The Role of Rainfall Variability on Constituent Transport from an Agricultural Watershed

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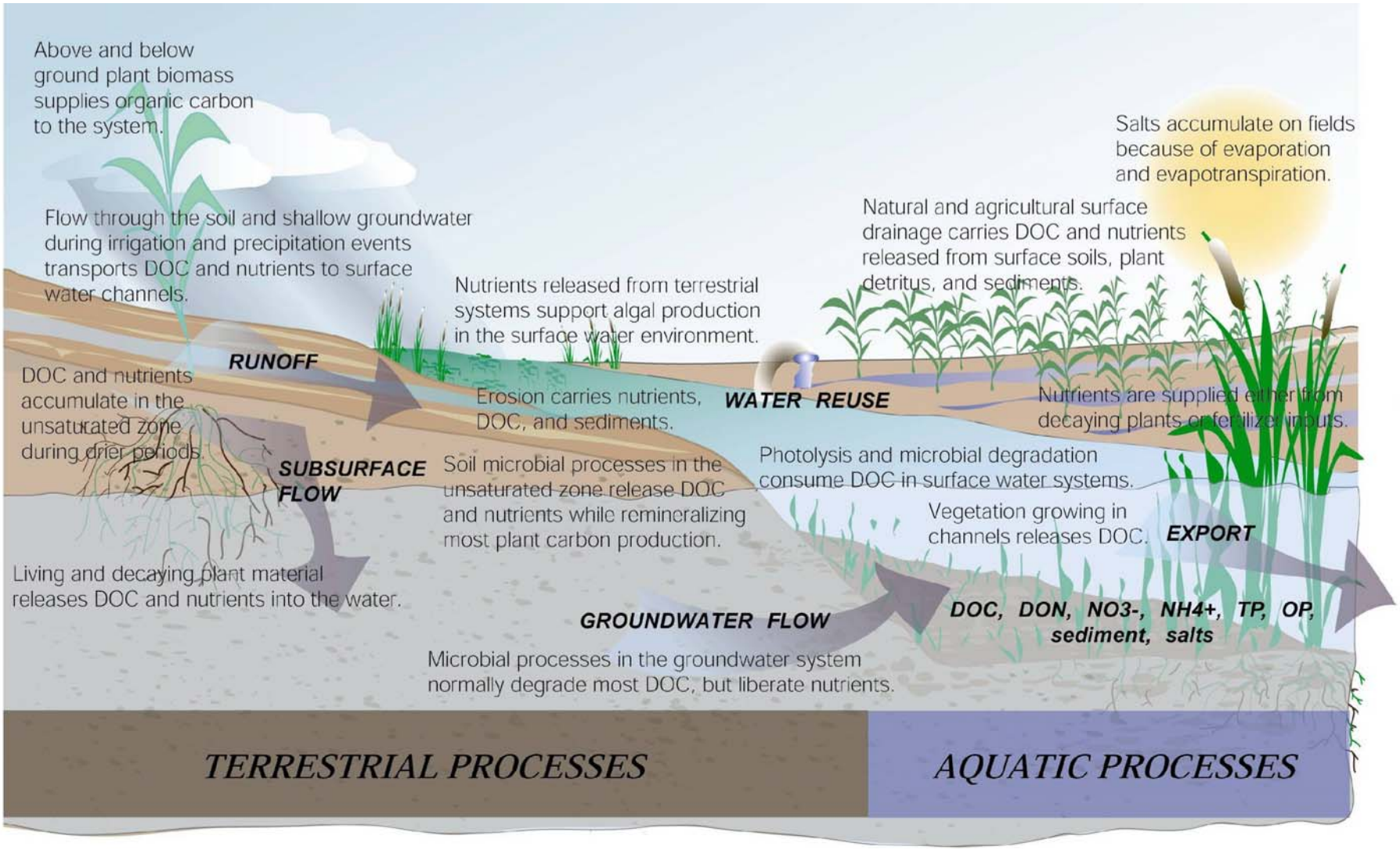
Landowners, Cooperators, and Advisory Groups

