UC CE | UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources | Cooperative Extension

Managing Water for multiple benefits in California

Dr. Laura Garza

Area Water Quality, Quantity, and Climate Change Advisor
UC Cooperative Extension

Agenda

1

California Water Setting

- Climate and Hydrology
- Water Challenges and Pressures
- Water monitoring indices

2

North Coast Case Study

- Water strategies to balance agriculture and biodiversity needs

3

Water Strategy for irrigation systems

- Water Budget
- Irrigation efficiency methods
- Best practices for improving Water conservation and quality
  - Cover Crops

Agenda

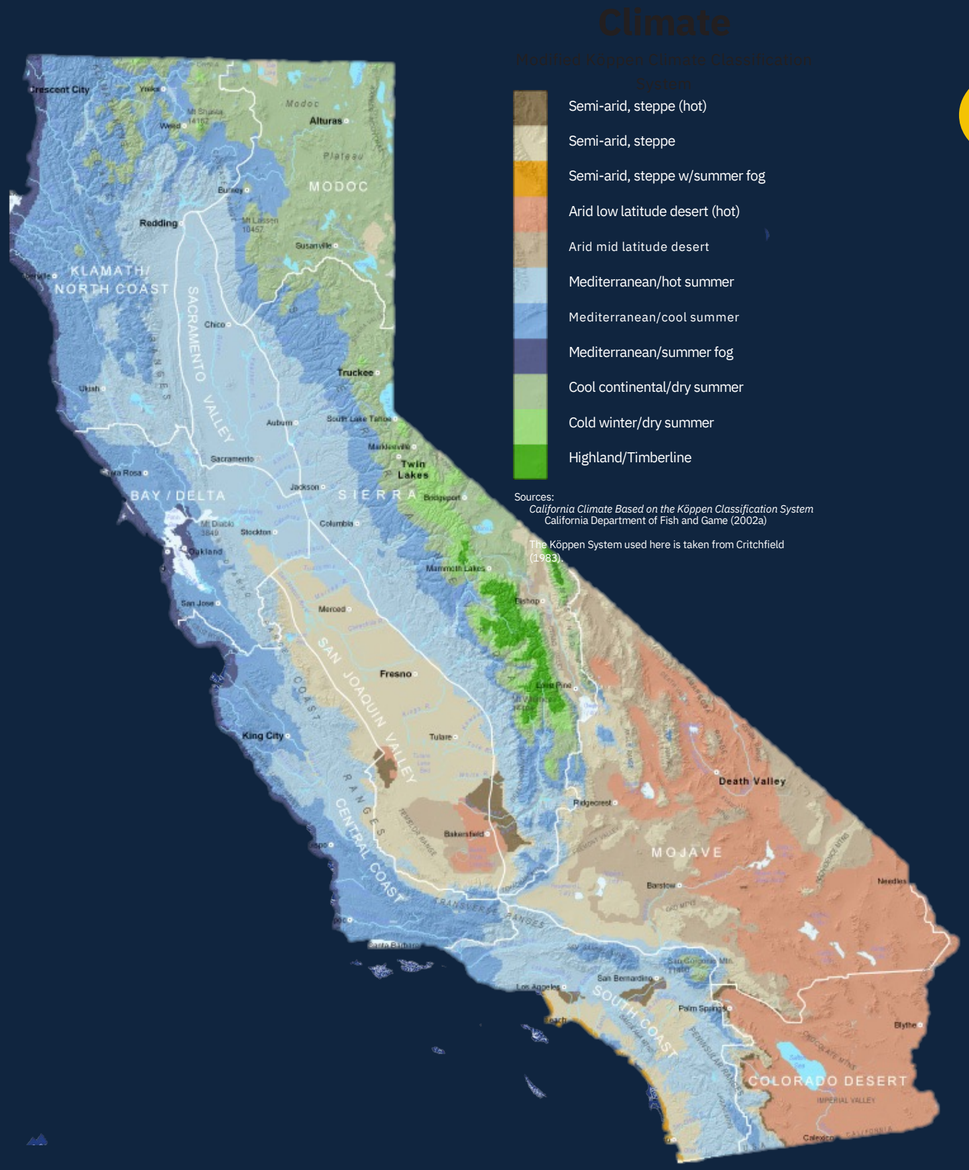
1

California Water Setting

- Climate and Hydrology
- Water Challenges and Pressures
- Water monitoring indices

UC CE UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources Cooperative Extension

California Climate and Hydro Setting



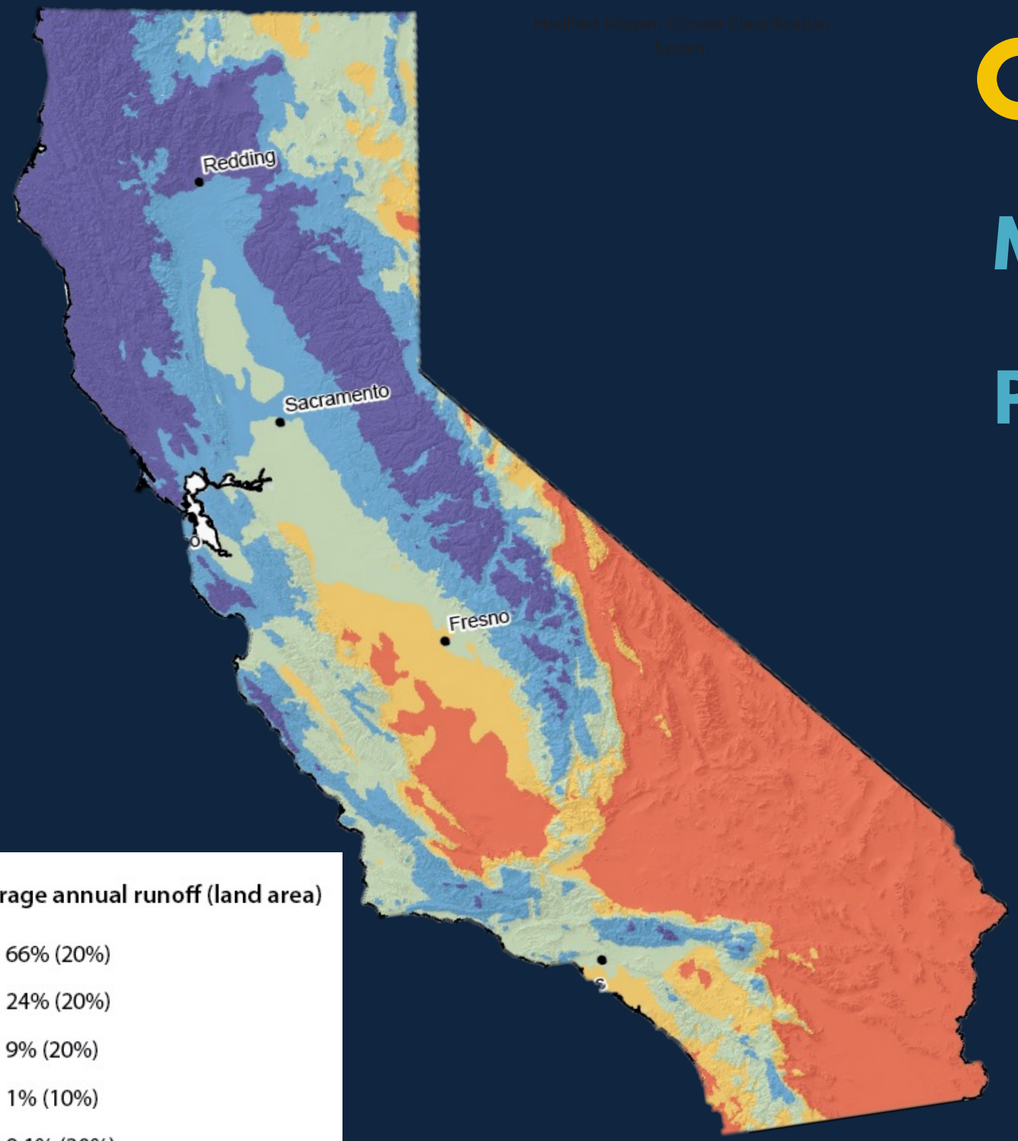
Climate

CA climate has five major climate types:

- Mediterranean (wet winters and dry summers)
- Desert
- Cool Interior
- Highland
- Steppe

UC CE UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources Cooperative Extension

California Climate and Hydro Setting



Mediterranean climate

- Wet winters and dry summers

Precipitation

- Less than 5 to 200 inches

UC CE UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources Cooperative Extension

California Climate and Hydro Setting

Mediterranean climate

- Wet winters and dry summers

Precipitation

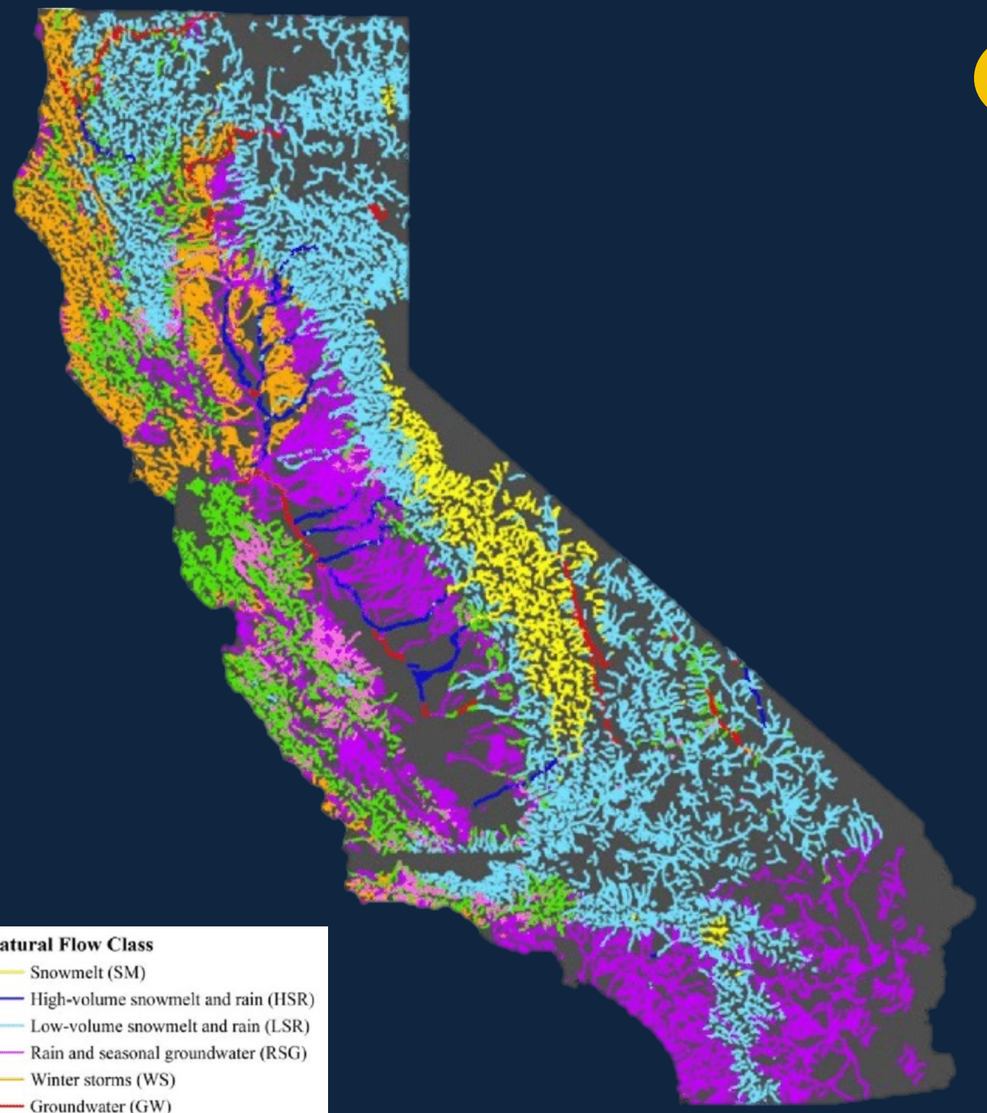
- less than 5 to 200 inches

Hydrologic Regions

- 10 hydrologic regions defined by a natural water flows or drainage areas

UC CE UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources Cooperative Extension

