# About Me--**Michael Singer**

*Specialty: Earth Surface Processes/Dynamics, Hydrology, Ecohydrology*

Education:

B.A., Environmental Science, 1993
The Evergreen State College, Olympia, Washington.

Ph.D., Bren School of Environmental Science and Management
University of California Santa Barbara, 2003

'*Modeling Spatial and Temporal Patterns in Flow and Sediment Transport and Storage in Large, Lowland Rivers*' Advisor: Tom Dunne

Current Positions:

Lecturer, Department of Earth and Environmental Sciences
University of St Andrews, Scotland, UK, 2007-

Researcher (PI status), Earth Research Institute
University of California Santa Barbara, USA, 2003-

# Overarching Research Theme

*Earth surface process responses* to climatic and/or anthropogenic forcing*

*Earth surface processes* – the time-varying elements of hydrology, sediment transport, and the landforms they produce. These impact landscape evolution, biogeochemical processing of nutrients/contaminants, ecological functioning, and hazards/risks to human society at multiple scales.

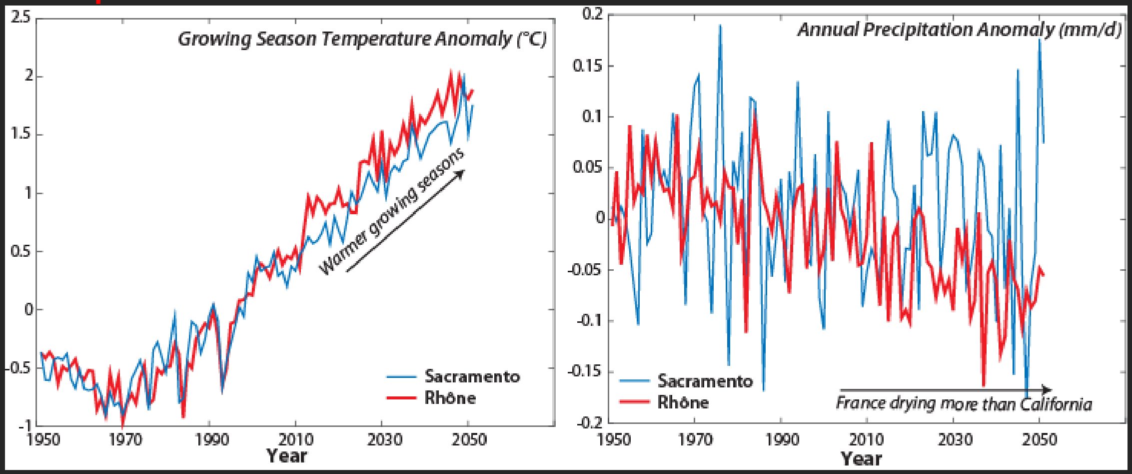
*Climatic forcing* – the expressions of climate (stationary) and climate change (nonstationary) are inherently spatial and temporal, affecting Earth surface processes in ways that typically confound prediction.

*Anthropogenic forcing* – landscapes are often affected by external human-induced perturbations such as engineering (e.g., dams, channelization) and industrial activities (e.g., mining, pollution), which may produce localized or basin-scale impacts at the Earth's surface that persist for millennia.

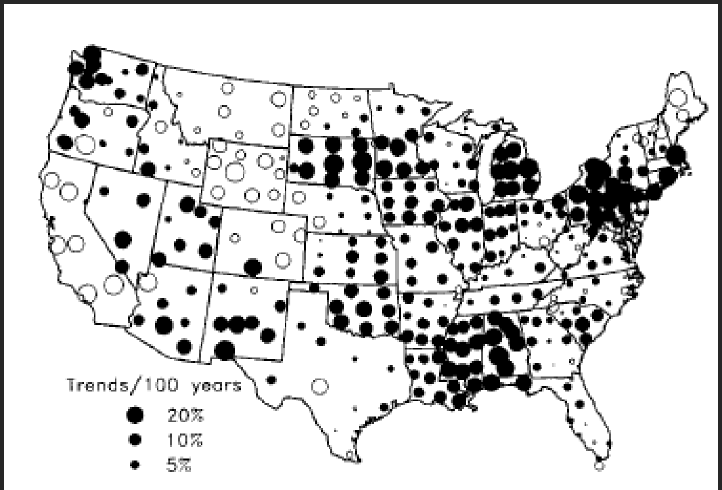
*Not necessarily recorded in the geologic (rock) record, but critical to predicting the consequences of climate and land-use changes at the landscape scale, as well as for management on human/engineering timescales.