Caveat: Not a "climate change" study, but…



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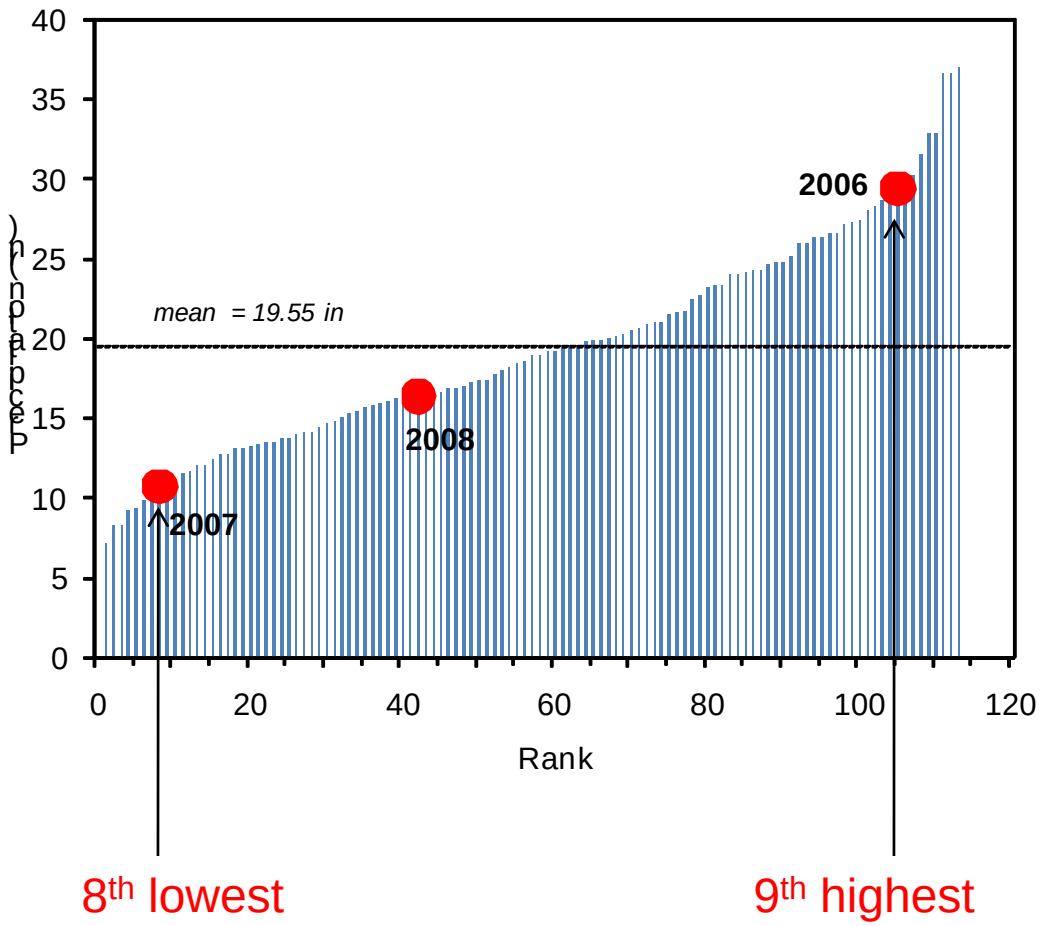
Total Annual Rainfall, Yolo County, CA

(95 % occurring between October and April)



http://www.cefa.dri.edu/Westmap/Westmap_home.php?page=timeplot.php

How does rainfall variability affect constituent fluxes from agricultural watersheds?

- Impact on freshwater and coastal ecosystems
  - Constituent transport to the Bay-Delta
  - Changes in aquatic processes
- Impacts on drinking water quality
  - Pre-treatment for high sediment, disinfection byproducts
- Need for water conservation / watershed management
  - Erosional losses and soil carbon storage
  - Development of best management practices
- Costs and damages associated with flooding

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Willow Slough Watershed Study

GOAL: A quantitative understanding of DOM dynamics (as well as sediments, nutrients and salts) in a model agricultural watershed.

APPROACH:

- ❑ Weekly surface water monitoring (2006-2009)
- ❑ Linked process studies at different scales
- ❑ Variety of analytical tools, models
- ❑ Applied elements (outreach, BMP development)
- ❑ Watershed comparison