California Climate and Hydro Setting



Mediterranean climate

- Wet winters and dry summers

Precipitation

- less than 5 to 200 inches

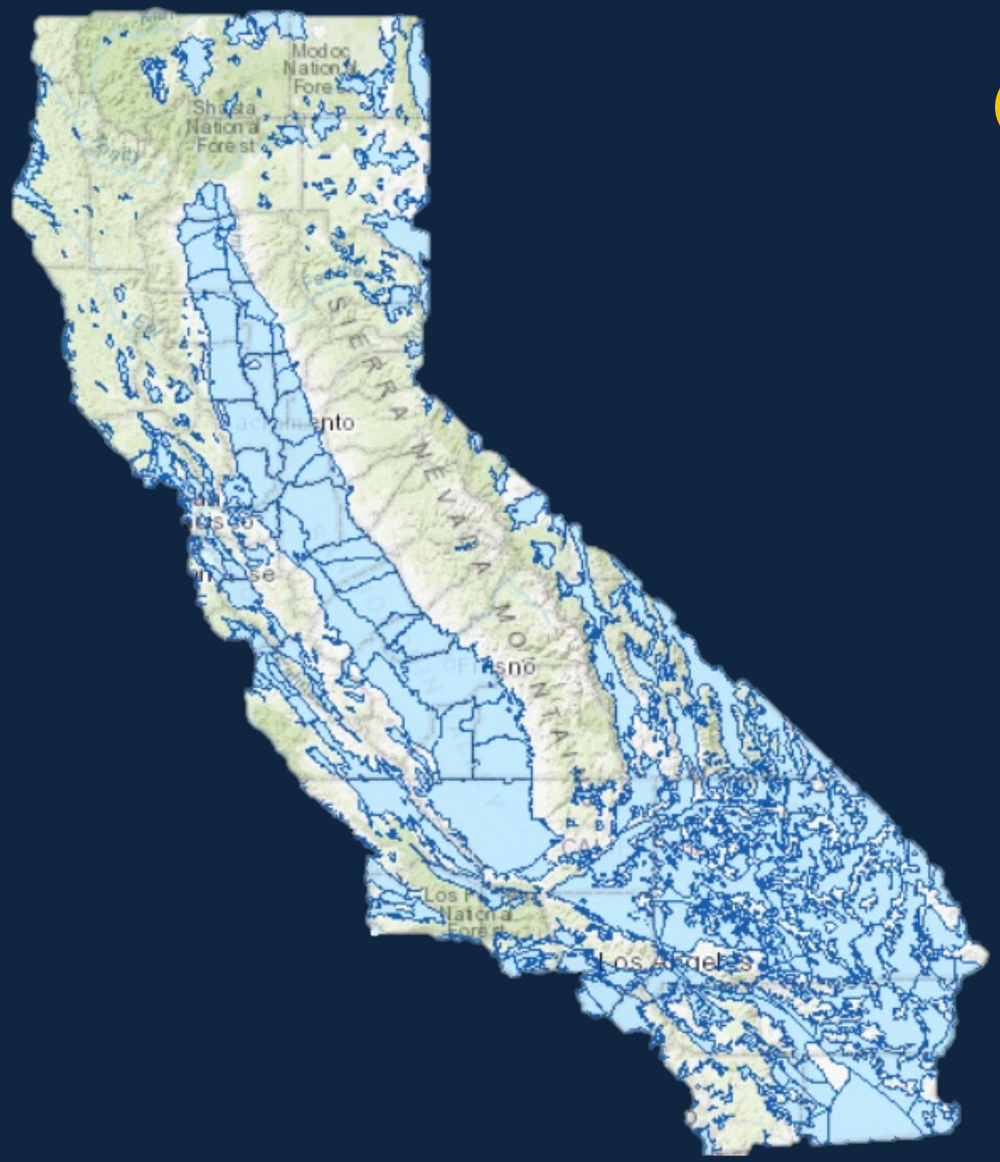
Hydrologic Regions

- 10 hydrologic regions defined by a natural water flows or drainage areas

Surface Water

- Rivers, creeks, lakes, springs
- 8 natural streamflow classes defined by hydrology and geospatial data (Lane, 2017)

UC CE | UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources | Cooperative Extension



California Climate and Hydro Setting

Groundwater

- Lake Me CA has 515 groundwater basins, covering 40% of CA landmass

UC CE UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources Cooperative Extension

California Climate and Hydro Setting

Groundwater

- Lake Me CA has 515 groundwater basins, covering 40% of CA landmass

Main Water Use

- Environmental, Agricultural, and Urban Uses.

UC CE | UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources | Cooperative Extension

California
Climate and Hydro Setting

Groundwater

- Lake Me CA has 515 groundwater basins, covering 40% of CA landmass

Main Water Use

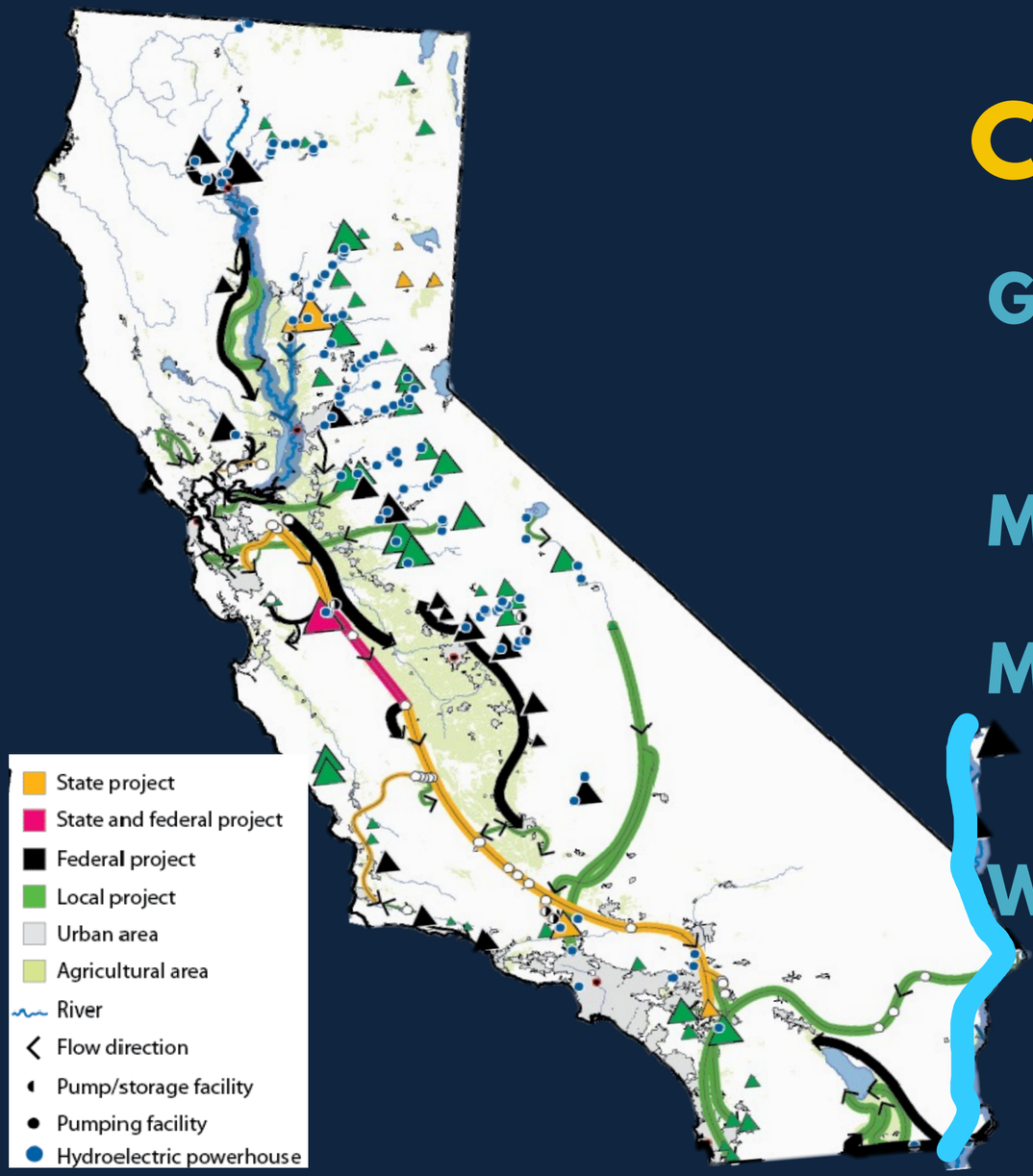
- Environmental, Agricultural, and Urban Uses.

Main Commodities

- Grapes, Strawberries, Nuts, Dairy, Hay, Row Crops, Tomatoes, Carrots, Cattle

UC CE UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources Cooperative Extension

California Climate and Hydro Setting



Groundwater

- Lake Me CA has 515 groundwater basins, covering 40% of CA landmass

Main Water Use

- Environmental, Agricultural, and Urban Uses.

Main Commodities

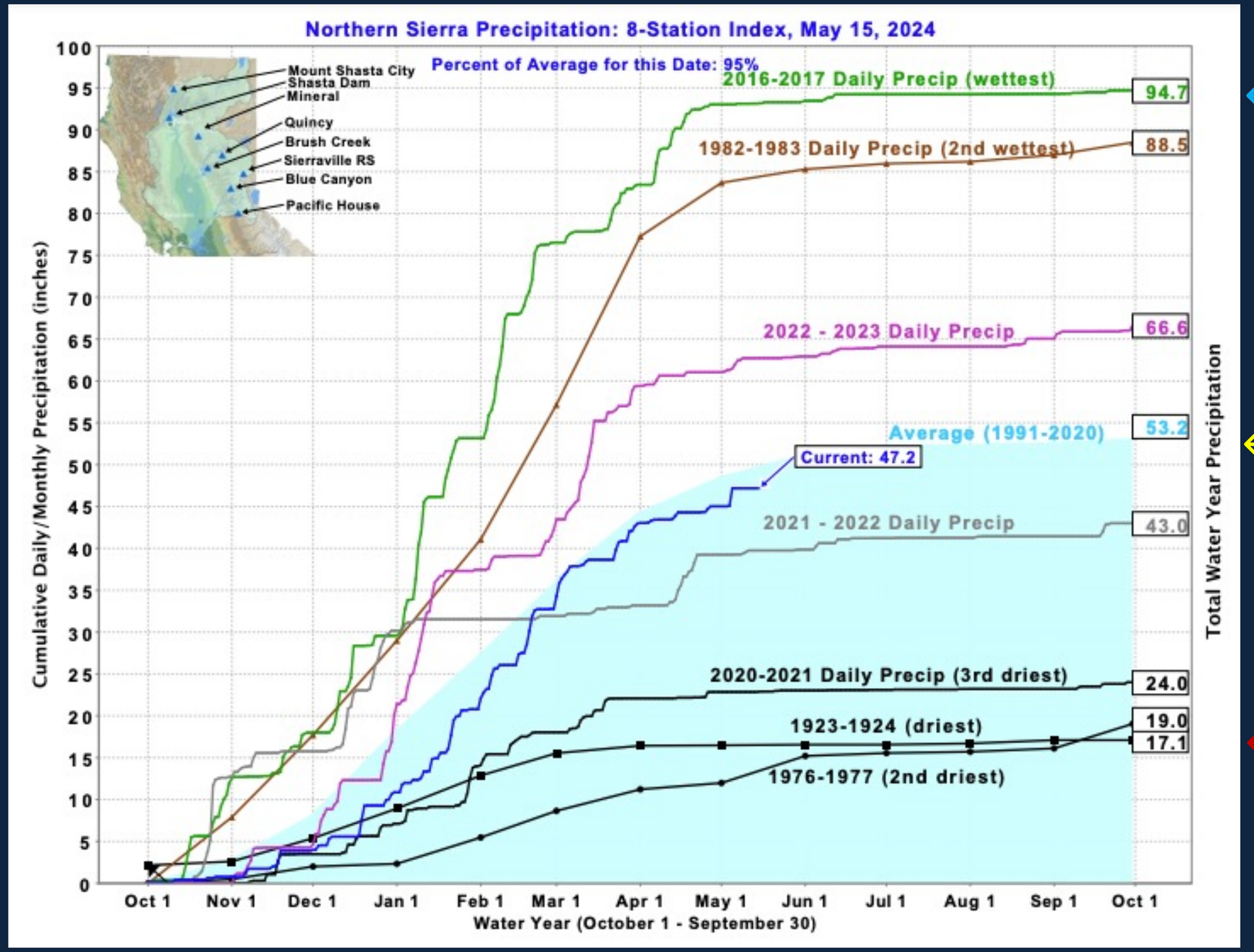
- Grapes, Strawberries, Nuts, Dairy, Hay, Row Crops, Tomatoes, Carrots, Cattle

Water System

- State, Federal, and Local projects (dams, reservoirs, power plants, pumping plants and aqueducts)

UC CE | UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources | Cooperative Extension