# Climate Change has a Spatial Expression

Temperature

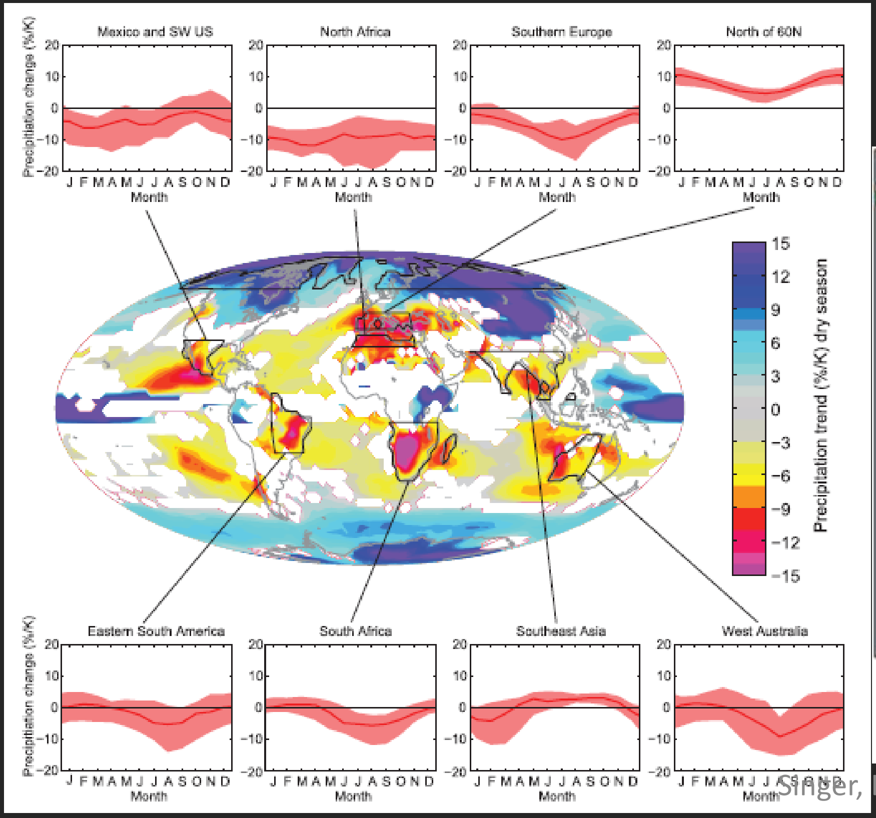



Singer, In Prep

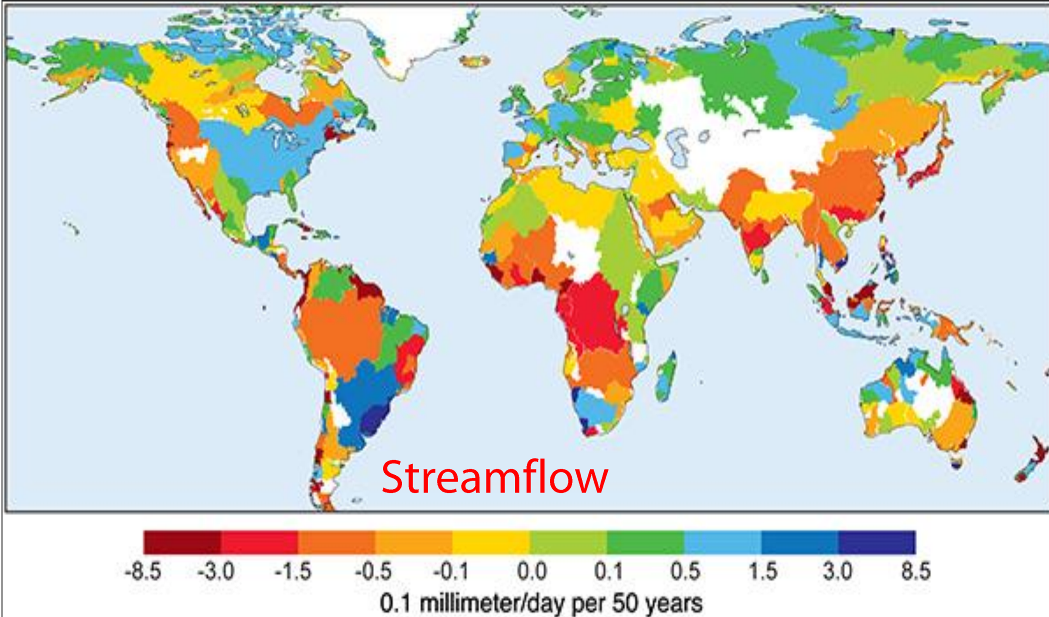



Karl et al., 1996

Precipitation

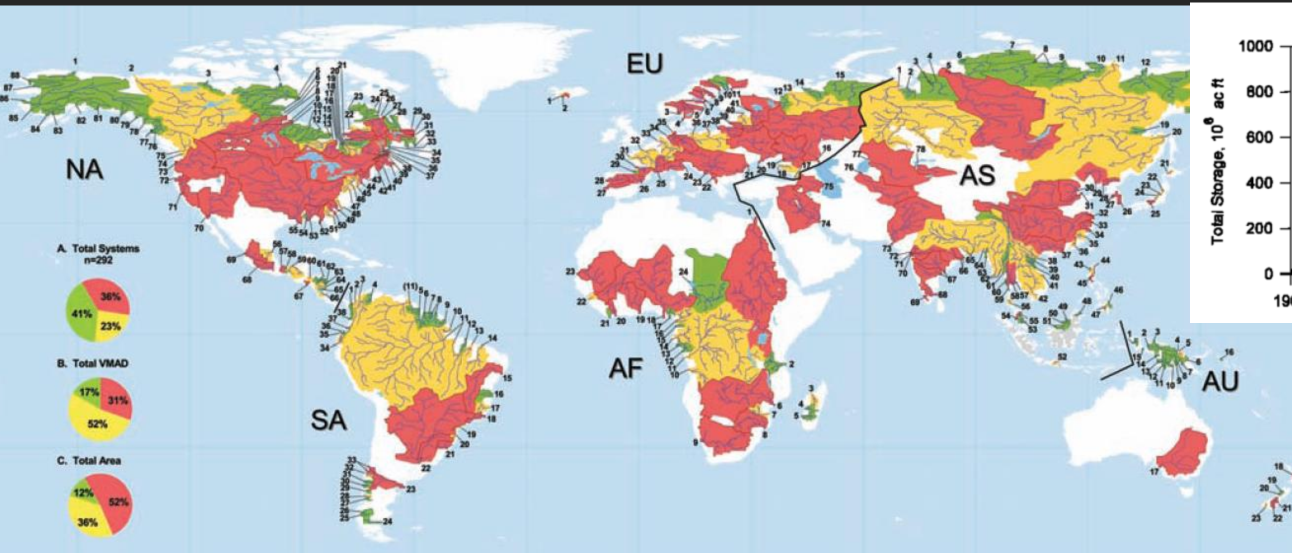



Solomon et al., 2009

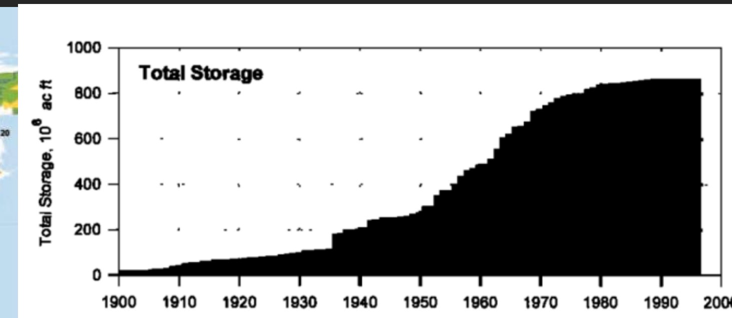



Dai et al., 2009

# Anthropogenic Impacts on Rivers




Nilsson et al., 2005




Dams

Graf, 1999

Mining

Alpers & Hunerlach

G.K. Gilbert

Singer, Loughborough, 2016

Channelization

# Current Research Foci

- Valley-floor evolution (grain size and topography) including sediment entrainment, deposition, and delivery from drainage basins to river mouths
- Transport and fate of sediment-bound pollutants in the environment (biogeochemistry)
- Hydrologic partitioning, water availability, and forest water use in floodplains (ecohydrology)
- Climatic and anthropogenic forcing of fluvial systems (including flood hazard and drought)

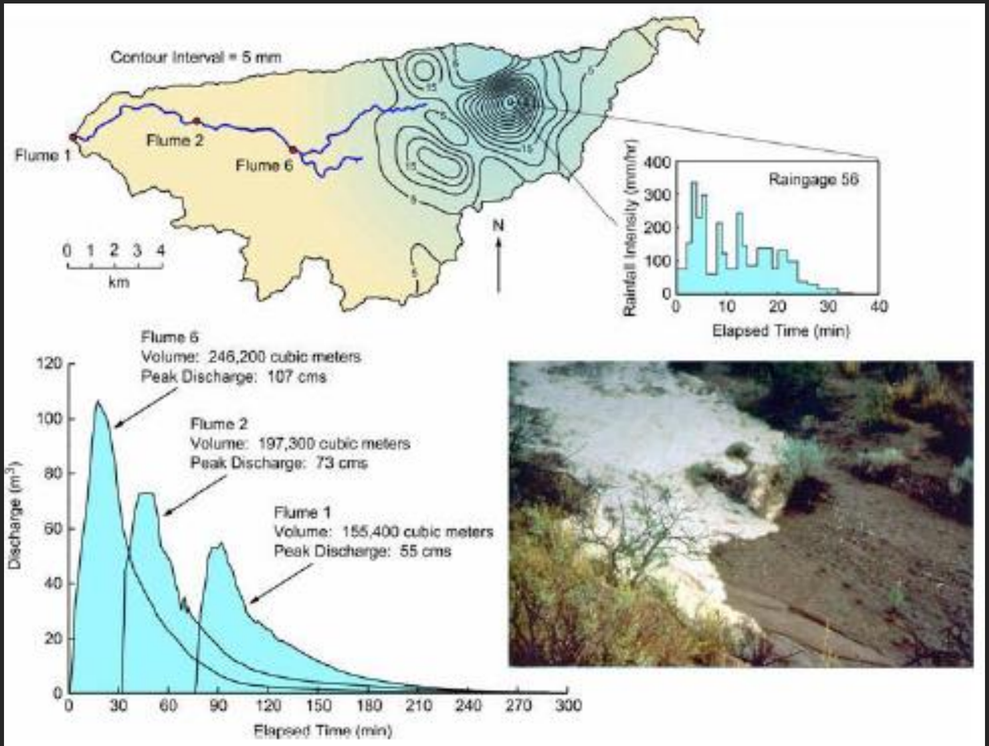


# Landscape Evolution in Drylands

How does hillslope erosion affect of sediment supply to channels?

What controls the spatial patterns of erosion/deposition in dryland channels?

What is the relative balance between hillslope sediment supply to channels and channel evacuation? This balance controls topographic evolution.