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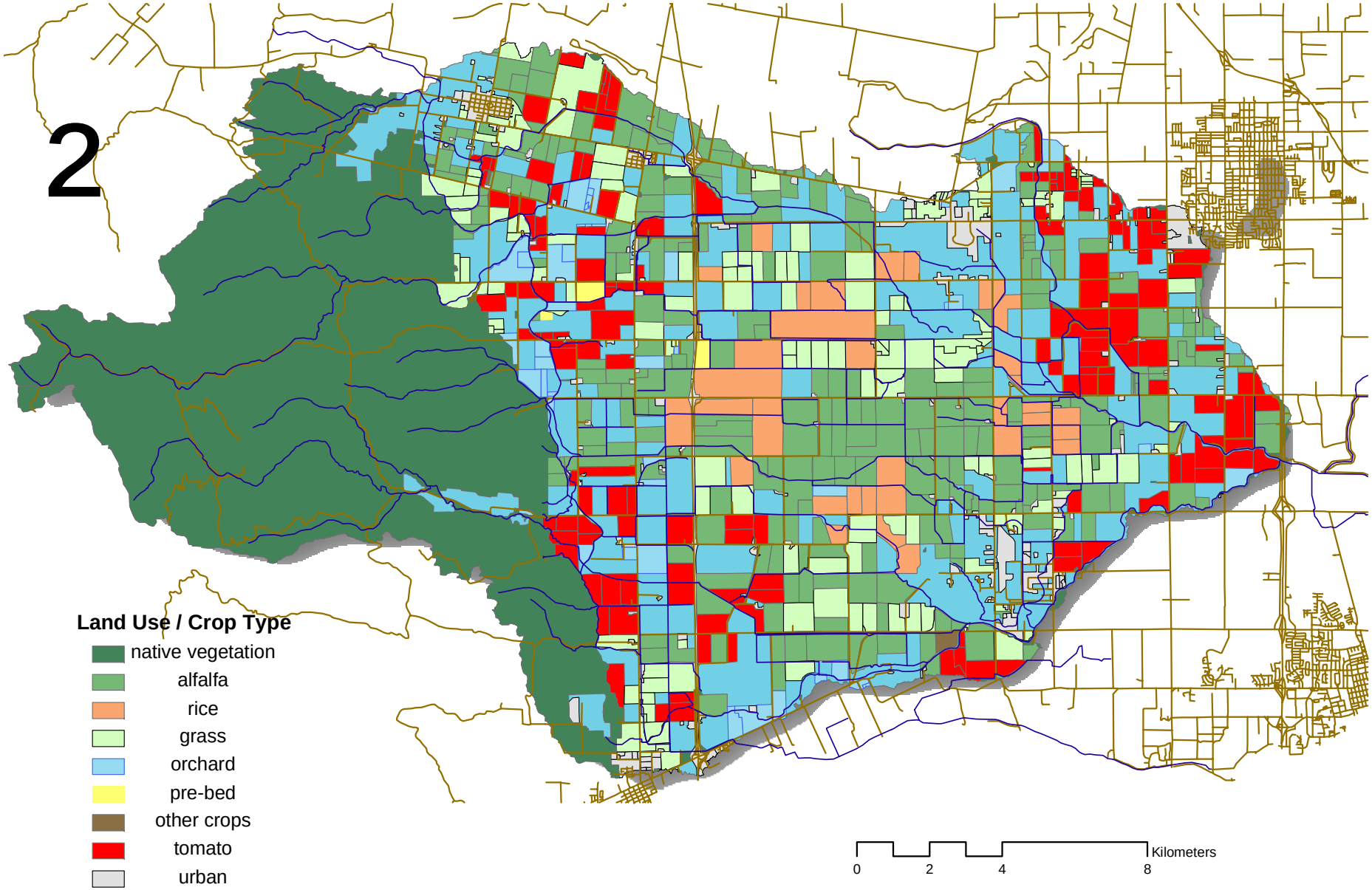
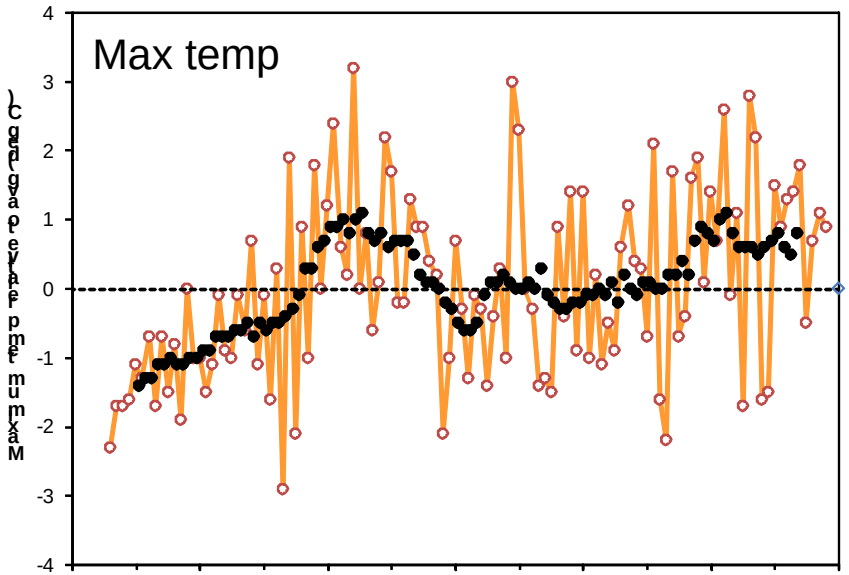
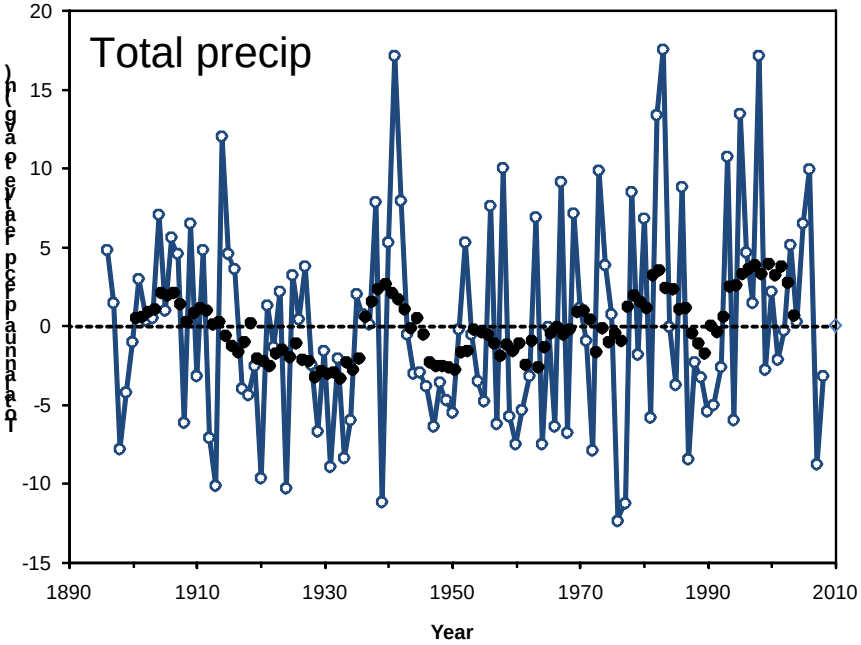