Rainfall index



← Wettest Year

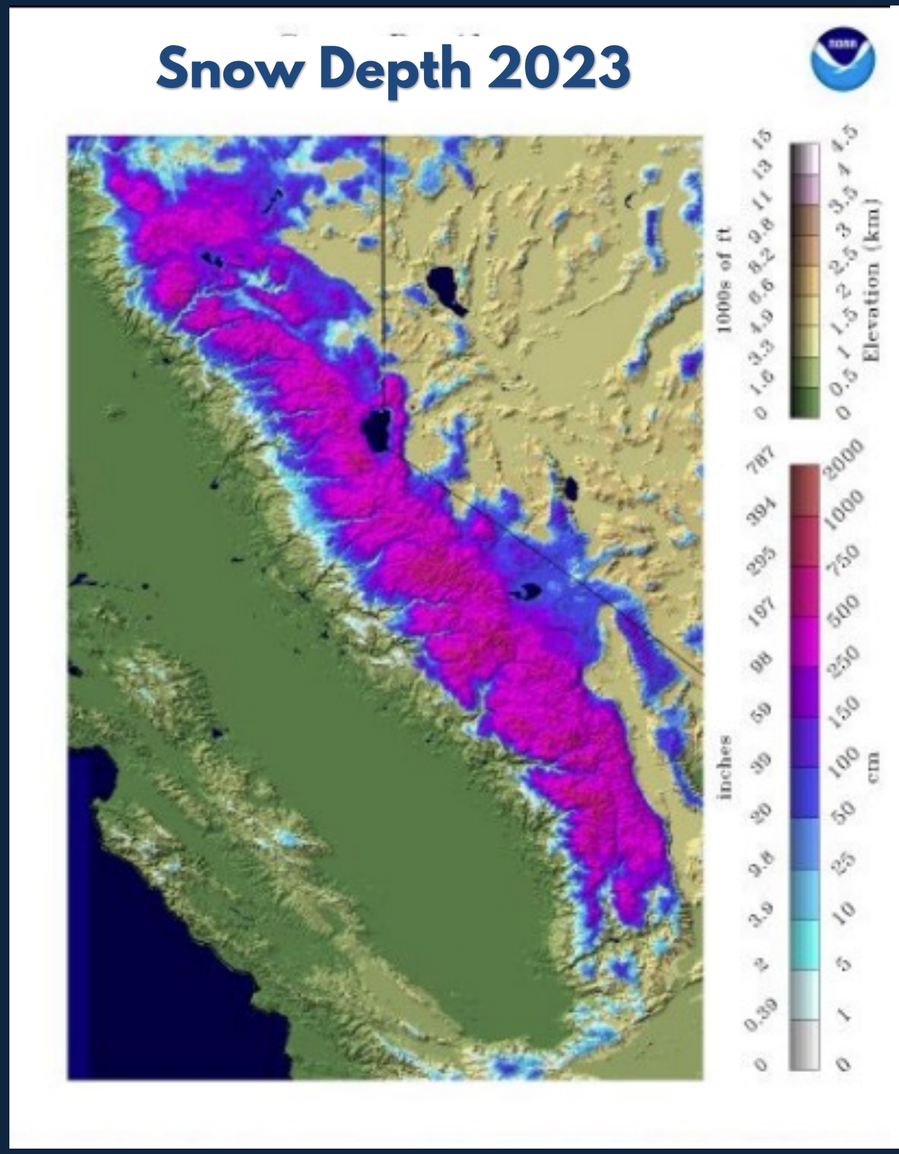
← Average Year

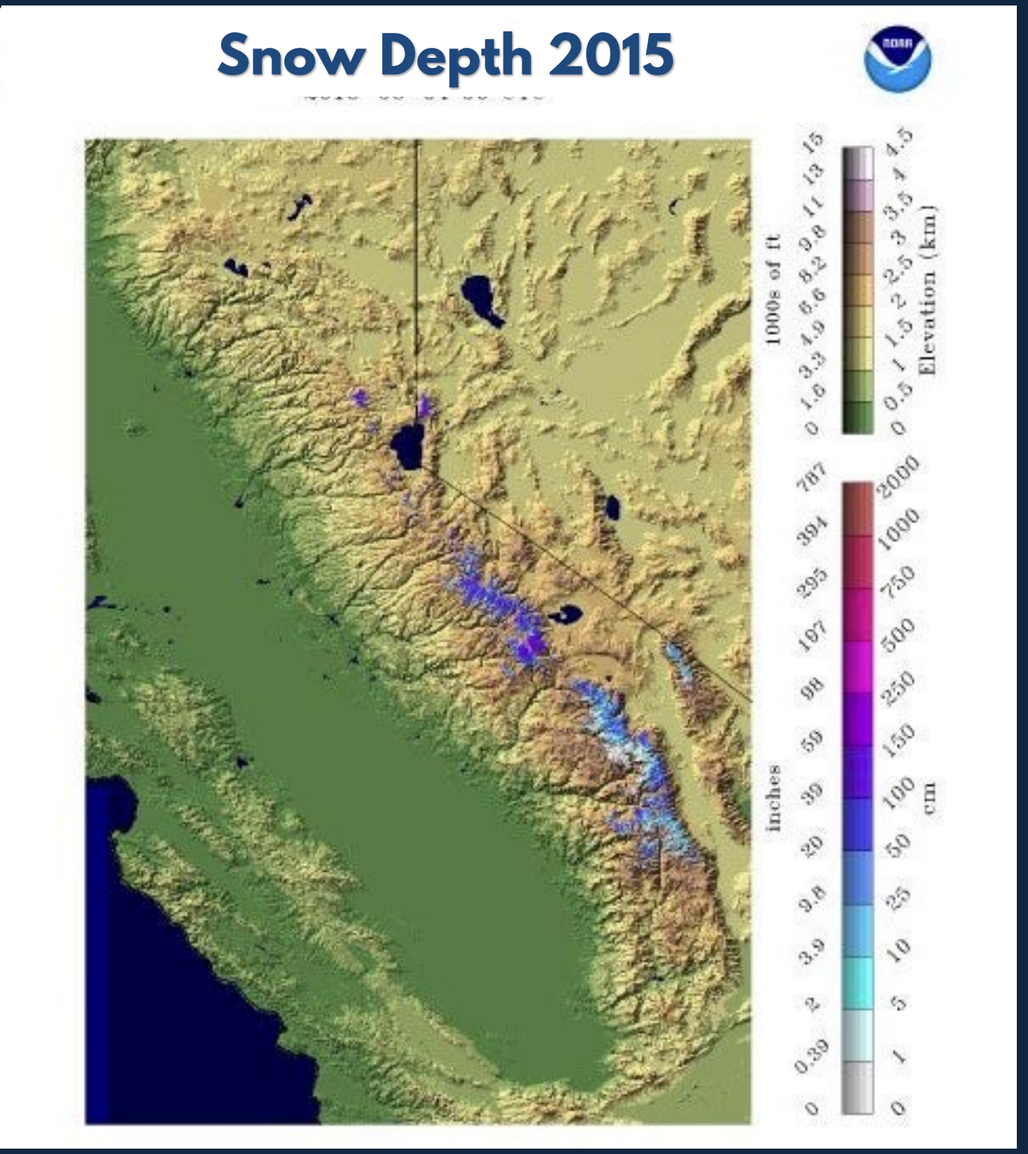
← Driest Year

UC CE | UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources | Cooperative Extension

Snow

Wet	2011
Drought — Dry	2012
Drought — Dry	2013
Drought — Dry	2014
Drought — Dry	2015
Drought — Dry	2016
Wettest	2017
Dry	2018
Wet	2019
Dry	2020
Dry	2021
Dry	2022
Wet	2023

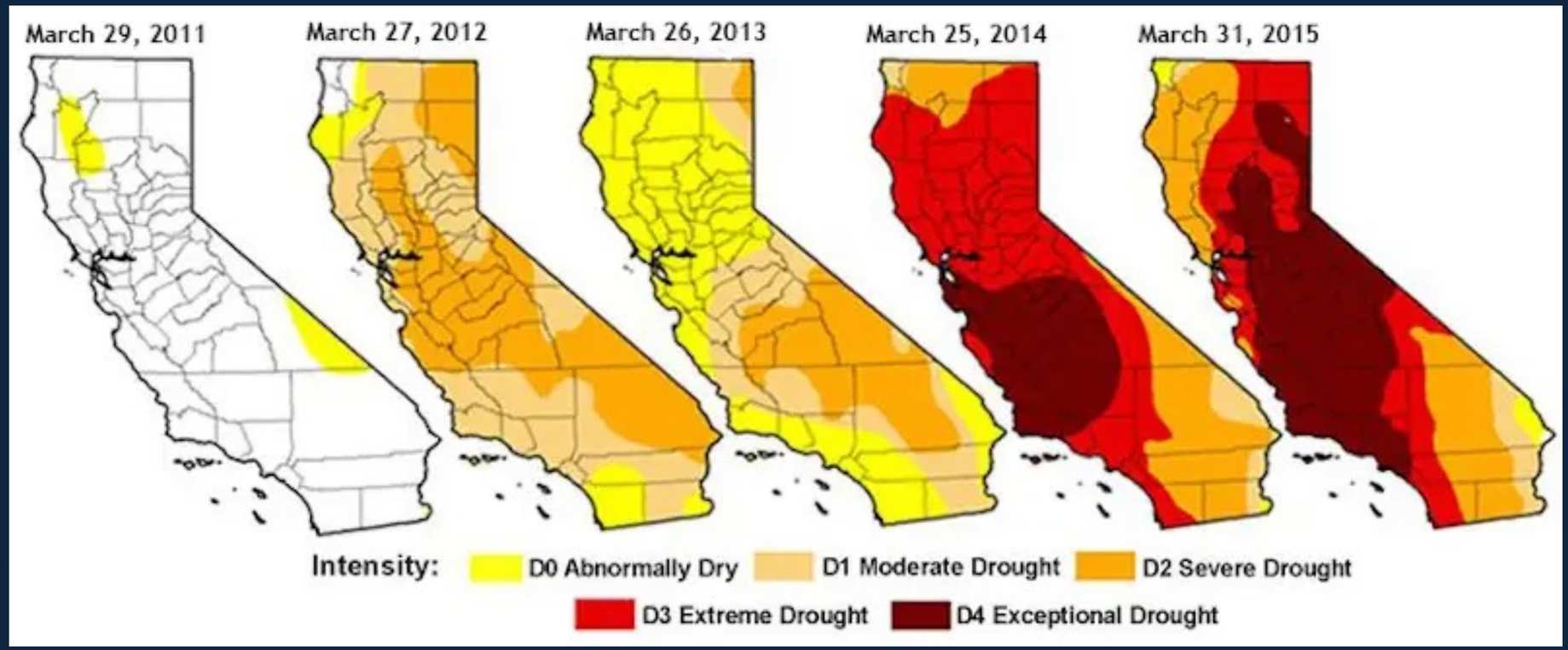




UC CE | UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources | Cooperative Extension

Drought Monitor

	Wet	2011
Drought	Dry	2012
Drought	Dry	2013
Drought	Dry	2014
Drought	Dry	2015
Drought	Dry	2016
	Wettest	2017
	Dry	2018
	Wet	2019
	Dry	2020
	Dry	2021
	Dry	2022
	Wet	2023



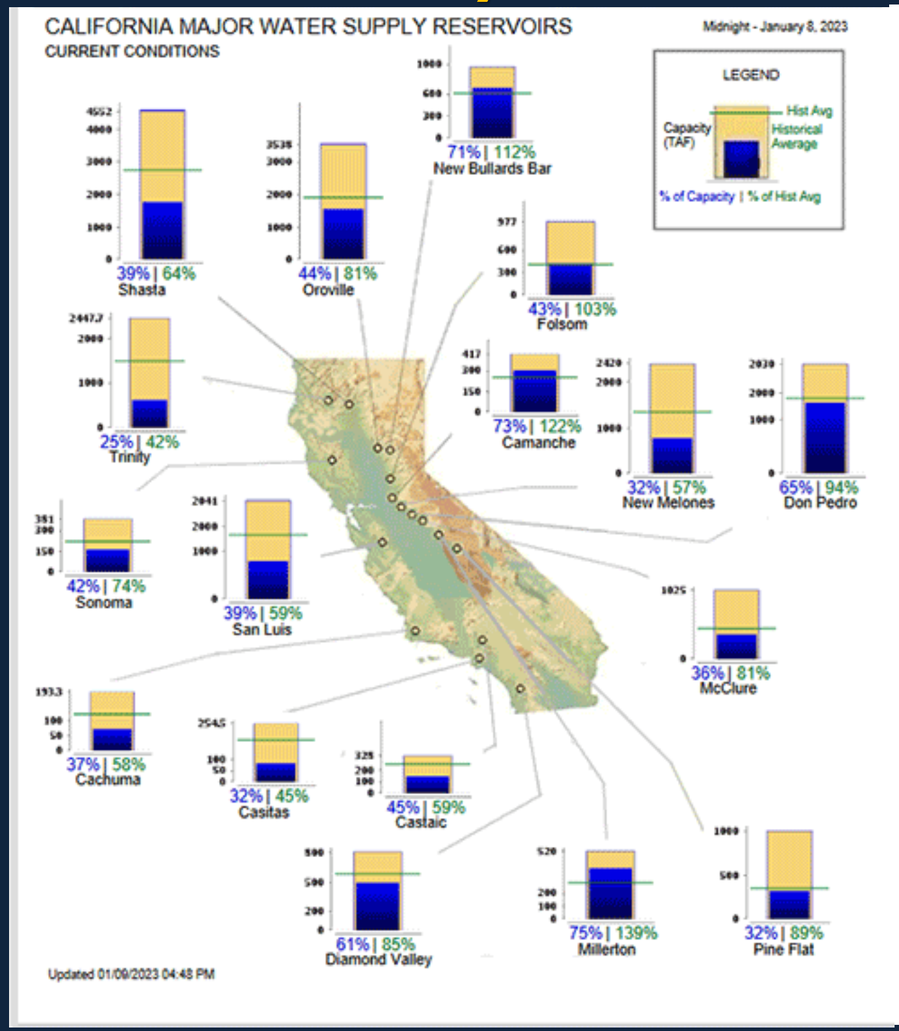
UC CE | UNIVERSITY OF CALIFORNIA Agriculture and Natural Resources | Cooperative Extension