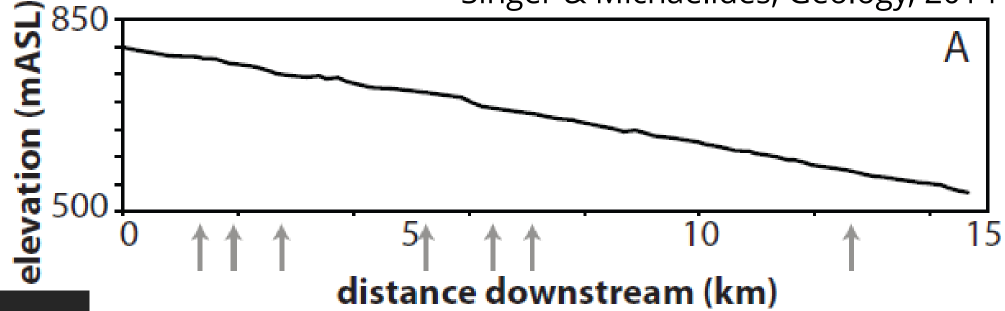

*Walnut Gulch Brochure, Tombstone, Arizona*

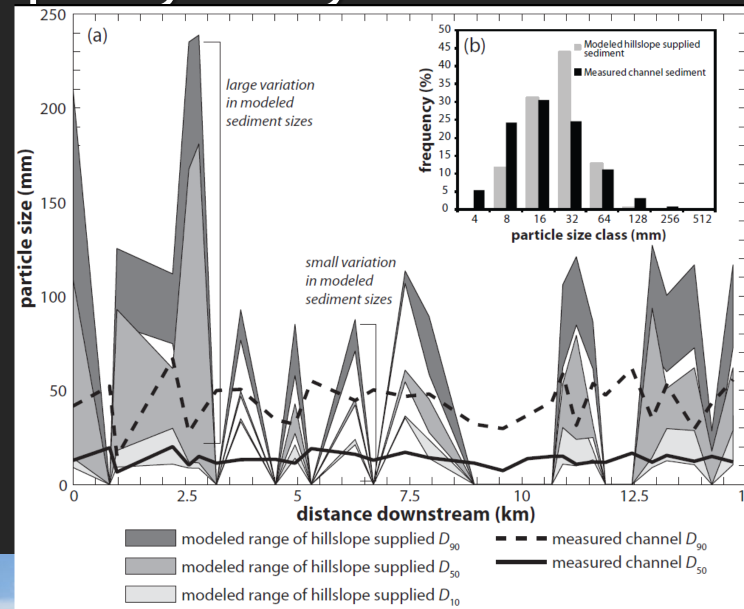
*Zwolinski*

Spatial/temporal variability in rainstorms force dynamic interactions between precipitation and erosion in drylands.

# The paradox of channel simplicity in drylands

Singer & Michaelides, Geology, 2014

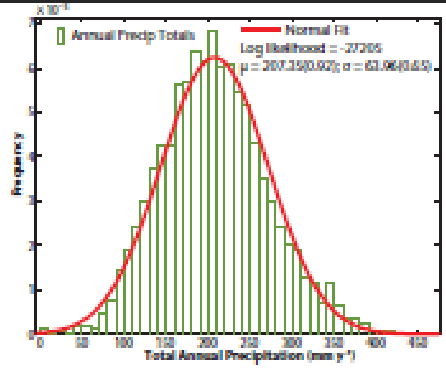


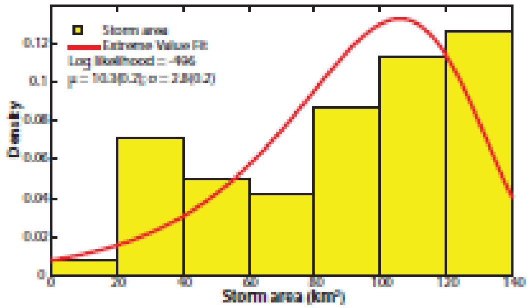

Michaelides & Singer, *JGR-ES*, 2014

# Stochastic Rainstorm Generator to Drive a Landscape Evolution Model

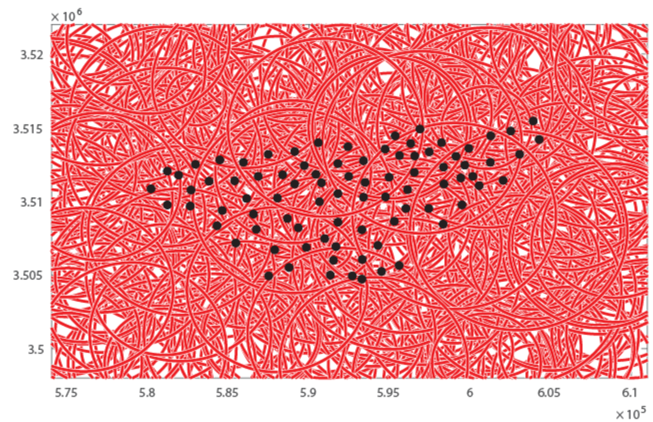
**1 Total Annual P (mm y$^{-1}$)**




**2 Storm Area (km$^2$)**

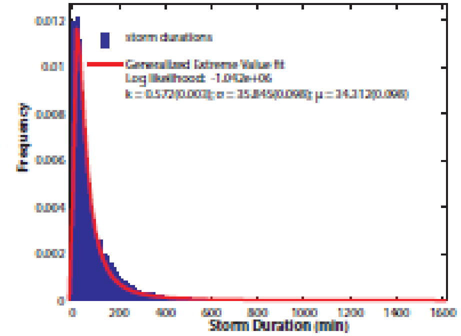



**3 Storm Center Location** 38 x 25 grid with 1000 m spacings; contains all gauges

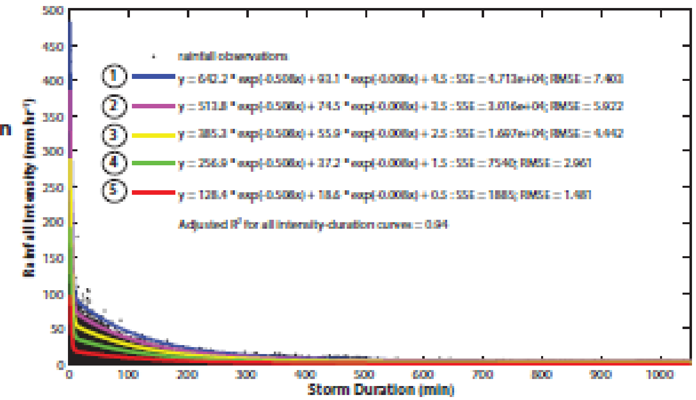


**4 Storm Spatial Gradient (mm km$^{-1}$)** $z = \alpha * \exp(-2a^2r^2)$ *Rodriquez-Iturbe et al., 1986*

**5 Storm Duration (min)**




**6 Intensity-Duration**




*Singer et al., In Prep*

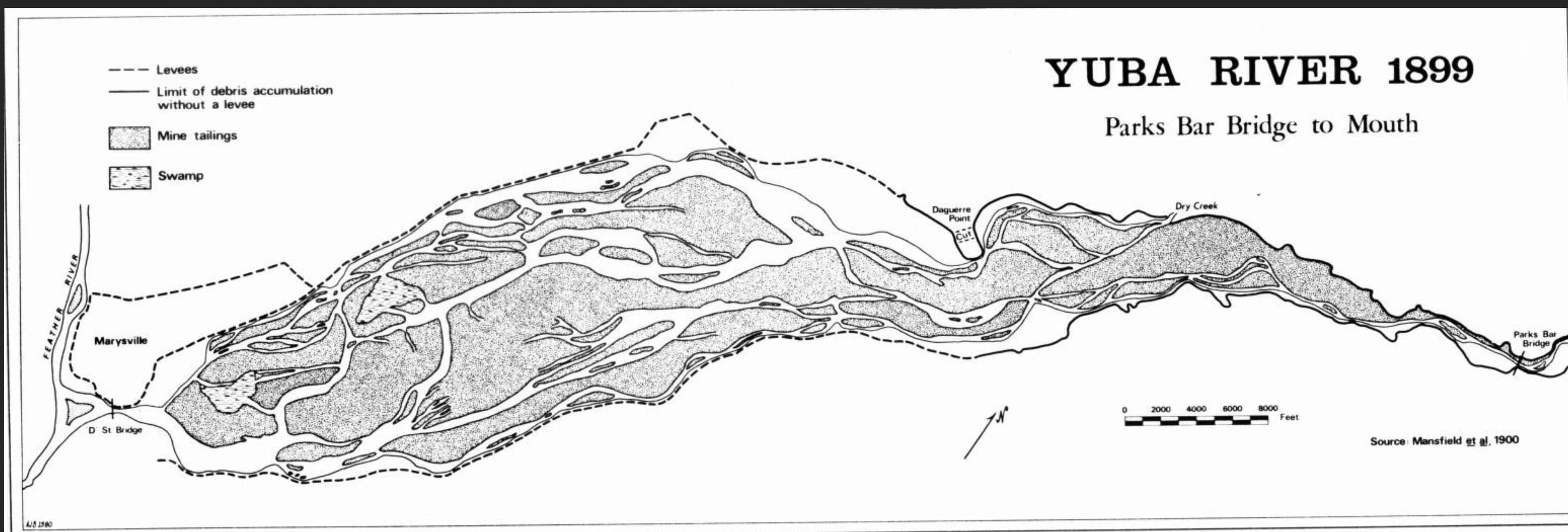
# Legacy of the California Gold Rush

Giambologna (Bargello)