2
Land Use / Crop Type
native vegetation
alfalfa
rice
grass
orchard
pre-bed
other crops
tomato
urban
0
2
4
8
Kilometers

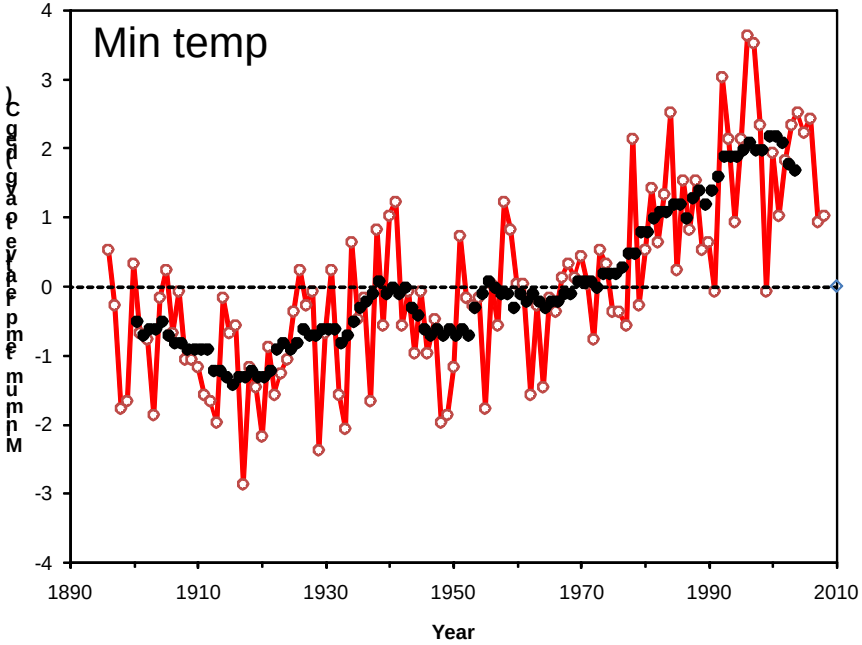
Climate Time Series for Yolo County

(1895-2008; PRISM modeled data interpolated to county level with precipitation, DEM, etc.)

- *Circles are 10 year running averages*







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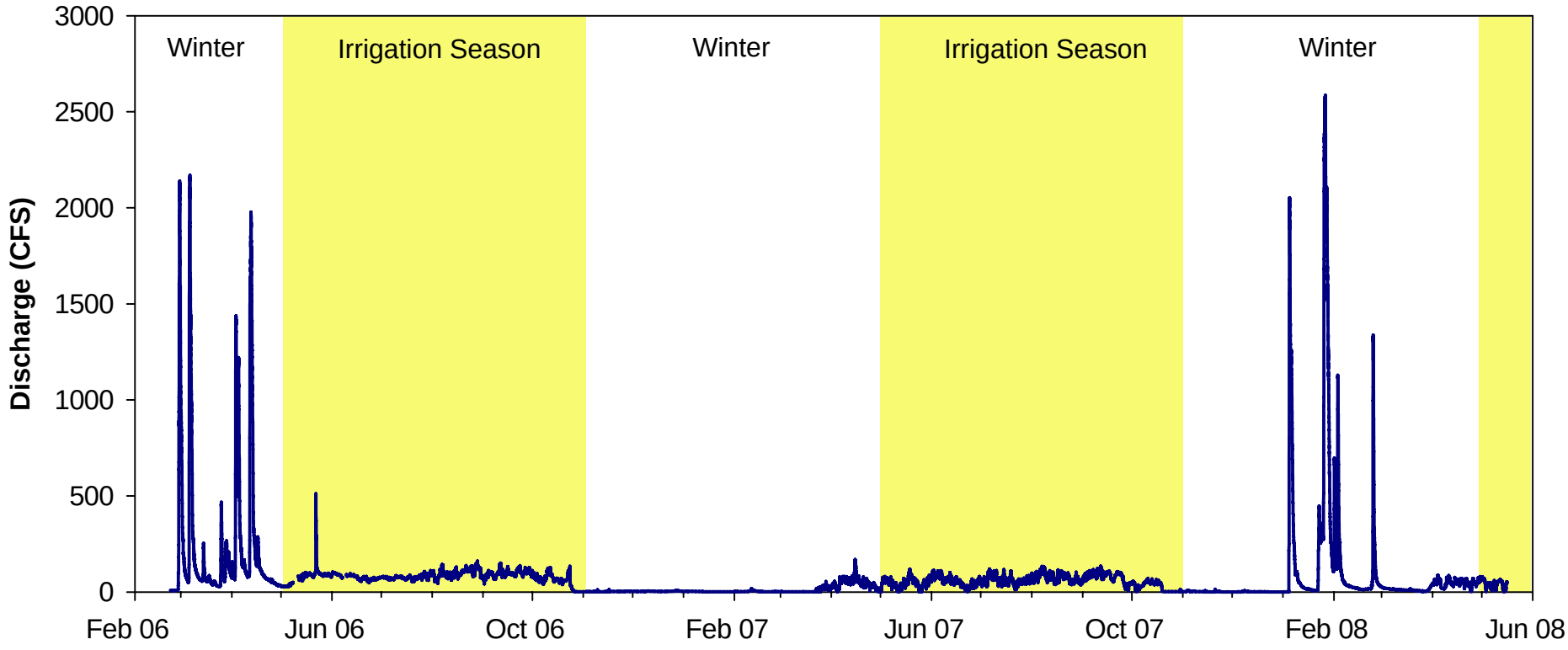
Observation 1: Winter storms are important drivers of variability in annual fluxes.



