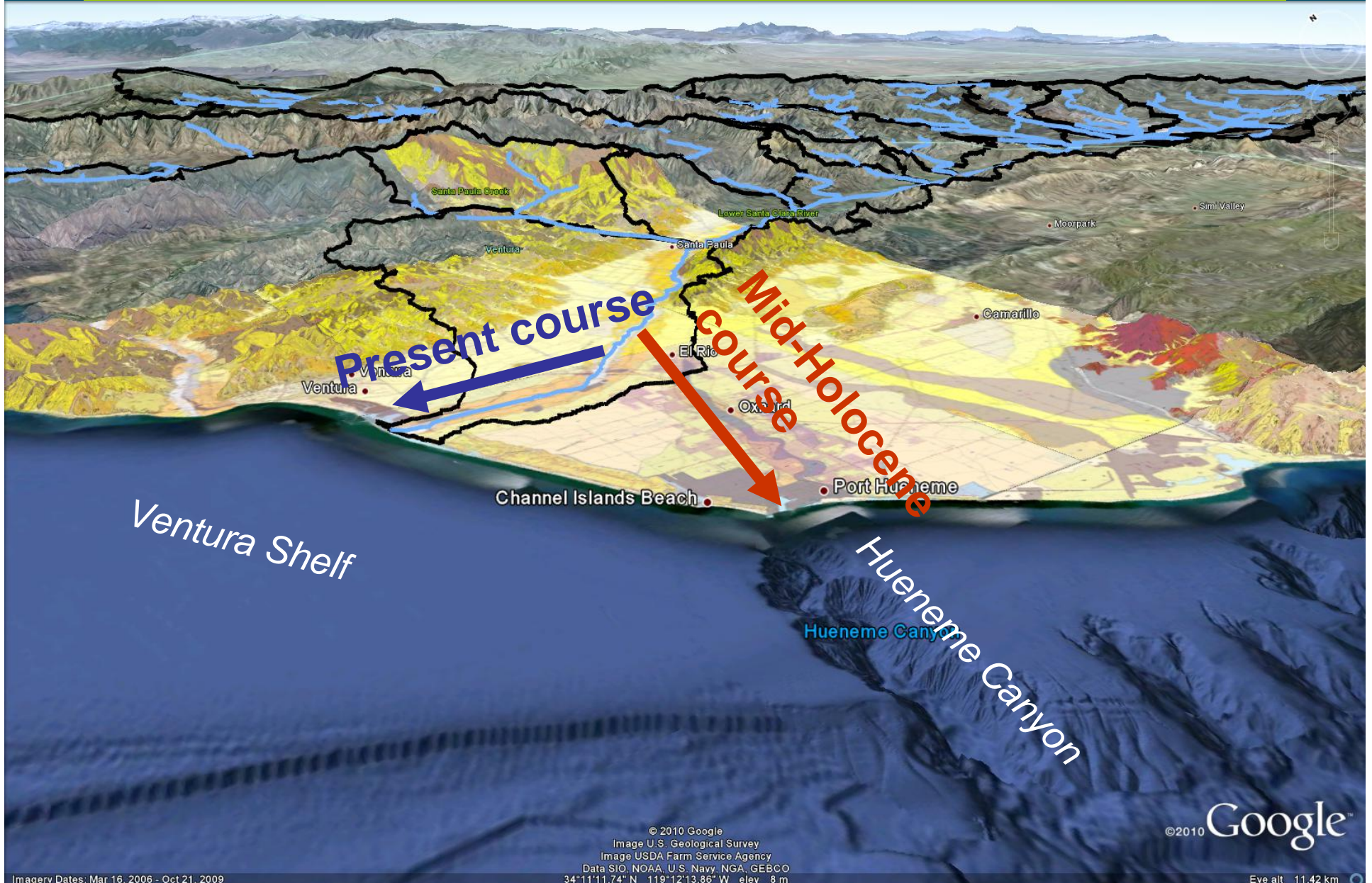
Highly dynamic mainstem



Channel Morphology – Holocene avulsion



Channel Morphology – Holocene avulsion



Summary

- Sediment production:
 - The watershed hosts a diverse patchwork of landscape types, each composed of a unique suite of geomorphic processes controlled by regional and local forces—**tectonics, climate, geology, topography, wildfires, and land use**
- Sediment transport / river morphology:
 - Not a “typical” river system, but is instead an episodic one where most of **the geomorphic “work” in the river and its tributaries occurs during very short periods of time**
 - The river morphology adjusts during each flood event; **very little change occurs between these events**

For more info:

santaclarariverparkway.org

ACKNOWLEDGEMENTS & SUPPORTING STUDIES

Lower Santa Clara River (Stillwater Sciences 2007):
California Coastal Conservancy



Santa Paula Creek (Stillwater Sciences 2007):
Santa Paula Creek Fish Ladder Joint Powers Authority
California Department of Fish and Game



San Francisquito Canyon (Stillwater Sciences 2009):
Power Engineers
Los Angeles Department of Water & Power



Sespe Creek (Stillwater Sciences 2010):
Ventura County Watershed Protection District
RBF Consulting



Upper Santa Clara River (Stillwater Sciences 2011):
Ventura County Watershed Protection District
Los Angeles County Department of Public Works
U.S. Army Corps of Engineers-LA District
RBF Consulting



Santa Clara River Estuary (Stillwater Sciences 2011):
City of Ventura and Carollo Engineers



Santa Clara River Parkway (Stillwater Sciences, ongoing):
California Coastal Conservancy and CBEC



Santa Paula Creek Fish Ladder (Stillwater Sciences, ongoing):
Santa Paula Creek Fish Ladder Joint Powers Authority
California Department of Fish and Game



Stillwater Sciences