*Bancroft Library*

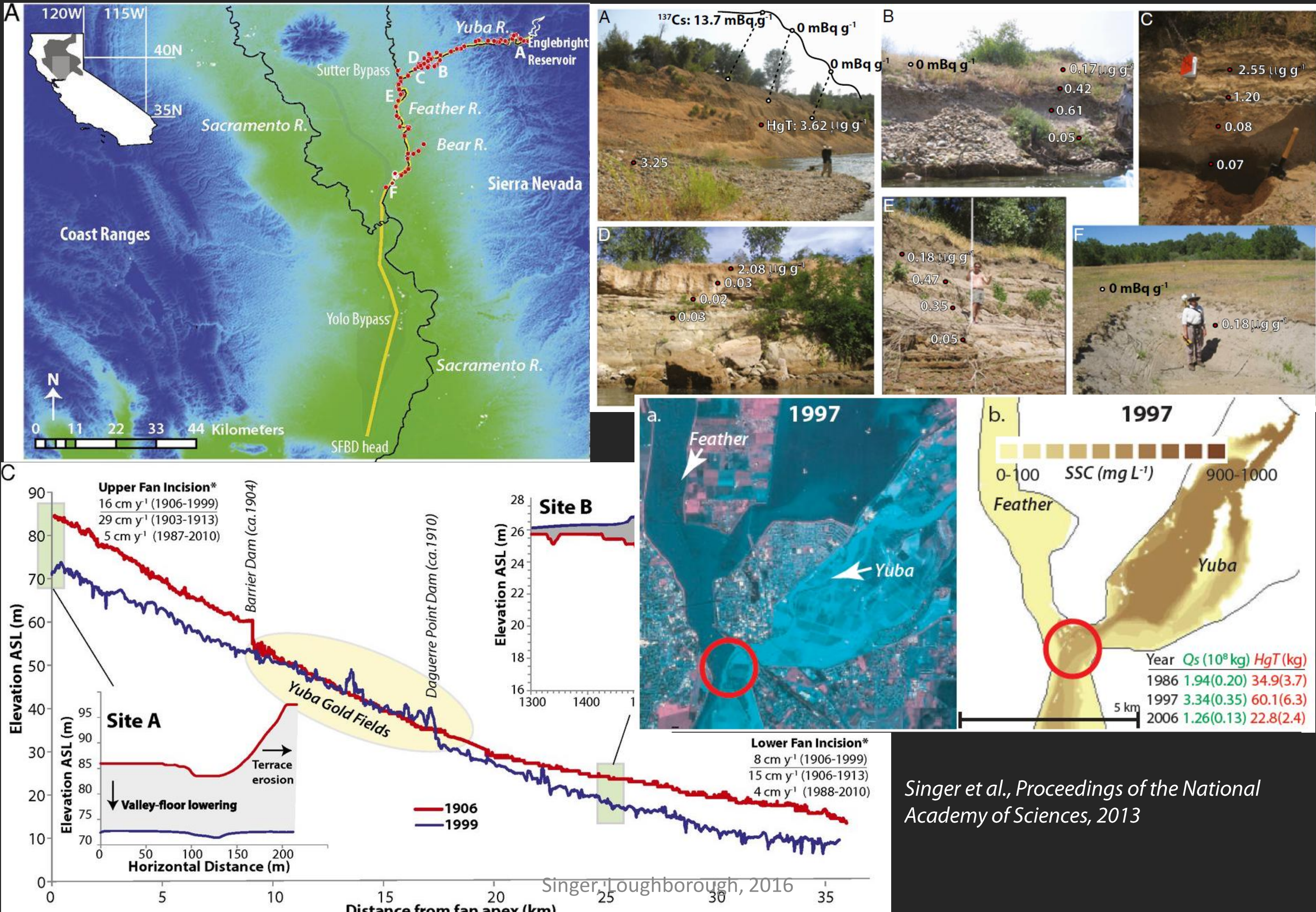
## Yuba 'Anthropogenic' Toxic Fan

Length: ~40 km
Area: 120 $km^2$
Original sediment volume: 252 x $10^6$ $m^3$ –most of which is contaminated with Hg



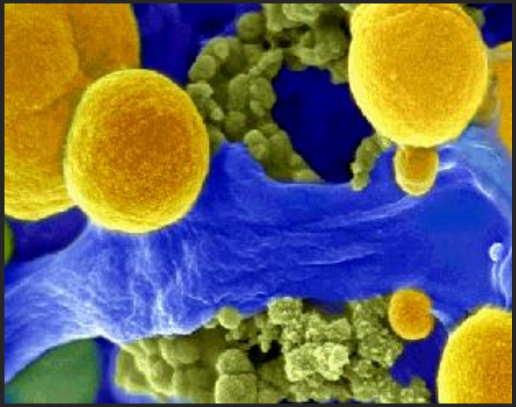

*Gilbert, 1917*

# Basin-scale geomorphic and contamination legacy of the 19th C. California Gold Rush




*Singer et al., Proceedings of the National Academy of Sciences, 2013*

# Hg that is toxic to the environment, methylmercury (MMHg), is produced by bacteria



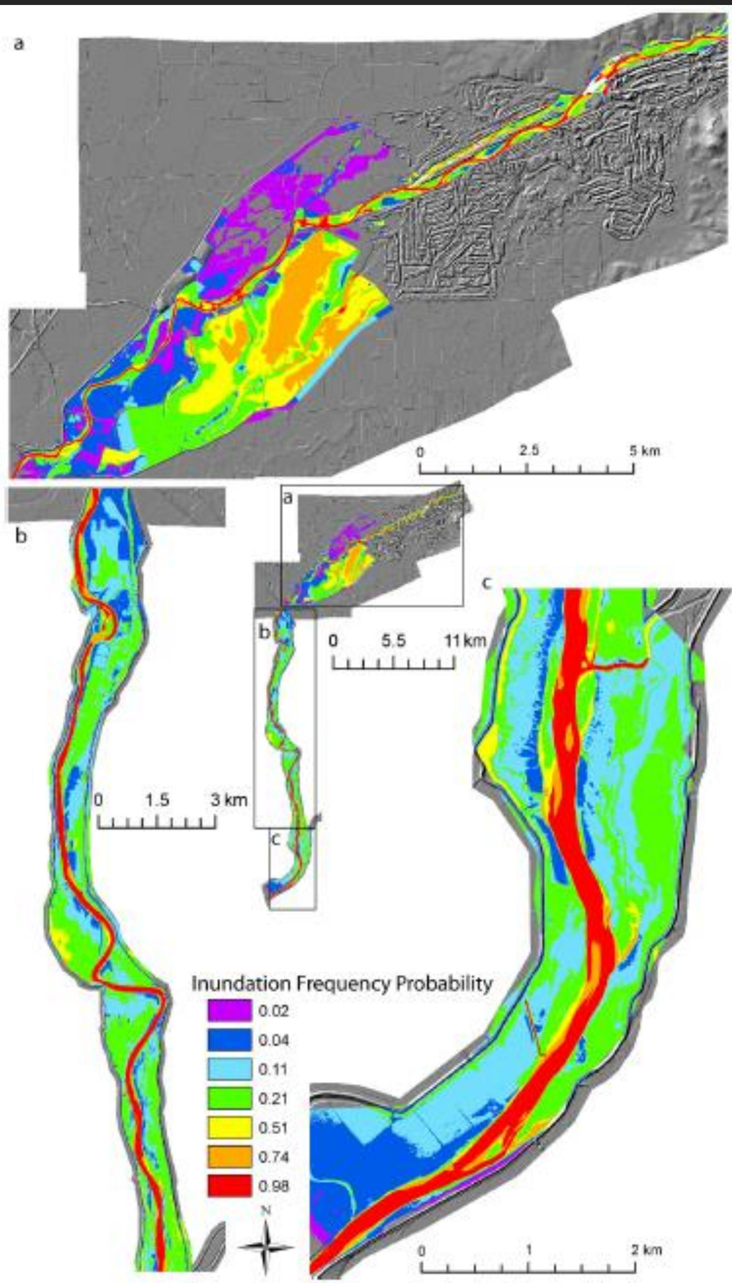
Floodplains and deltas are potential hotspots for Hg methylation.