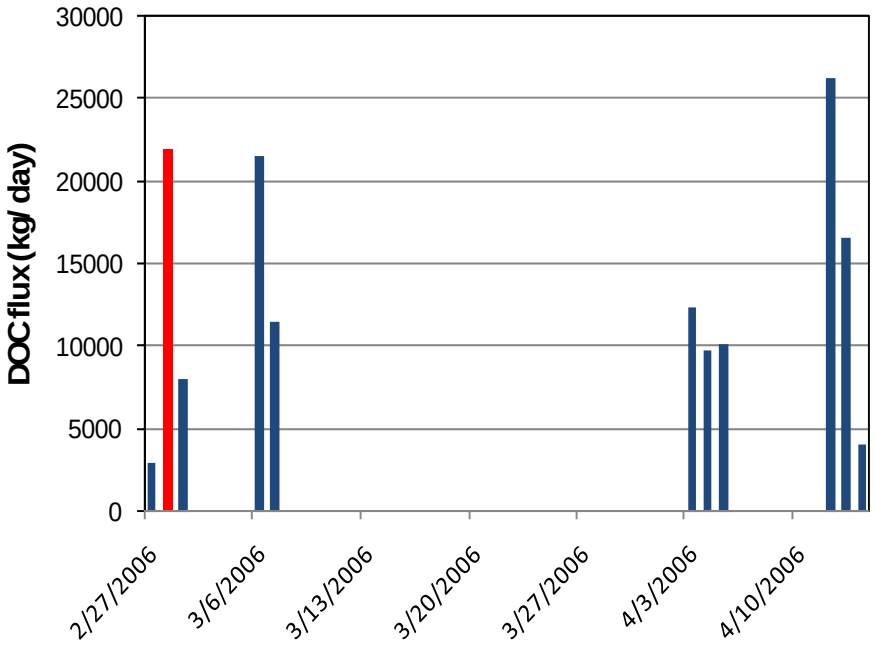
Data from 415 km^2 Willow Slough mouth

February 28, 2006 Storm

1.5 inch rainfall event (2/26 – 2/27)