Reservoir levels

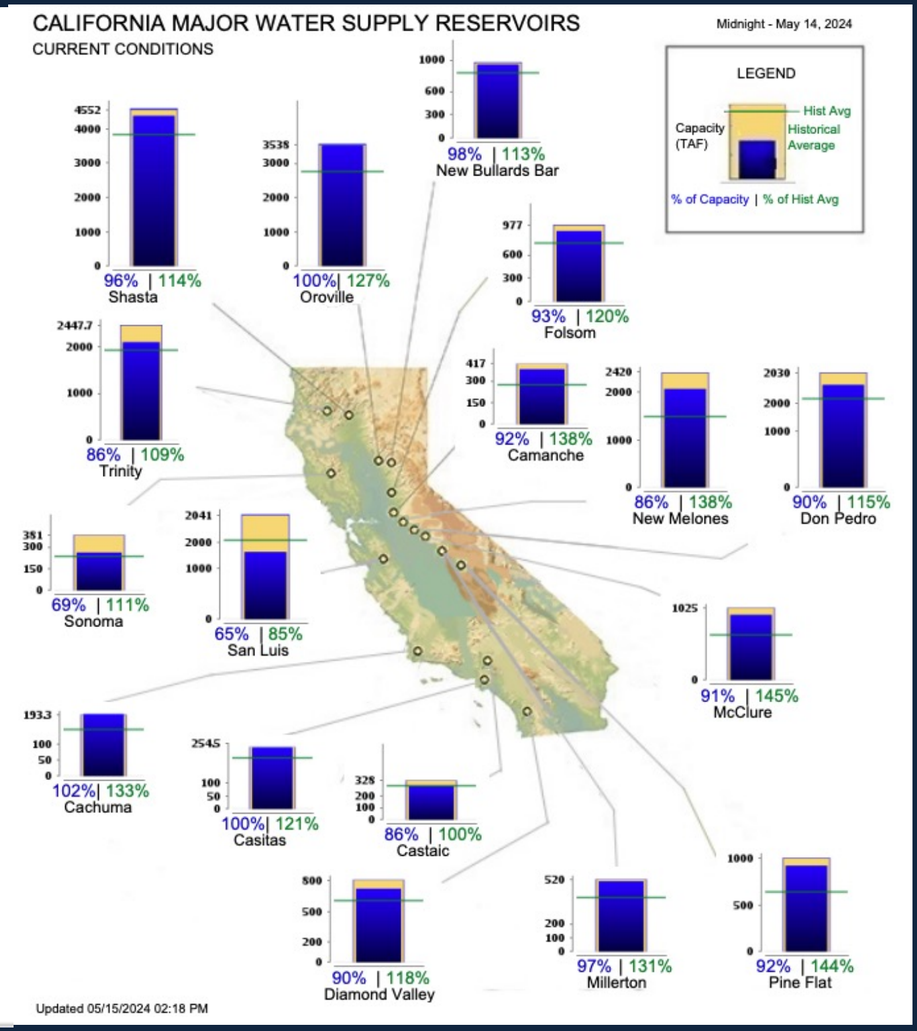
Drought

- Wet 2011
- Dry 2012
- Dry 2013
- Dry 2014
- Dry 2015
- Dry 2016
- Wettest 2017
- Dry 2018
- Wet 2019
- Dry 2020
- Dry 2021
- Dry 2022
- Wet 2023

January 2023



May 2024



UC CE | UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources | Cooperative Extension

California has abundant surface and groundwater resources

Water Pressures and Challenges

WATER QUANTITY and WATER QUALITY

CLIMATE CHANGE

Agenda

1

California Water Setting

- Climate and Hydrology
- Water Challenges and Pressures
- Water monitoring indices

2

North Coast Case Study

- Water strategies to balance agriculture and biodiversity needs

UC CE UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources Cooperative Extension

What are we doing in California to balance water resources

Urban and Domestic Water Supply

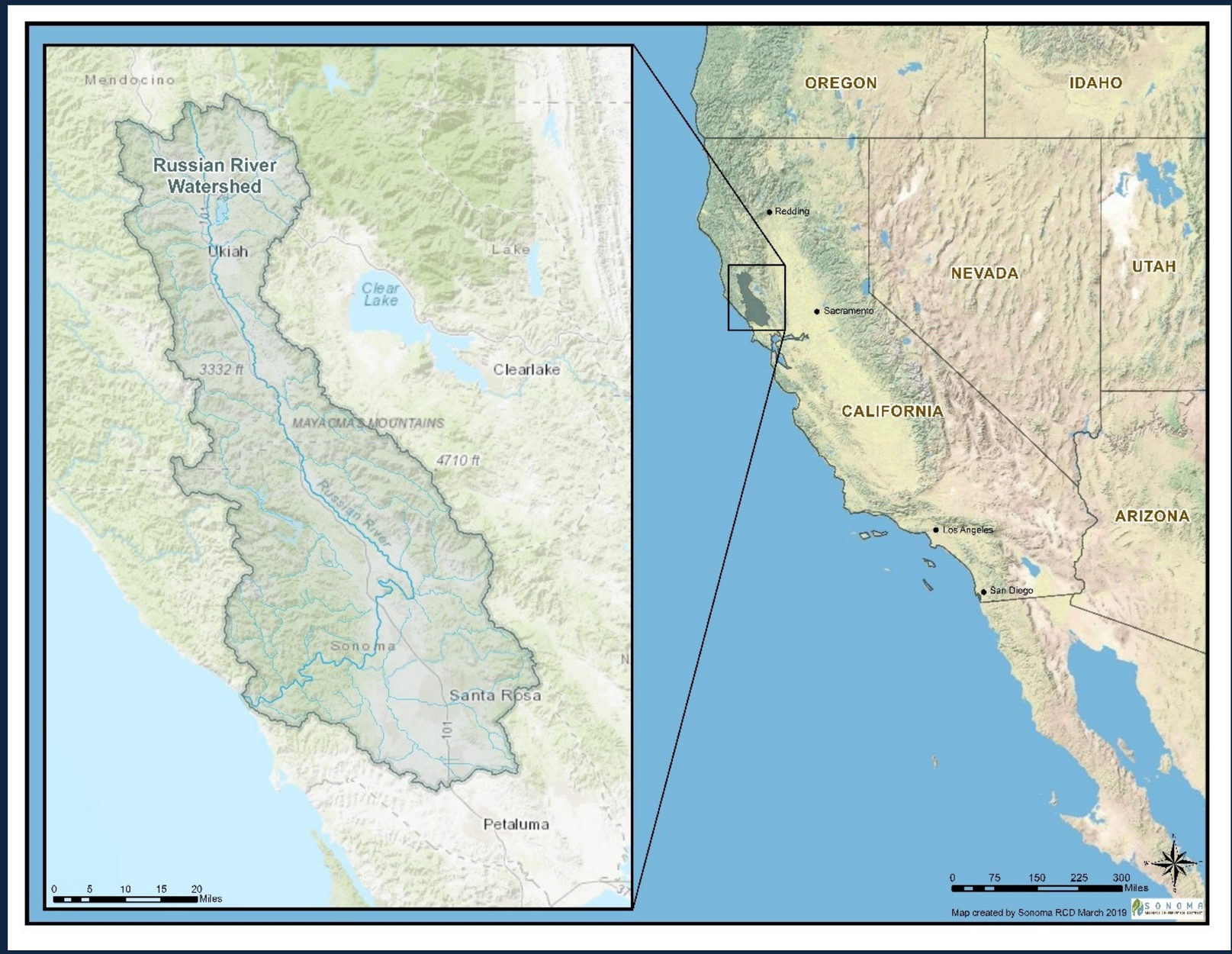
Agriculture

Fish and Biodiversity

Climate Change

UC CE | UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources | Cooperative Extension

A story from the North Coast…



UC CE | UNIVERSITY OF CALIFORNIA Agriculture and Natural Resources | Cooperative Extension

A story from the North Coast…

In spring of 2008 the upper Russian River watershed faced an unprecedented challenge – a freezing situation that would test the resilience of Mendocino.

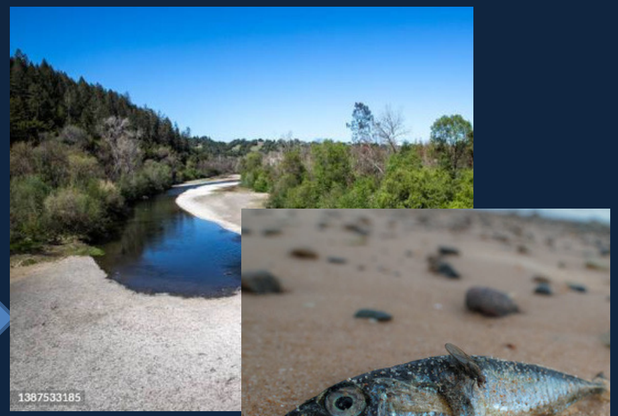
20 nights of frost protection
required for vineyards and orchards

UC CE | UNIVERSITY OF CALIFORNIA Agriculture and Natural Resources | Cooperative Extension

A story from the North Coast…

In spring of 2008 the upper Russian River watershed faced an unprecedented challenge – a freezing situation that would test the resilience of Mendocino.

20 nights of frost protection required for vineyards and orchards



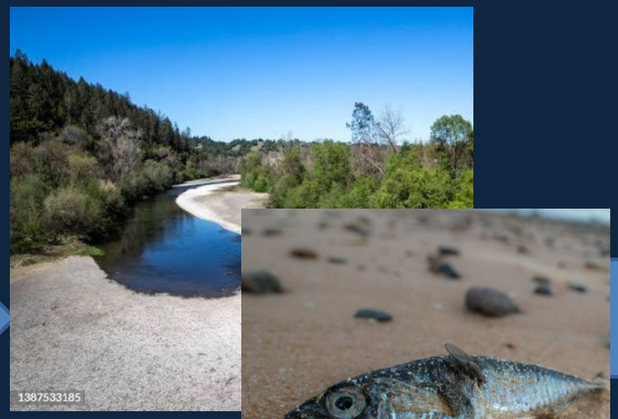
Decrease of streamflow to 85 cfs from the usual 200-600 cf.
stranding of endangered species

UC CE | UNIVERSITY OF CALIFORNIA Agriculture and Natural Resources | Cooperative Extension

A story from the North Coast…

In spring of 2008 the upper Russian River watershed faced an unprecedented challenge – a freezing situation that would test the resilience of Mendocino.

20 nights of frost protection required for vineyards and orchards



Decrease of streamflow to 85 cfs from the usual 200-600 cf. stranding of endangered species

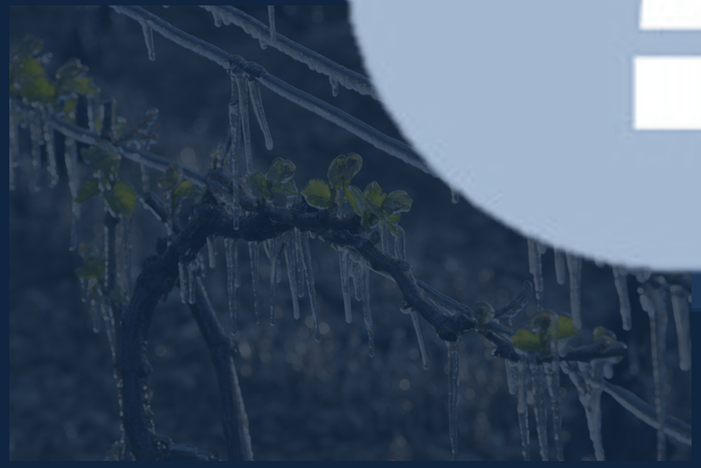
NOAA FISHERIES

Moratorium in the use of water for frost protection. Representing in millions of dollar losses for Ag.

UC CE | UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources | Cooperative Extension

A story from the No...

In spring of 2008 the upp...ed faced an unpre... that would t...



20 nights of frost protection required for vineyards and orchards

Decrease of streamflow to 85 cfs from the usual 200-600 cf. stranding of endangered species

...AA
...HERIES

Moratorium in the use of water for frost protection. Representing in millions of dollar losses for Ag.

UC CE UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources Cooperative Extension

Strategies

Weather and Streamflow stations for improved frost forecasting

Off-stream ponds to be used during dry season

Creation of stakeholder groups

Use of recycled water

UC CE UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources Cooperative Extension

Additional Strategies

Weather and Streamflow stations for improved frost forecasting

Off-stream ponds to be used during dry season

Ukiah Valley Basin
Groundwater Sustainability Agency

The UVBGSA is a public agency formed to sustainably manage groundwater to comply to the Sustainable Groundwater Management Act (SGMA)

Creation of stakeholder groups

Use of recycled water

UC CE UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources Cooperative Extension

Additional Strategies

Weather and Streamflow stations for improved frost forecasting

Off-stream ponds to be used during dry season

Ukiah Valley Basin
Groundwater Sustainability Agency

The UVBGSA is a public agency formed to sustainably manage groundwater to comply to the Sustainable Groundwater Management Act (SGMA)

Creation of stakeholder groups

Use of recycled water

Best practices for efficient irrigation and water quality

Agenda

1

California Water Setting

- Climate and Hydrology
- Water Challenges and Pressures
- Water monitoring indices