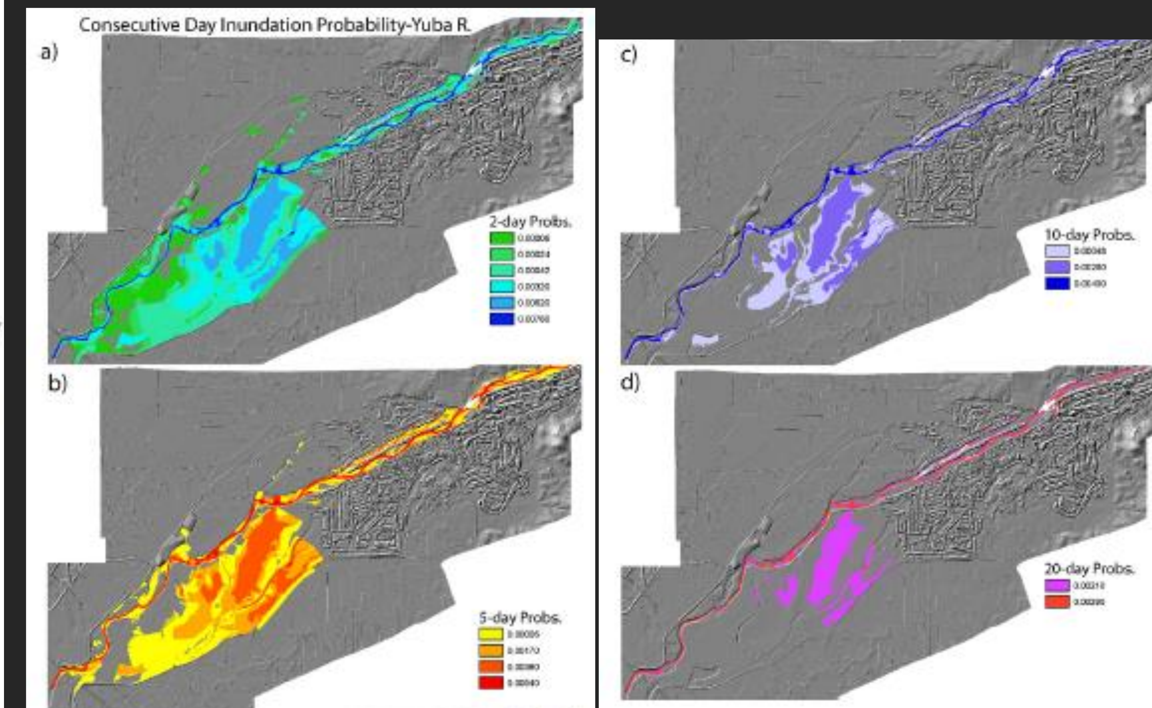
Wetting and drying may stimulate resident sulfate-reducing bacteria to methylate Hg near the sediment-water interface to its toxic form, posing risk to lowland ecosystems.

*CDWR*

*CDWR*

The cumulative history of inundation frequency and duration at each topographic position along a river corridor affects the potential production rate of *toxic MMHg*.

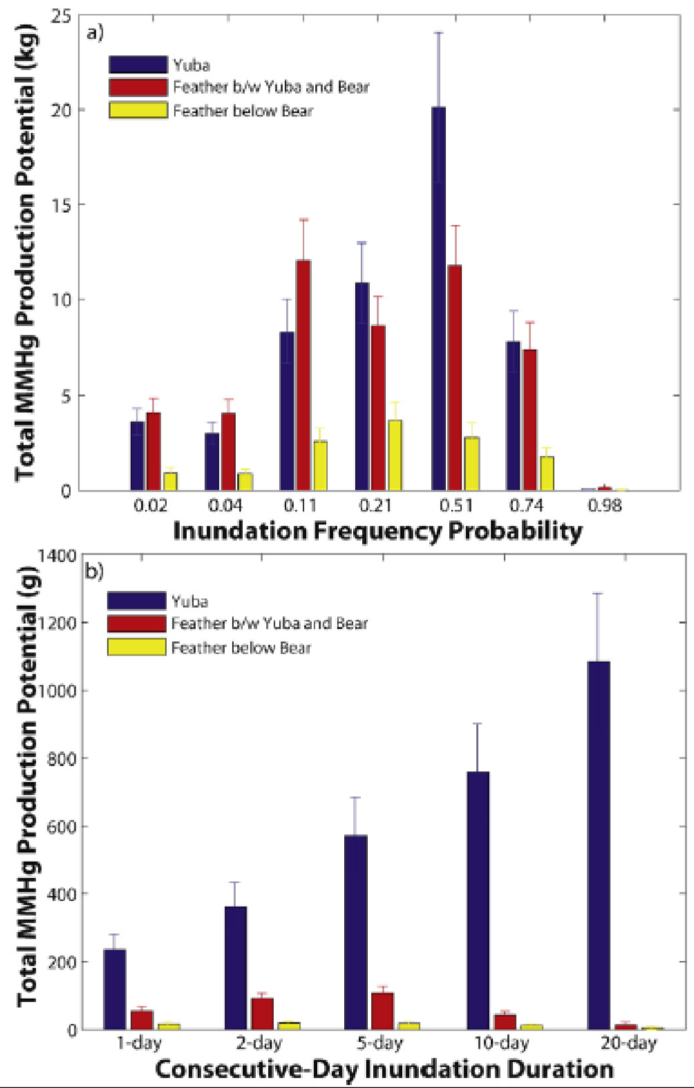



*Singer et al., Science of the Total Environment, 2016*

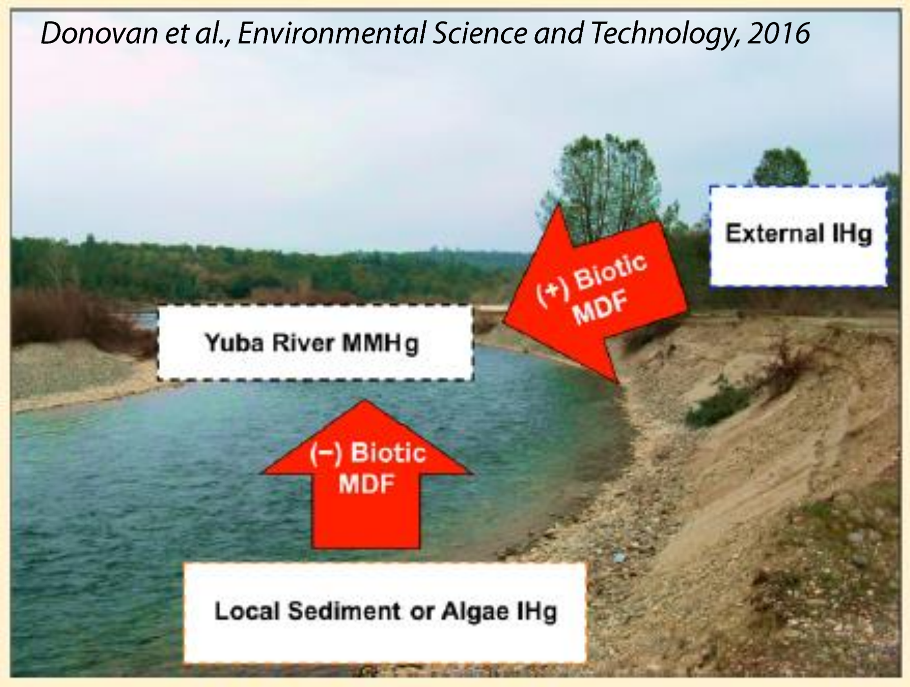
Thus, we can quantify MMHg production as a function of *frequency* and *duration* of inundation.

We are also working with *stable isotopes of Hg* to understand the conversion from inorganic to organic Hg and its uptake and biomagnification in food webs.