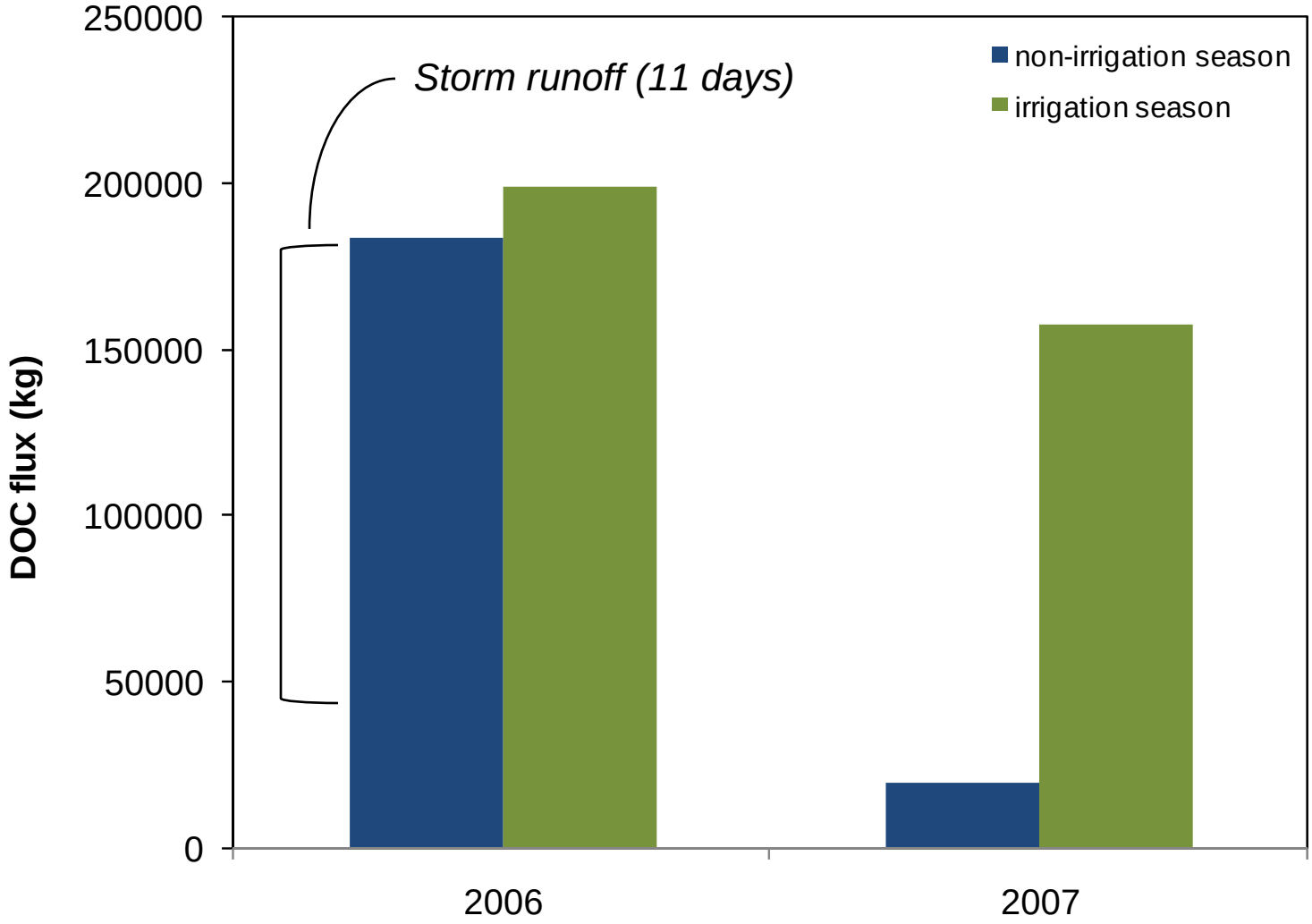
10 % of the total annual DOC flux from the watershed

~ 1 month of irrigation season flux



Willow Slough DOC Fluxes (Oh et al., in prep)

Dissolved organic carbon (DOC) – organic material from living and dead plants, animals, and bacteria in terrestrial and aquatic systems