2

North Coast Case Study

- Water strategies to balance agriculture and biodiversity needs

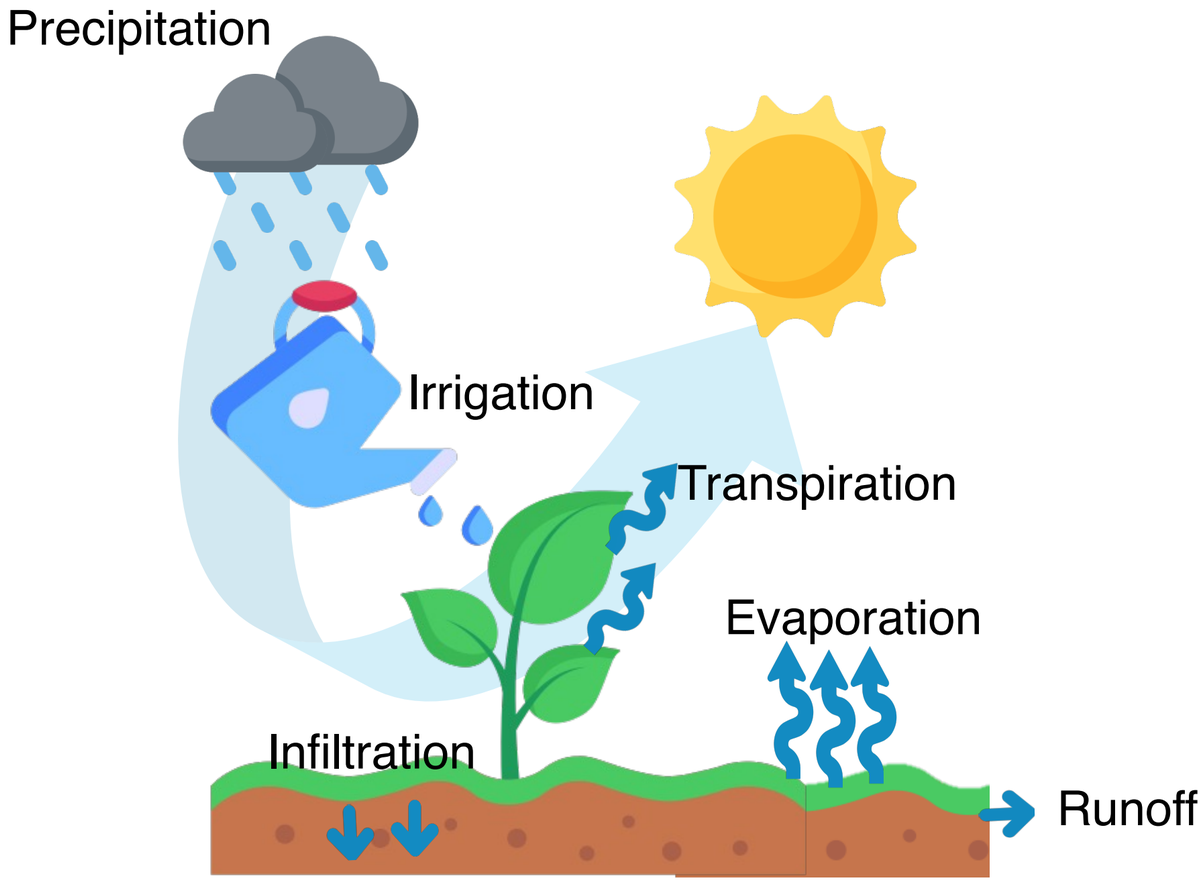
3

Water Strategy for irrigation systems

- Water Budget
- Irrigation efficiency methods
- Best practices for improving Water conservation and quality

Water Strategy for irrigation and water quality

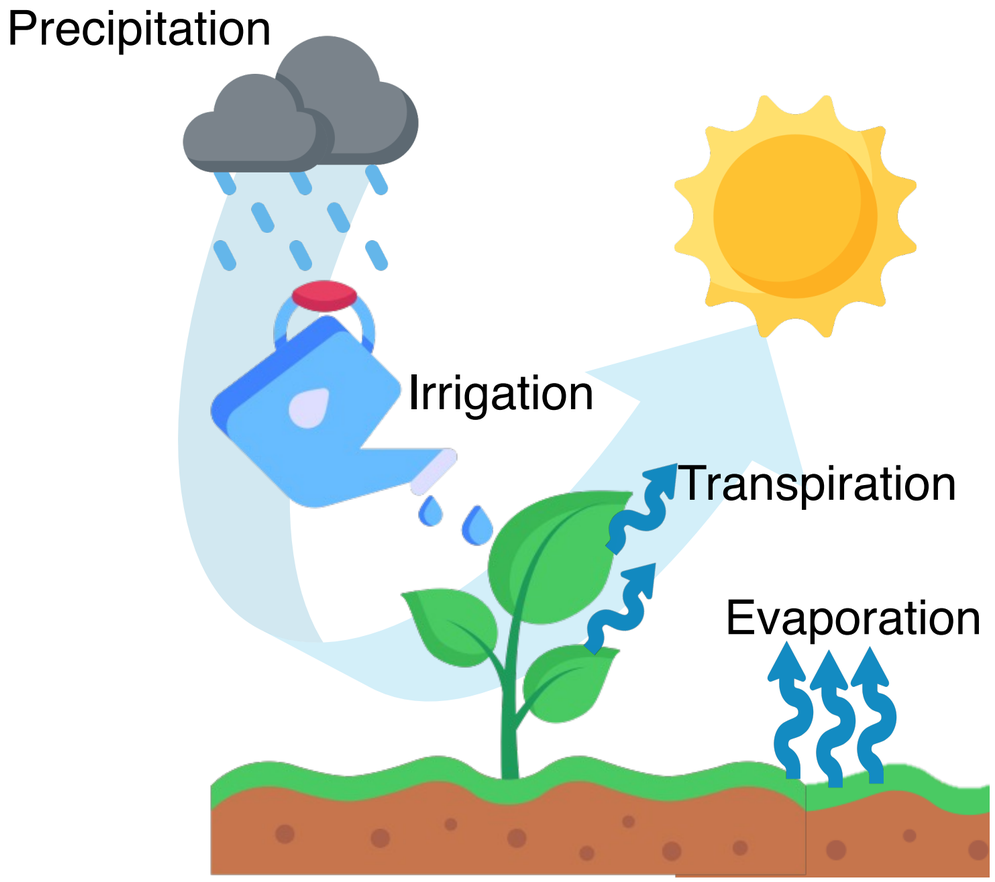
WATER BUDGET



The water budget is a way to measure how much water enters and leaves an area.

WATER BUDGET

Irrigation



Evapotranspiration (ET)

Loss of water through
Evaporation + Transpiration

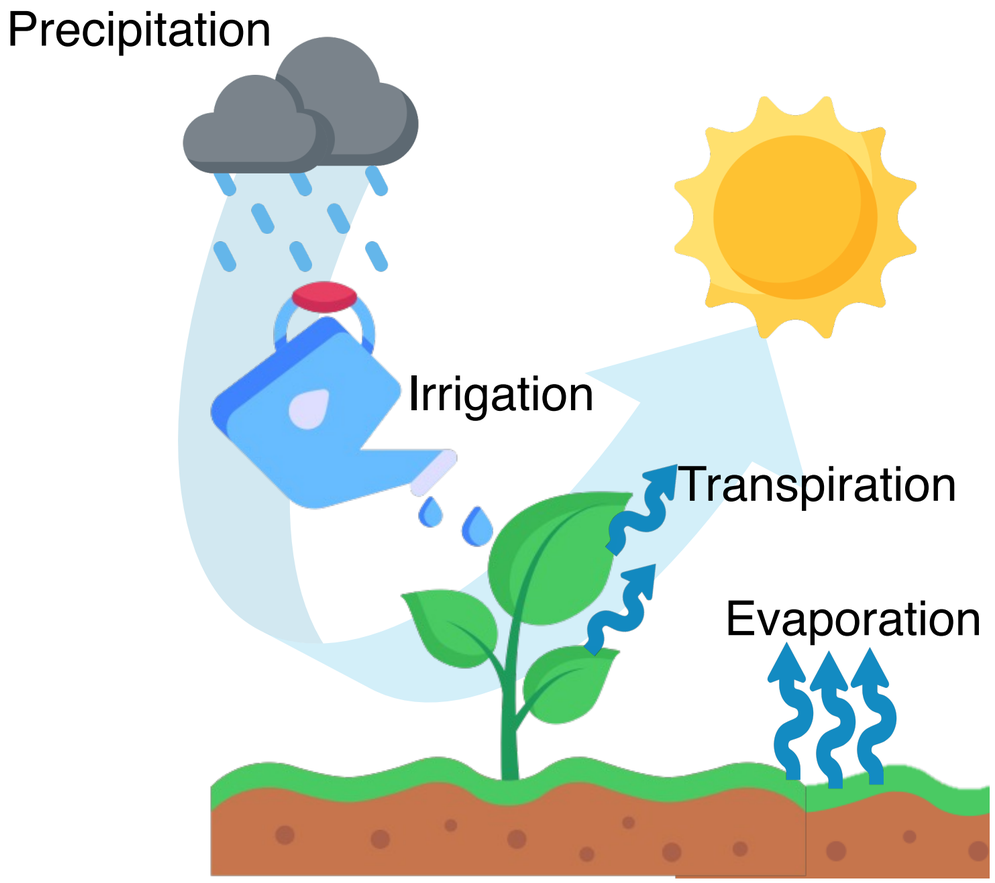
Soil

Plants

ET = Crop water needs

WATER BUDGET

Irrigation



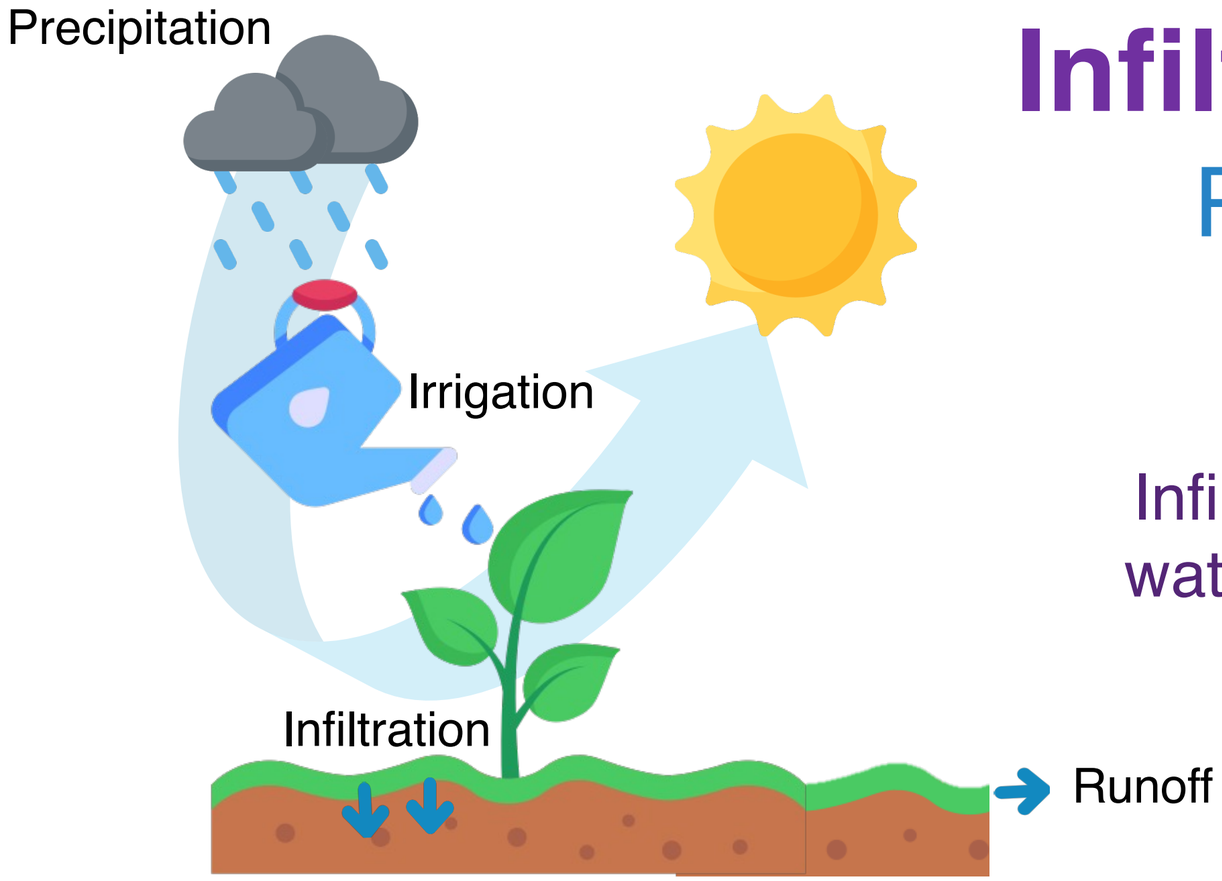
Factors Affecting Evapotranspiration (ET)