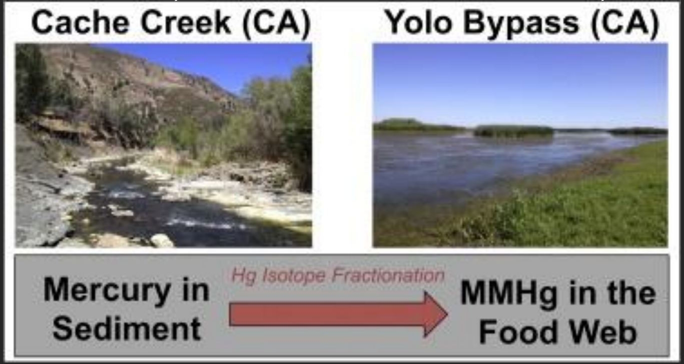


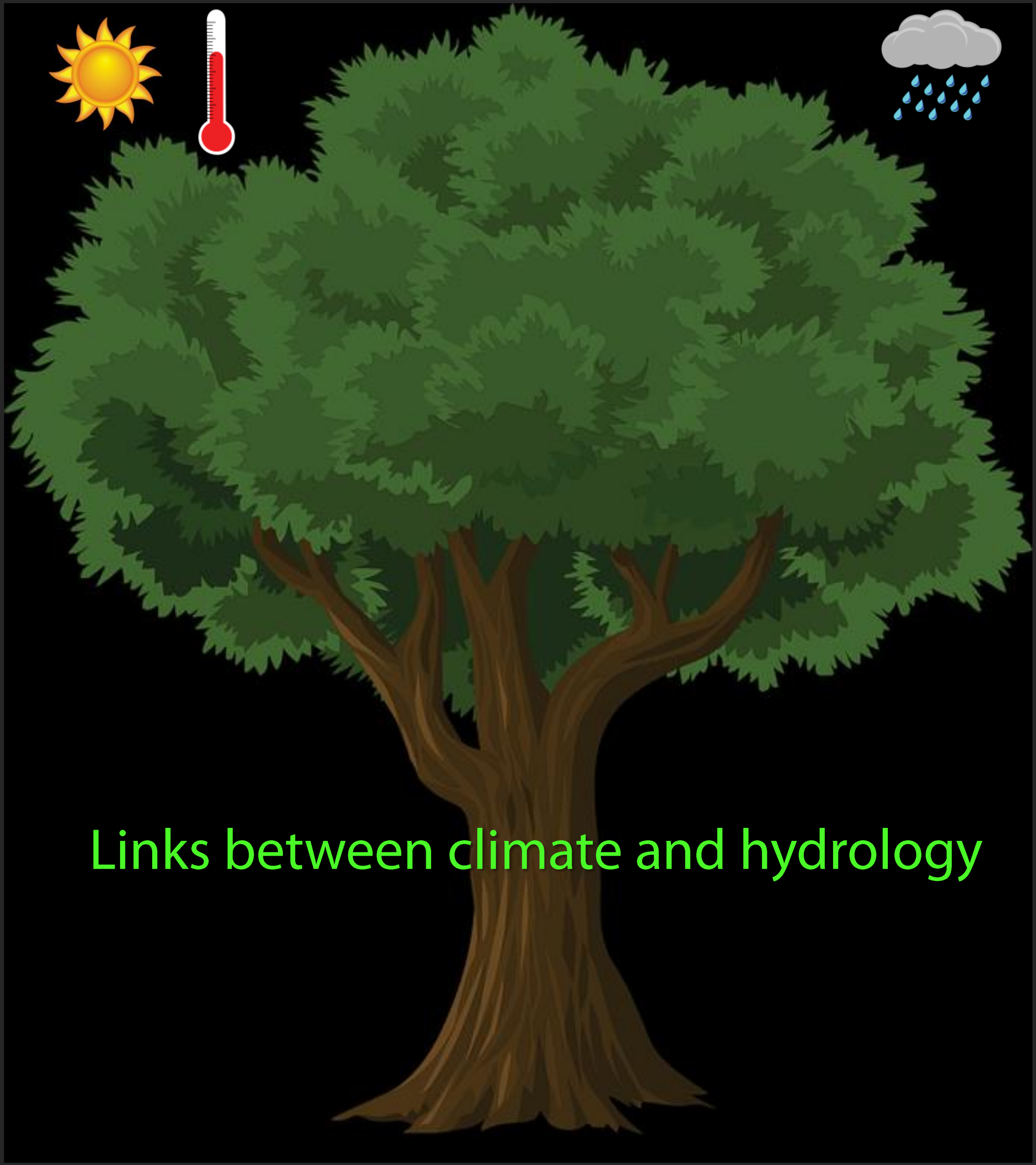

*Singer et al., Science of the Total Environment, 2016*

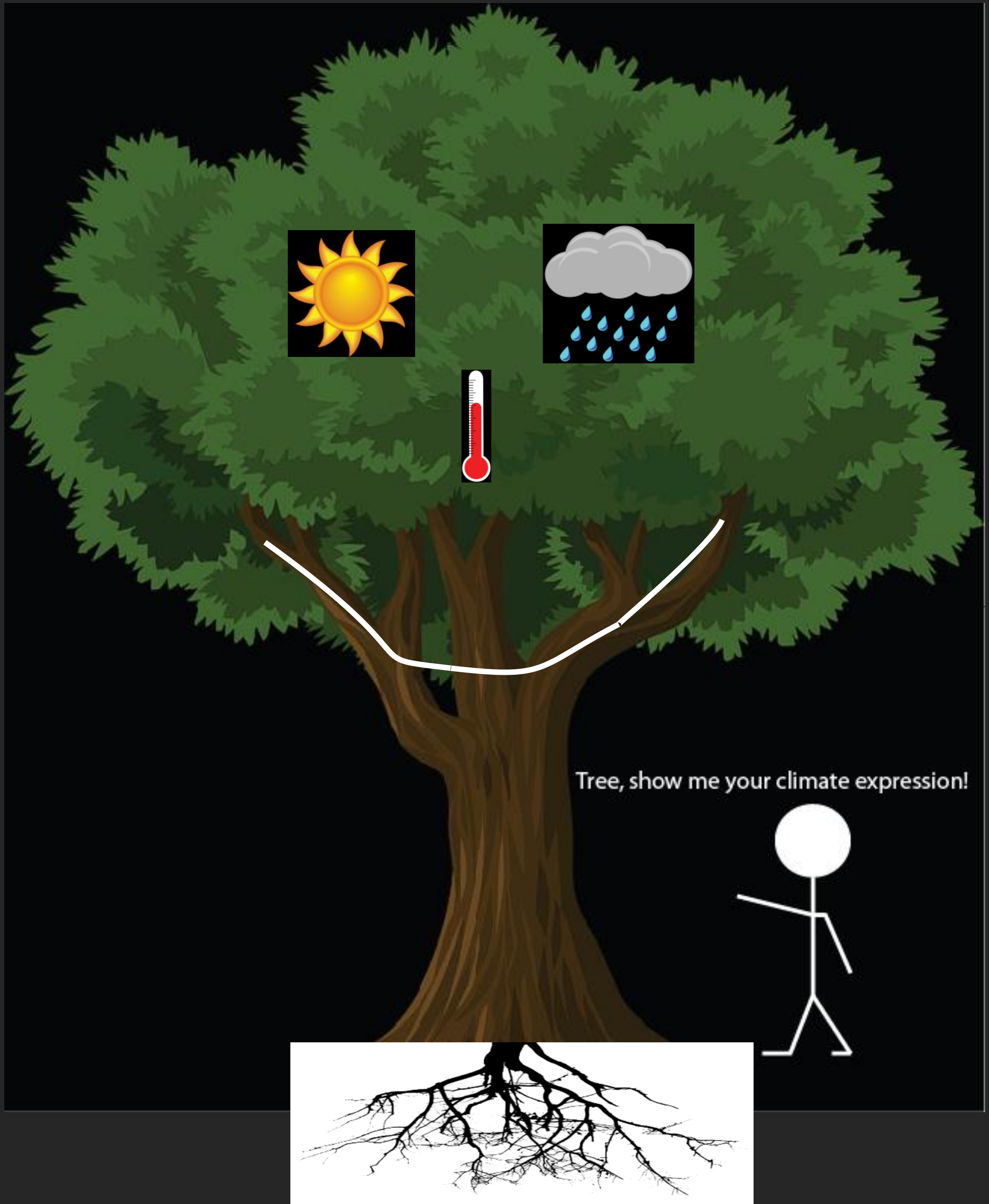
*Donovan et al., Environmental Science and Technology, 2016*




*Donovan et al., Science of the Total Environment, 2016*




Links between climate and hydrology

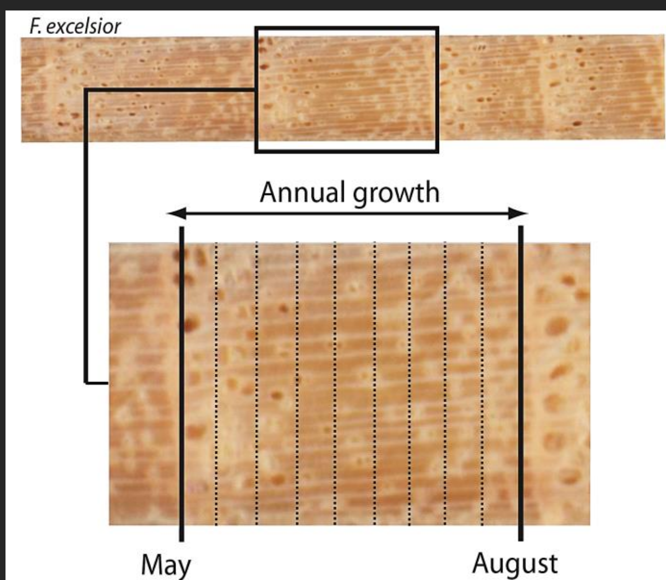

Tree, show me your climate expression!