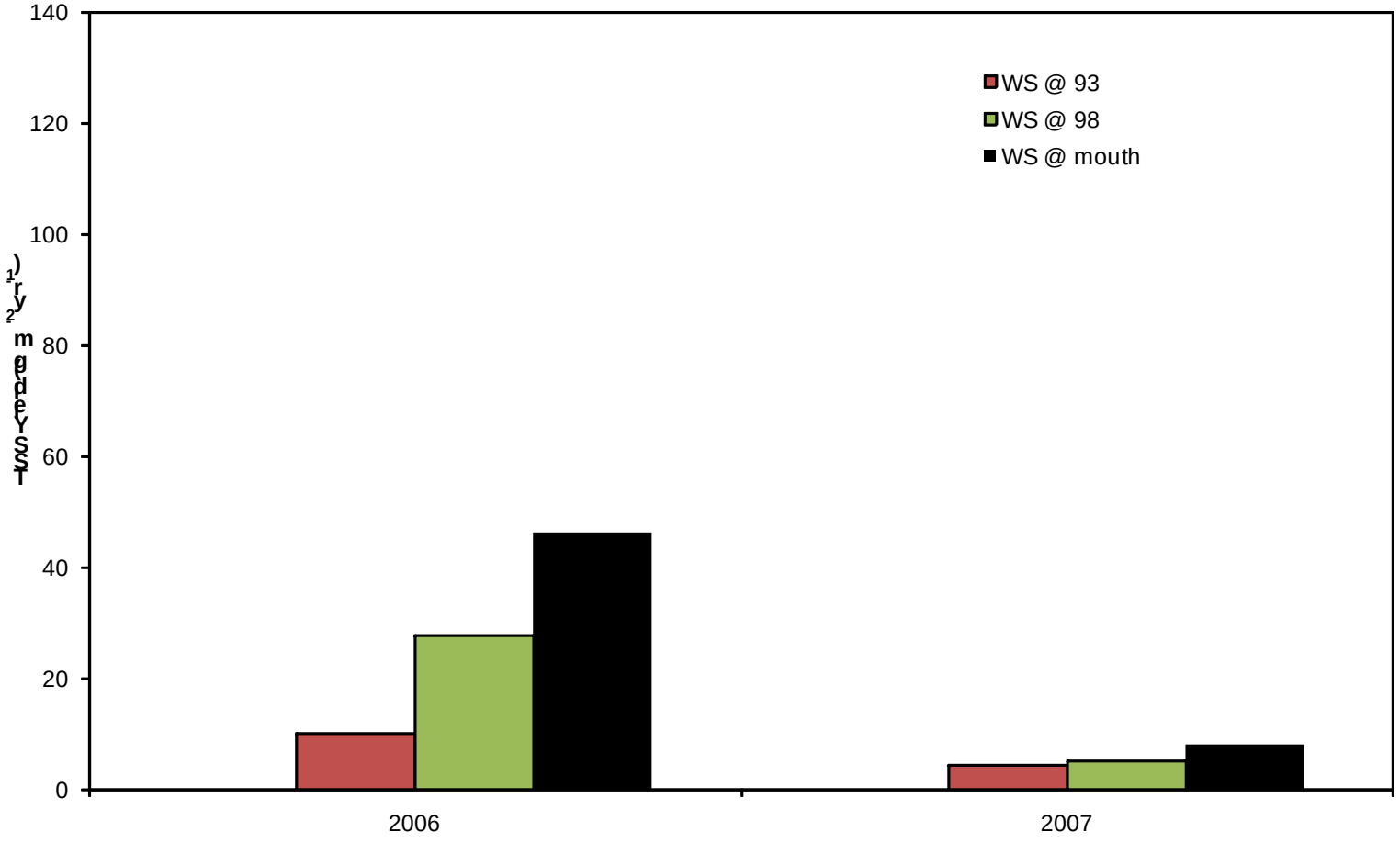


Seasons defined as ~ 180 day periods (irrigation = 5/1-10/31)

Observation 2: Fluxes from the ‘natural’ landscape depend entirely on storms (frequency and intensity).

Suspended sediment yields*

Sub-watershed locations along W-E gradient (e.g. less to more intensive ag)



** Yield = flux normalized to watershed area*

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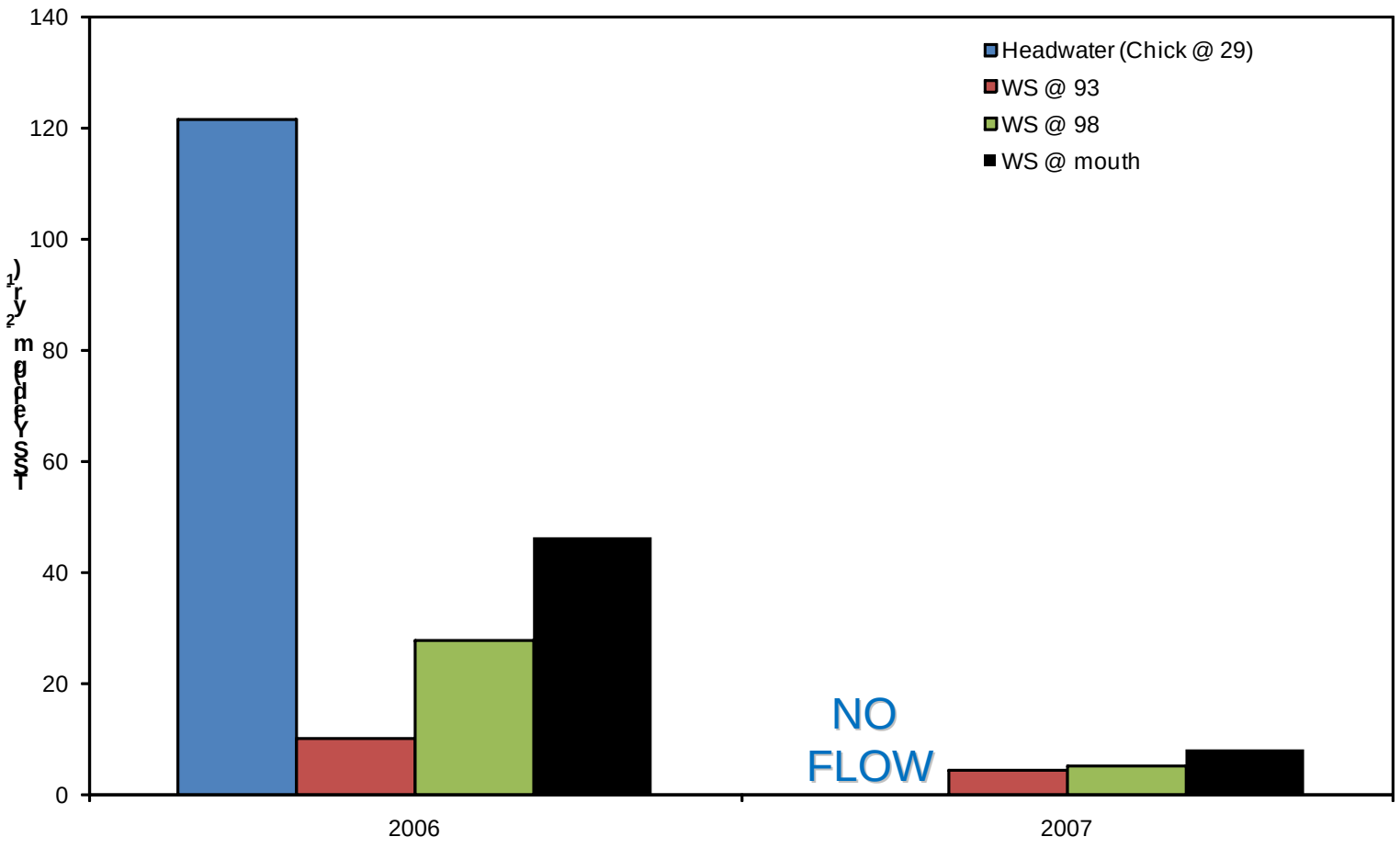