- Temperature
- Wind
- Soil Moisture
- Solar Radiation
- Region / Altitude

ET = Crop water needs

WATER BUDGET

Water Quality



Infiltration and Runoff

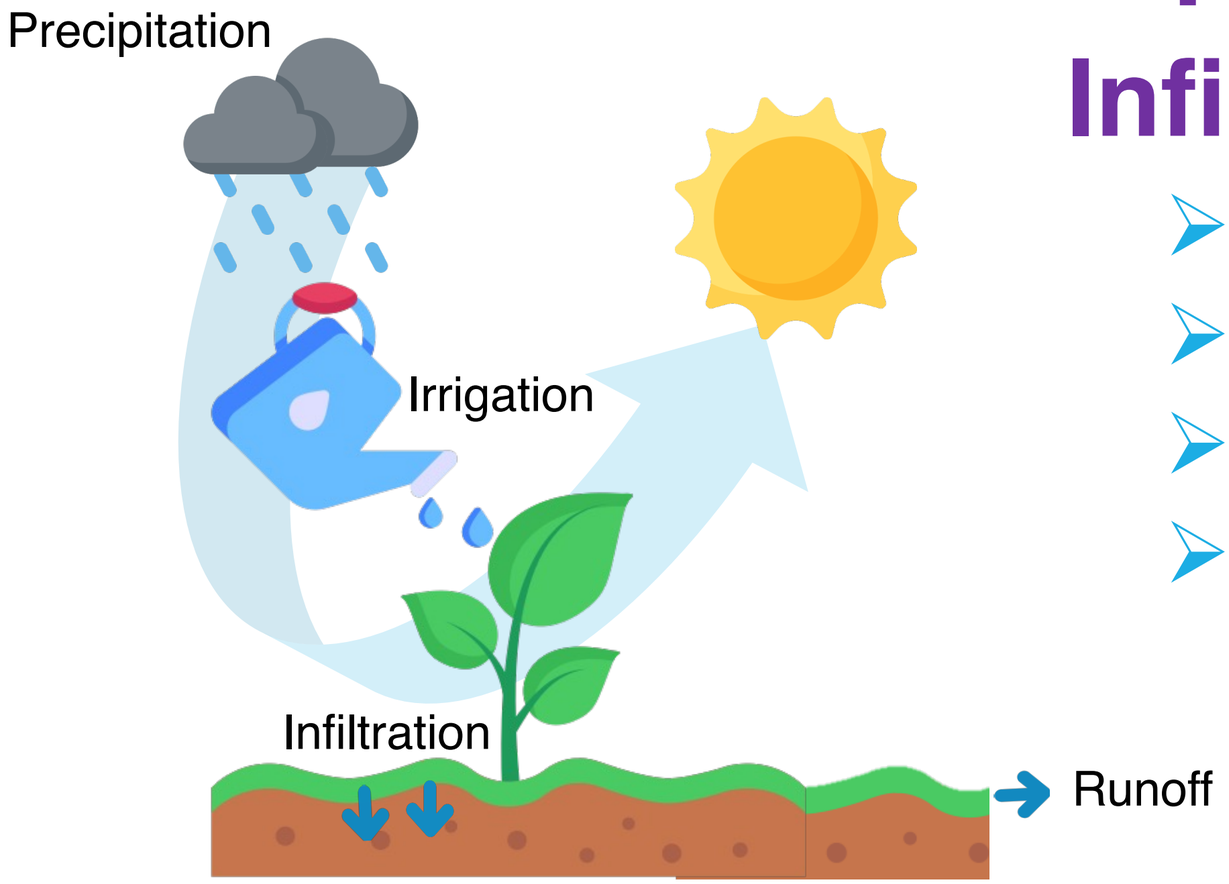
Pollutant Transport

Infiltrate in water table

Runoff to streams, lakes, ocean

WATER BUDGET

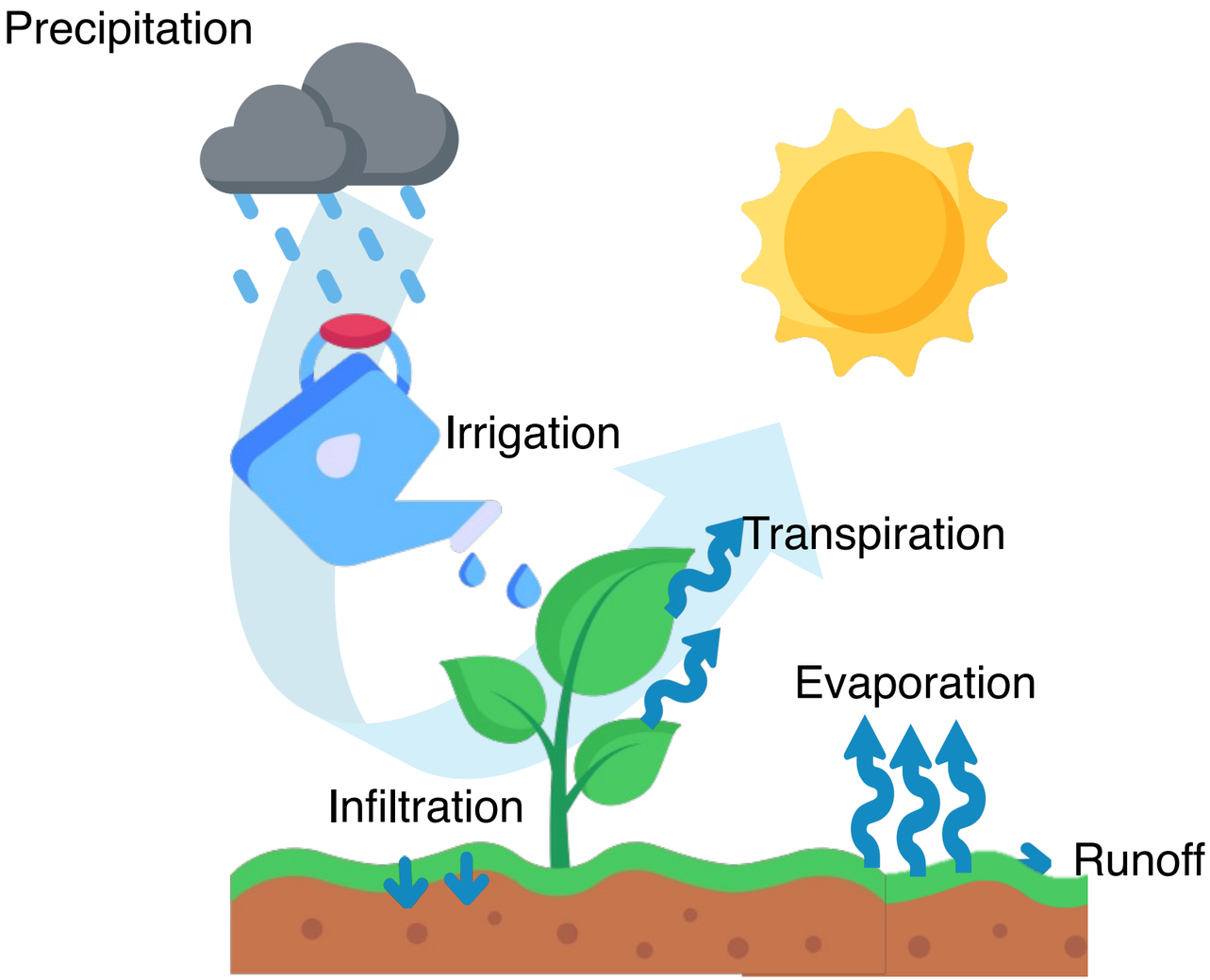
Water Quality



Factors Affecting Infiltration and Runoff

- Slope
- Permeability
- Saturation of soil
- Vegetation cover

WATER BUDGET

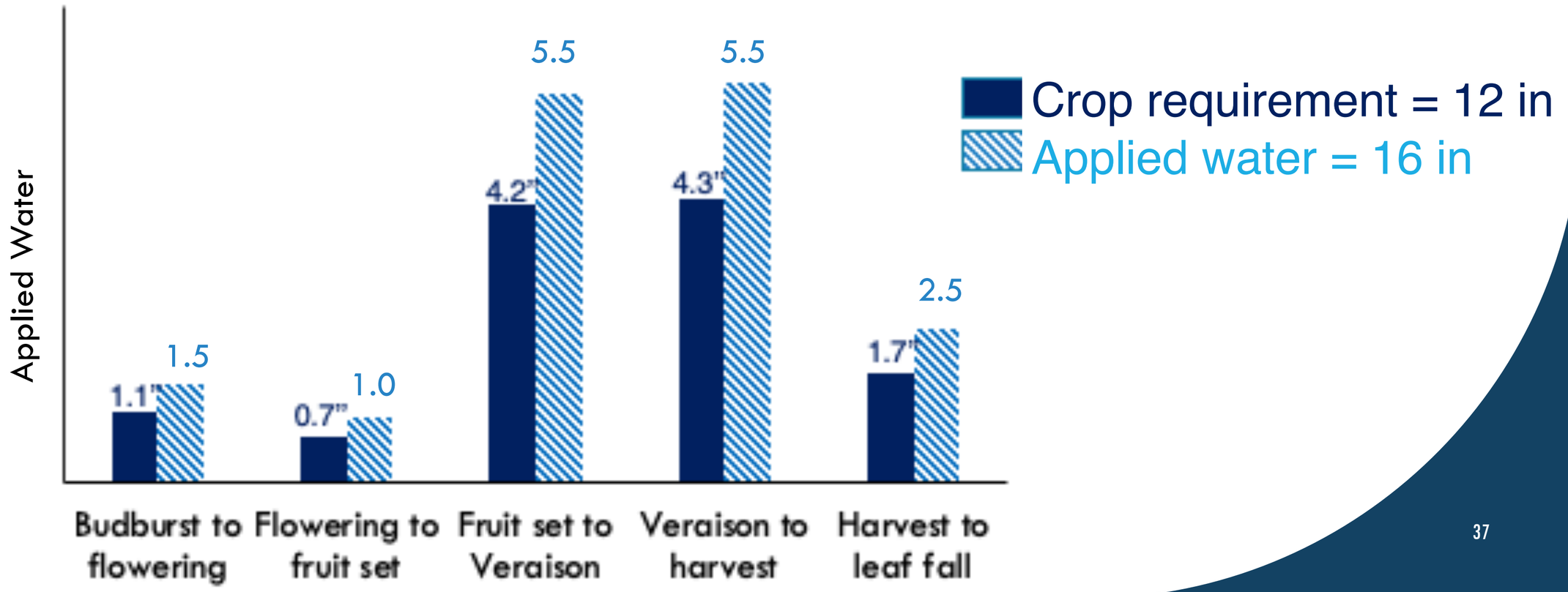


BEST PRACTICES FOR IRRIGATION AND WATER QUALITY

IRRIGATION EFFICIENCY

Volume of water applied to the crop compared to the volume of water required by the crop for its irrigation requirement.

IRRIGATION EFFICIENCY

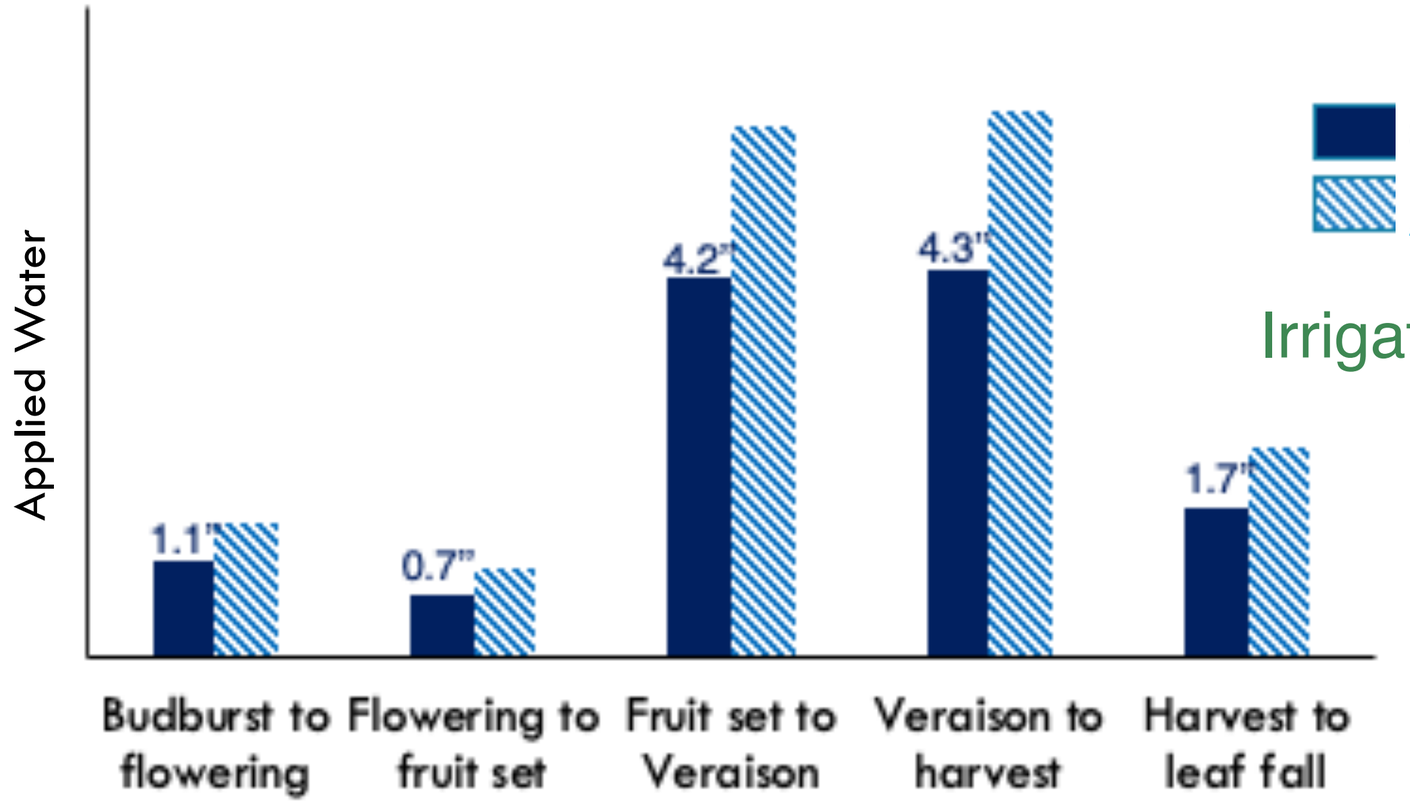


IRRIGATION EFFICIENCY

How <u>efficient</u> was our <u>irrigation</u> application?

Crop requirement = 12 in
Applied water = 16 in

IRRIGATION EFFICIENCY



Crop requirement = 12 in

Applied water = 16 in

$$\text{Irrigation efficiency} = \frac{12\ inches}{16\ inches} = 75\%$$

IRRIGATION EFFICIENCY

Can we improve our irrigation efficiency?