# New methodology for determining tree water use

## Tree coring

## Tree-ring chronology / dating


## Micro-slicing of annual rings



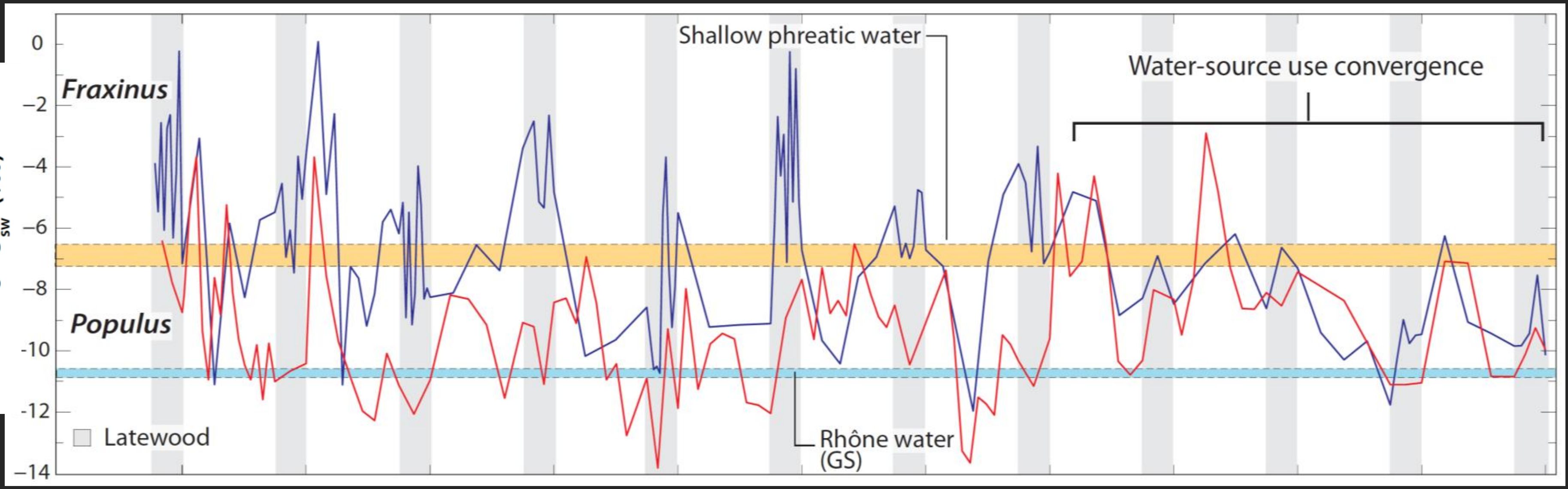

## α-cellulose extraction

(Modified Brendel method)

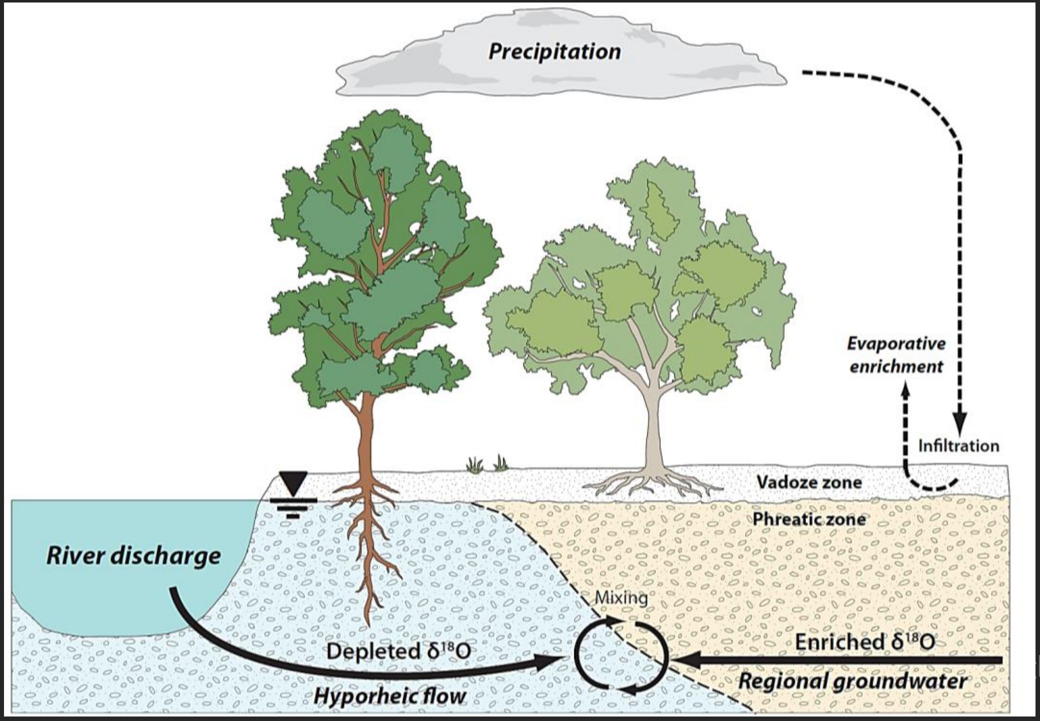
## Isotopic analysis ($\delta^{18}O$)