** Yield = flux normalized to watershed area*

Impact of Rainfall Variability?

Process	Below Average Rainfall	Above Average Rainfall *
Annual Constituent Yields and Fluxes	LOWER	**HIGHER**
Irrigation Season Fluxes and Yields	**NO CHANGE**	**NO CHANGE**
Relative Contribution from “Natural” Headwaters	LOWER	**HIGHER**
Connectivity of Agricultural Watersheds to the Bay – Delta and	LOWER	**HIGHER**
Erosion Rates (including Soil Carbon)	LOWER	**HIGHER**
Flooding Risks and Damage	LOWER	**HIGHER**
Difficulty in Setting Management Goals and defining BMPs	**HIGHER**	**HIGHER**

* “Moderate tendency” toward increased number and magnitude of large events (Cayan et al., 2008)

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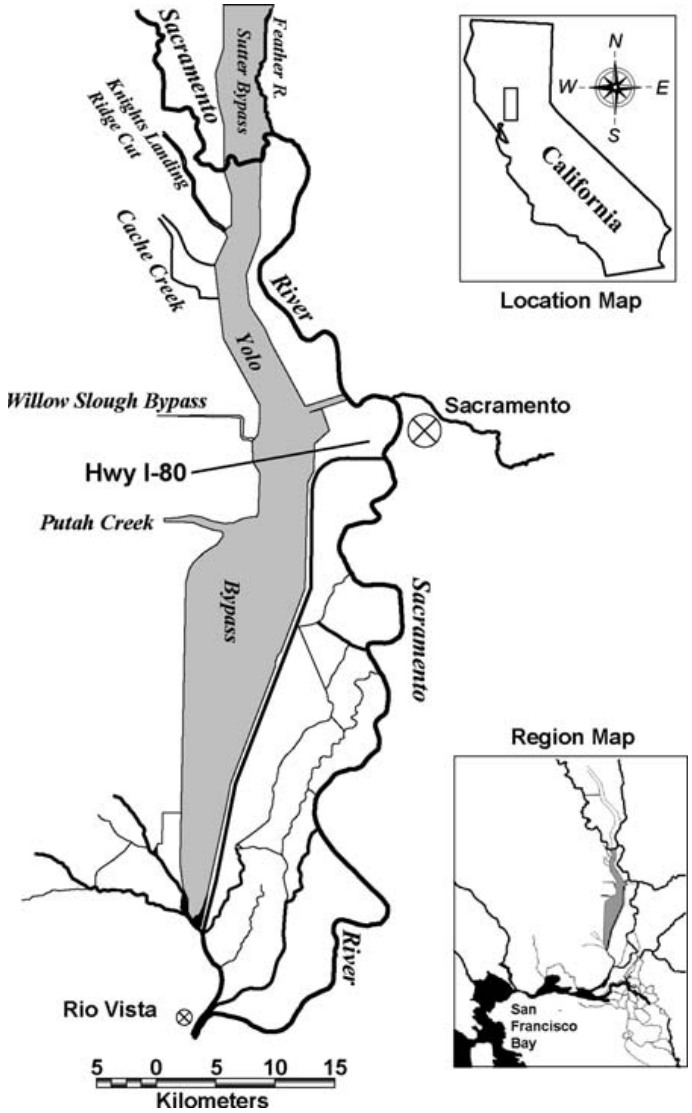
Observation 3: Impacts are complex and uncertain.

Suspended sediment delivery to the Bay – Delta: *beneficial for ecosystems, but bad for drinking water treatment…*

So do we retain sediment pulses in the watershed or allow transport to the Delta? What about drinking water?

www.fws.gov



Sommer et al., 2008

Targeted management strategies and infrastructure for larger winter storms?

Changes in the demand (higher ET, longer growing season) and cost of irrigation water?

Big Picture

Even "moderate tendency" toward higher (or lower) intensity or frequency of storms deserves more attention:

- Disproportionate influence on watershed fluxes
- Builds on "baseline" (?) irrigation season flux
- Not all landscape types respond to rain in the same way
- Complexity for drinking water treatment, ecosystems, and management