Crop requirement = 12 in

Applied water = 16 in

Irrigation efficiency = $\frac{12\ inches}{16\ inches}$ = 75%

Irrigation Systems

Surface

Application efficiency: 50 – 75%

Sprinklers

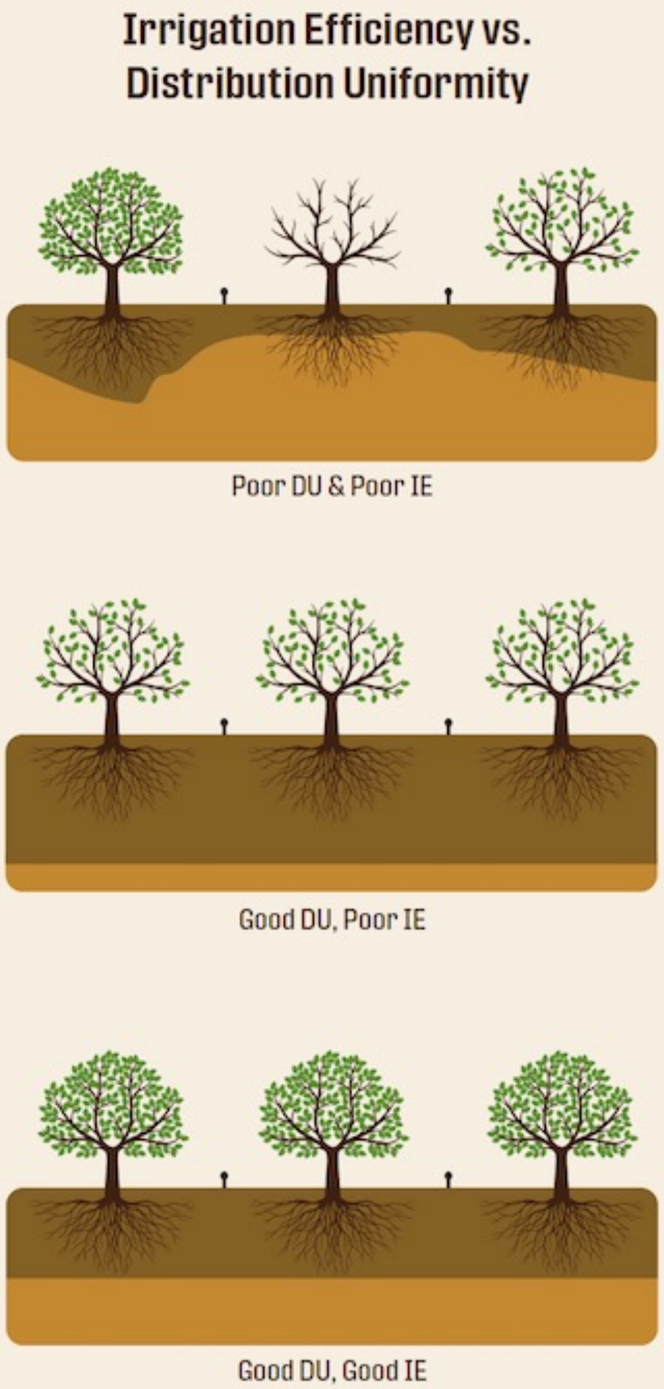
Application efficiency: 70 – 90%

Microirrigation

Application efficiency: 85 – 95%

Factors to think about:

- natural conditions
- type of crop
- type of technology
- previous experience
- required labor inputs
- costs and benefits.



Distribution Uniformity

Distribution Uniformity (DU) measures how well irrigation water and fertigation is distributed to different areas in the field.

How to achieve good DU and good IE

- Monitor drip emitter flow rates
- Check pressure at the pump and drip hoses
- Replace plugged emitters or damaged hoses.
- Evaluate DU every 3 to 5 years

Irrigation Scheduling

Irrigation scheduling involves planning when and how much water to apply

Irrigation Scheduling

Irrigation scheduling involves planning when and how much water to apply

Soil-based

Weather ET-based

Irrigation Scheduling

Weather ET-based

Crop water Needs

$$ET_{crop} = ET_{ref} \times K_{crop}$$

Evapotranspiration of my crop = is my crop water needs

Irrigation Scheduling

Weather ET-based

Crop water Needs

$$ET_{crop} = ET_{ref} \times K_{crop}$$

Reference ET is the water needs of grass

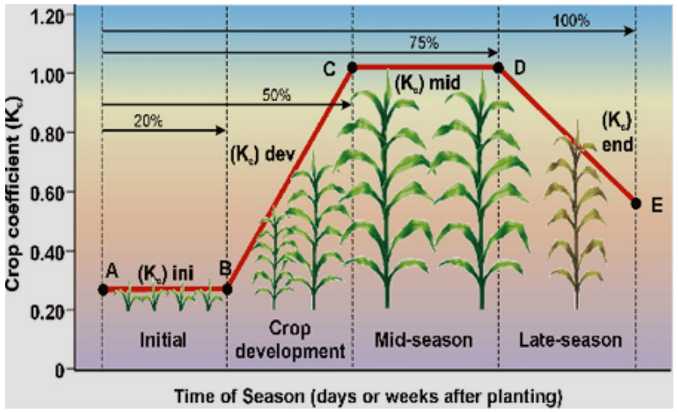
Irrigation Scheduling

Weather ET-based

Crop water Needs

$$ET_{crop} = ET_{ref} \times K_{crop}$$

Kc is the crop coefficient. It represents the integrated changes in plant development

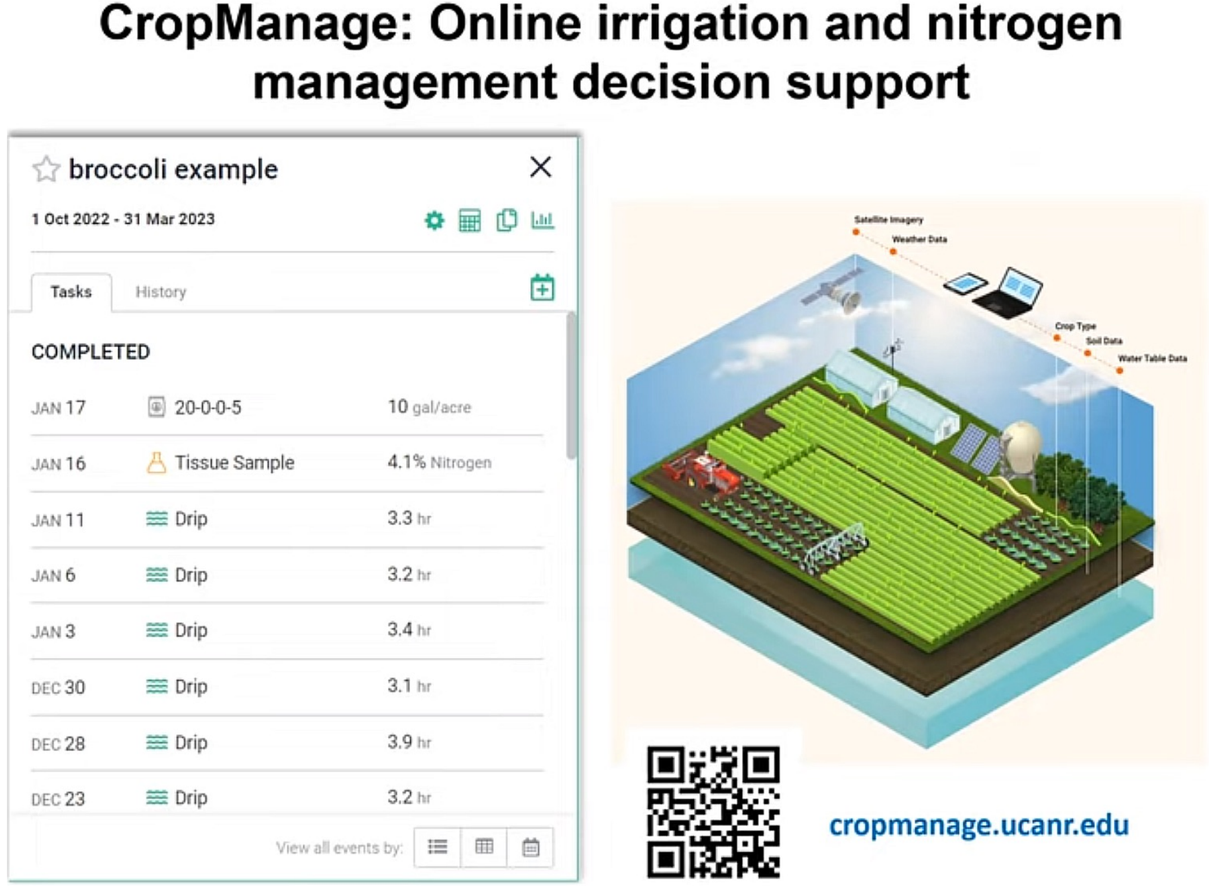


Date	K_c (W. Gape)
Mar 16-31	0.32
Apr 1-15	0.41
Apr 16-30	0.50
May 1-15	0.59
May 16-31	0.69
June 1-15	0.78
Jun 16-31	0.82
July 1-15	0.82
July 16-31	0.82
Aug 1-15	0.82
Aug 16-31	0.77
Sep 1-15	0.66
Sep 16-30	0.55
Oct 1-15	0.44

Crop Coefficient Values of Wine Grapes

(UC Cooperative Extension)

Irrigation Scheduling Tools



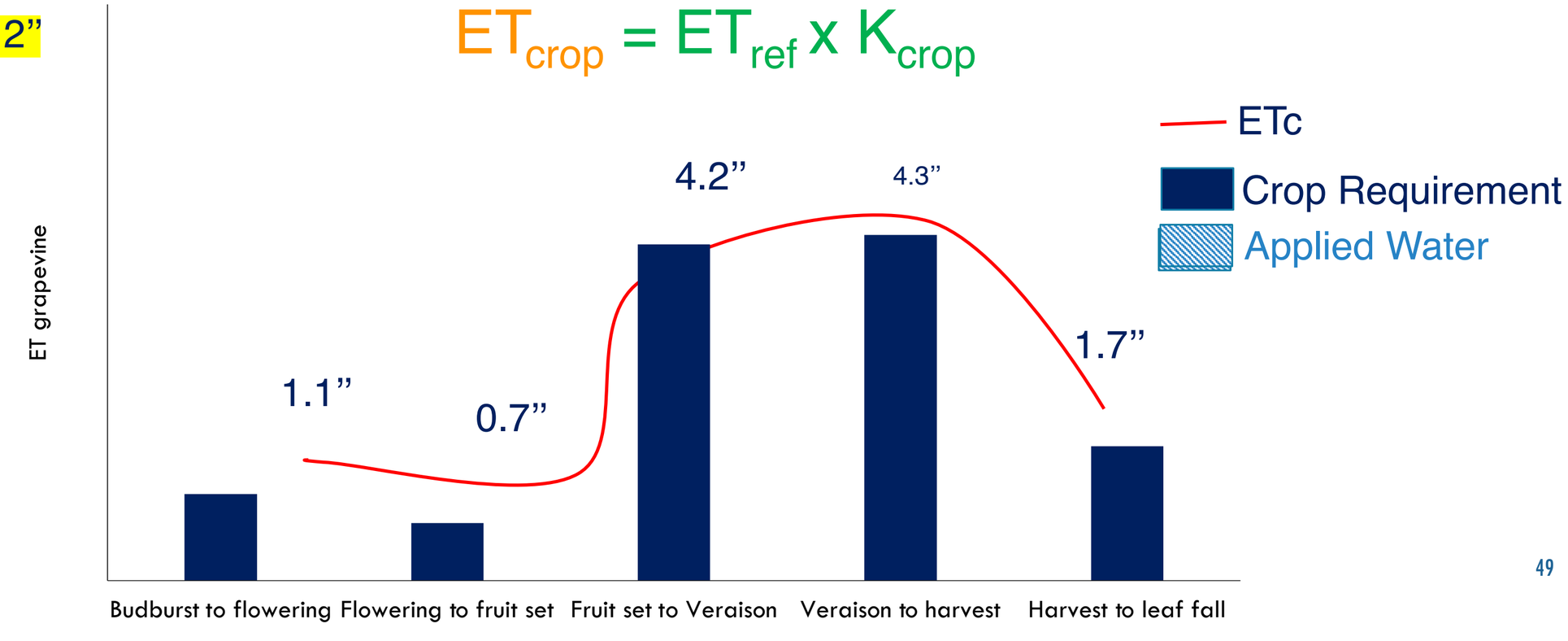
Irrigation Scheduling

Weather ET-based

Crop requirement is 12”