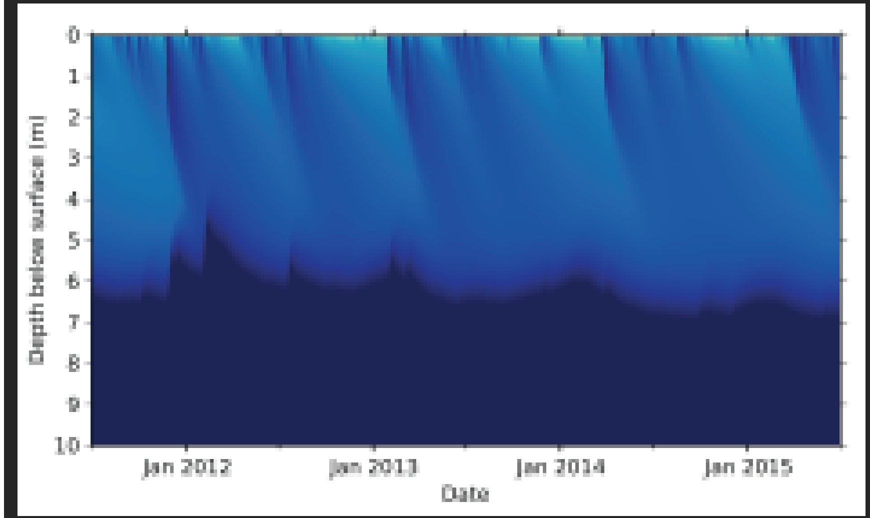
## Biochemical fractionation modelling

# Advancing Floodplain Ecohydrology




*Sargeant and Singer, Ecohydrology, 2016*

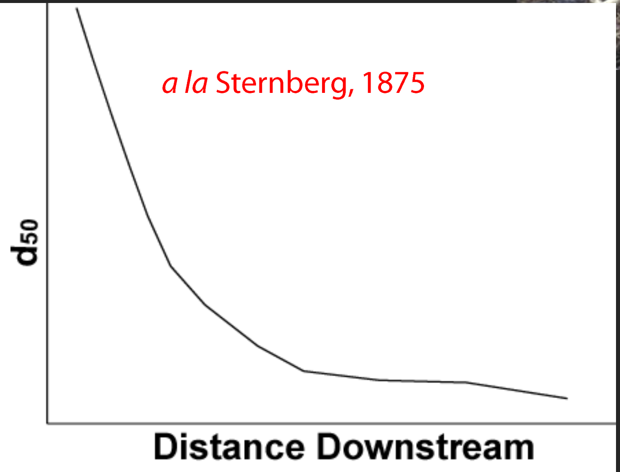



*Evans, Dritschel, Singer, In Prep.*

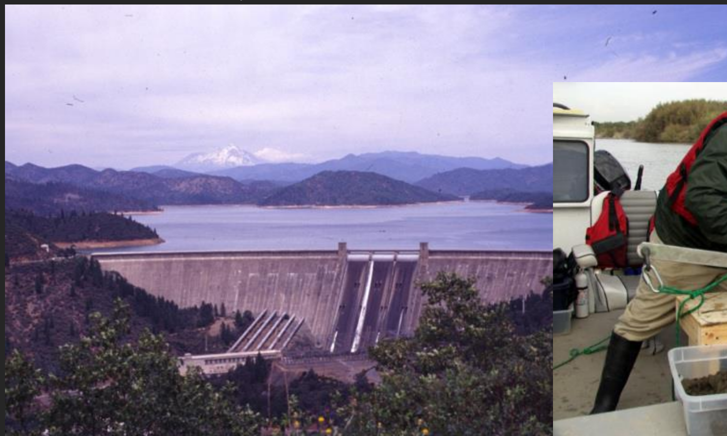
h, 2016

# Riverbed Grain Sizes

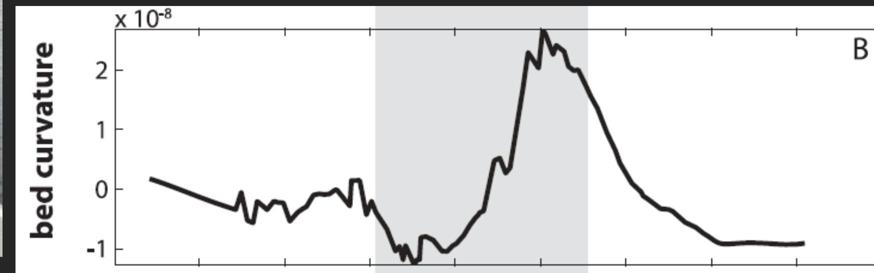



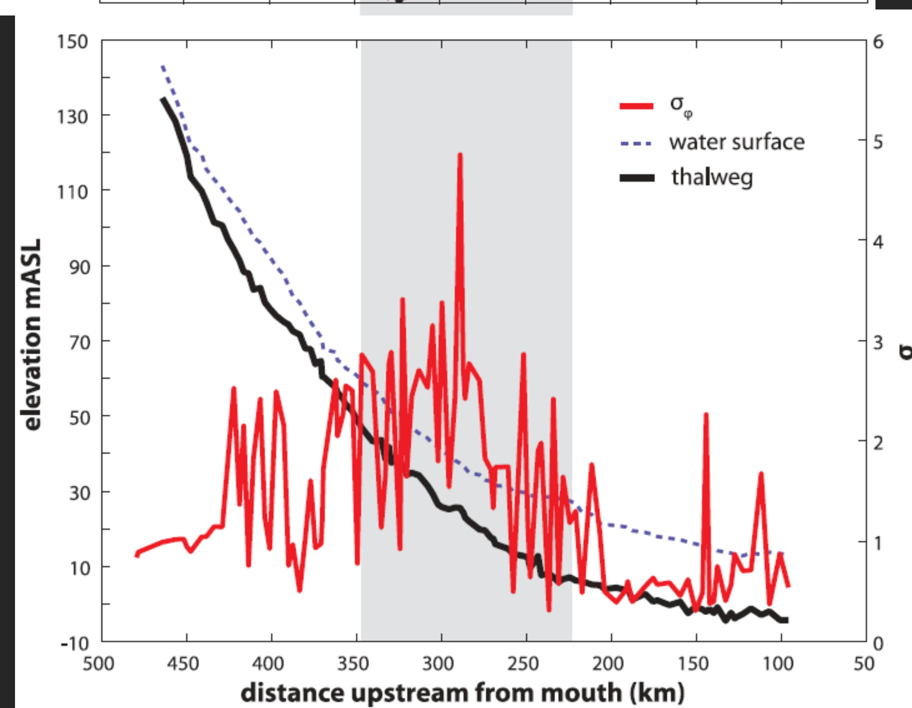

# Changes in sediment supply alter longitudinal profile and grain size patterns

The ‘hungry water’ downstream of a major dam redistributed riverbed sediment and disrupted the fining profile.

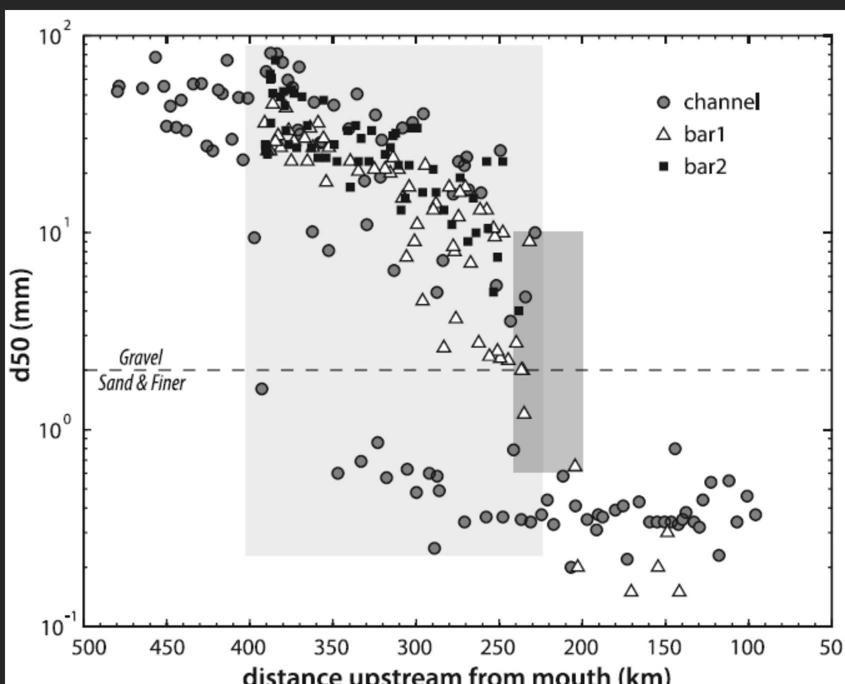


Singer, *Earth Surf. Proc. Landforms*, 2008




Singer, *Geophysical Research Letters*, 2010




Singer, *Water Resources Research*, 2008

# Teaching Philosophy

Experiential learning of theory reinforced by practical skills and real-world case studies.

My courses typically include practical components, and some make use of computers for computation and modelling.

I emphasize translatable skills training and long-term knowledge acquisition, rather than merely performing for exams.

# Current Teaching

*Earth Surface Processes*
1st Year introduction to a range of earth surface processes. Includes some quantification and various global case studies.

*Water Cycle*
1st Year introduction to runoff generation, flow pathways, water balance, measurement, and isotopic tracers.

*Fluvial Processes*
3rd Year submodule links whole basin perspective of earth surface processes with analytical and quantification skills (e.g., sediment transport) and management.

*Water in the Environment*
Masters level module provides foundational knowledge of hydrological theory, critical thought about the expression of hydrological cycle, and facility with computation.

*Rio Tinto Field Course*
2nd Year trip investigates causes and effects of acid mine drainage, and offers practical skills training for undergraduate dissertations.

# Teaching prospects at Loughborough

I could contribute teaching expertise to various modules on the BSc Geography and the MSci courses.

I am interested to teach courses that link surface processes to driving hydrology and affected environmental health.

I am particularly enthusiastic about field courses.

# Research prospects at Loughborough

I can envision good synergies with the Centre for Hydrological and Ecosystem Science and with various individuals in Geography. For example (not an exhaustive list):

Various fluvial and dryland topics in Earth surface processes (Baddock, Bullard, Graham, Reid, Rice)

Climate-driven changes to the water cycle, flood hazard, and ecohydrology (Anderson, Hillier, Millett, Rendell, Wilby, Wood, Yu)

Also, I would be keen to collaborate more broadly at Loughborough with researchers from Civil Engineering (Water and Waste Management) and Mathematics (Mathematical Modelling).

# Thank you!

Singer, Loughborough, 2016

# River Corridor Perspective

Sediment in river corridors affects:

Boundary roughness
Channel (conveyance) capacity
River alignment/gradient
Hyporheic flow/bank strength/infiltration
Fate/transport of nutrients/contaminants
Aquatic and riparian habitats

Flow in rivers constitutes:

Water supply
Hydropower
Flood risk
Hyporheic exchange
Climate signal
Cumulative of runoff generation


Singer, Loughborough, 2016