Crop water Needs

$ET_{crop} = ET_{ref} \times K_{crop}$



Irrigation Scheduling

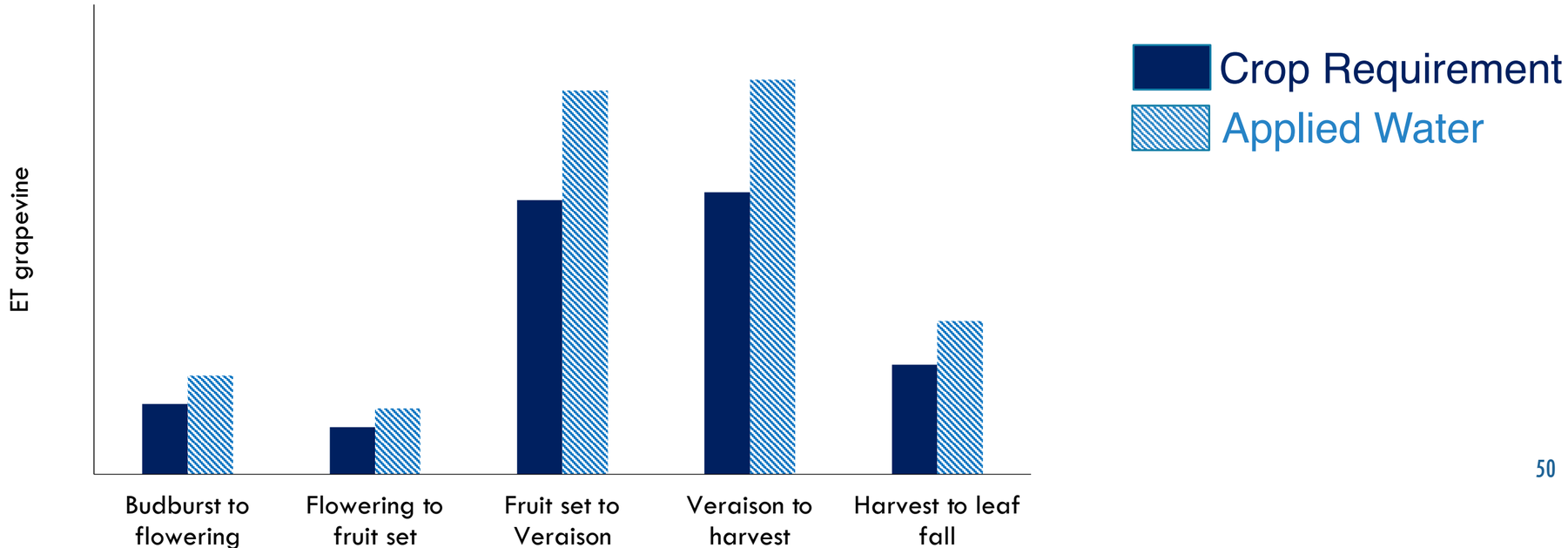
Weather ET-based

Crop requirement is 12” but initially we applied 16”

Irrigation efficiency 75%

Crop water Needs

$ET_{crop} = ET_{ref} \times K_{crop}$



Irrigation Scheduling

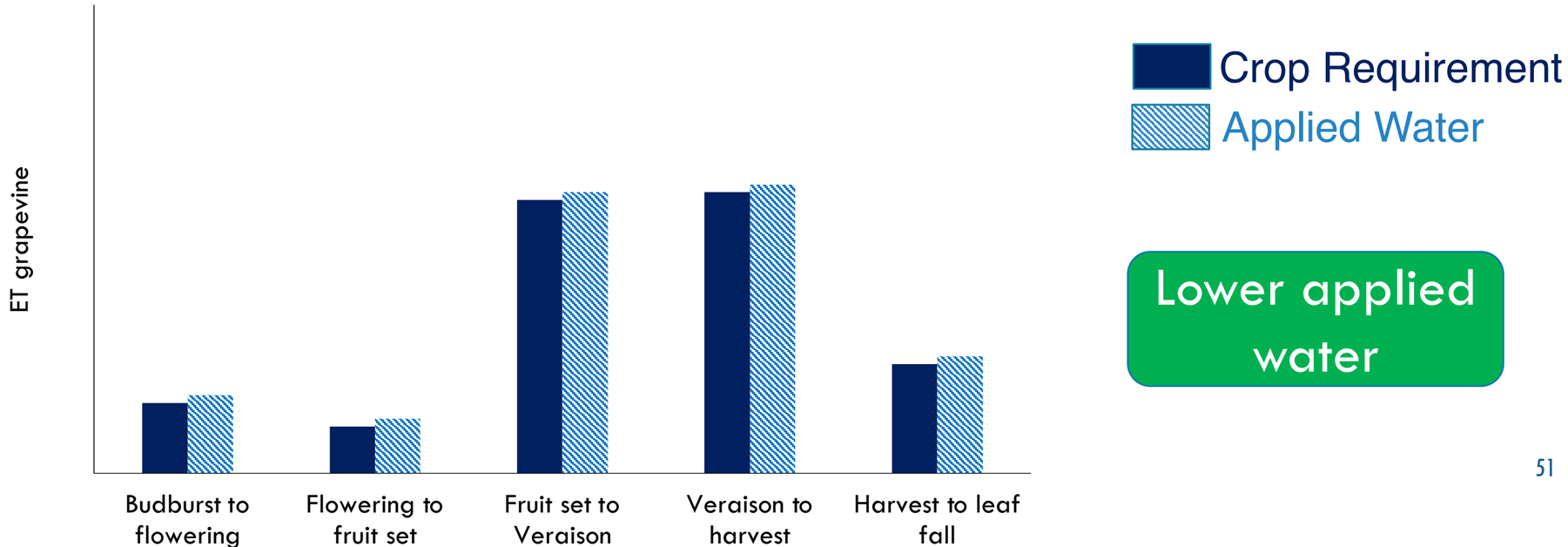
Weather ET-based

Crop requirement is 12” but now we applied 12.7”

Irrigation efficiency 95%

Crop water Needs

$ET_{crop} = ET_{ref} \times K_{crop}$



Lower applied water

Efficient Practices

Irrigation Scheduling

Water Quality Practices

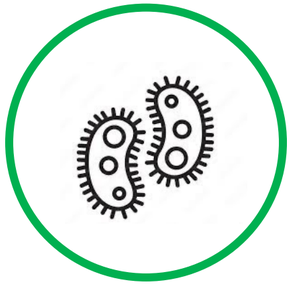
Monitoring and Maintenance

WATER QUALITY

How clean or safe water is based on chemical, physical, and biological properties that determine its suitability for drinking, irrigation, or supporting aquatic life.

Chemical

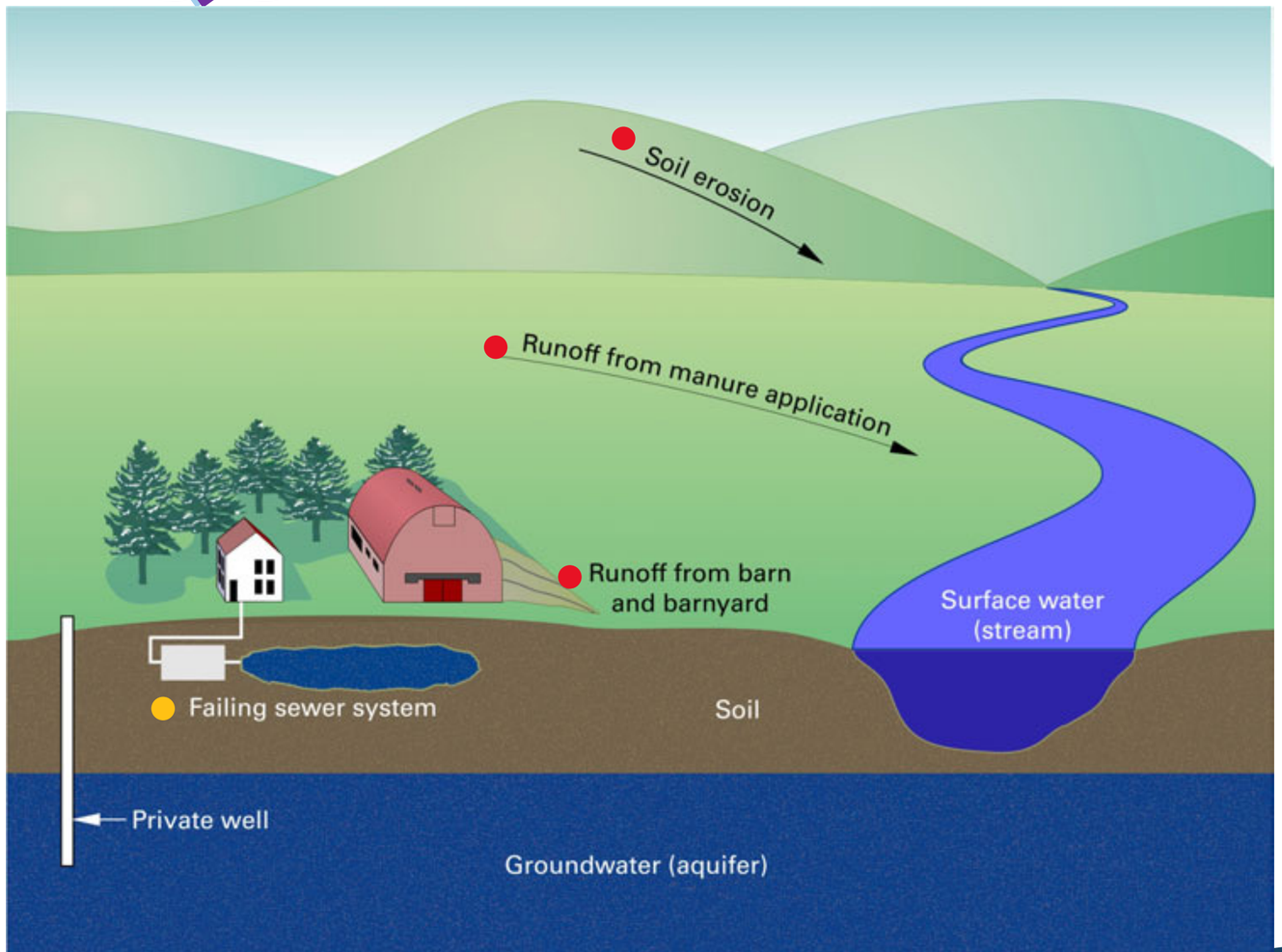
Physical



Biological

WATER QUALITY

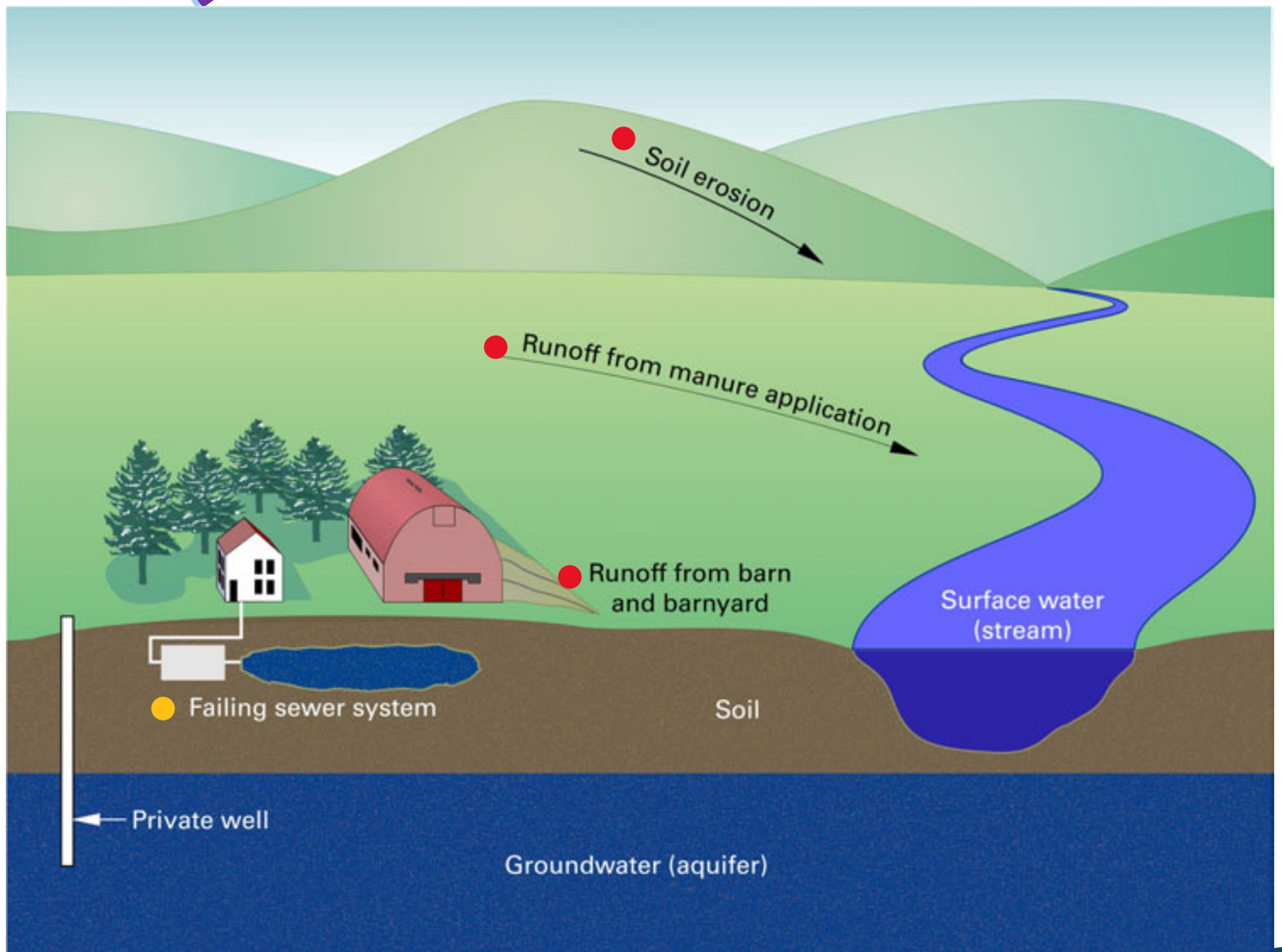
Point Source Pollution



Non Point Source Pollution

WATER QUALITY

Point Source Pollution



Non Point Source Pollution

Prevent Erosion

- Conservation Tillage
- Cover Crops

Efficient Practices

Irrigation Scheduling

Water Quality Practices

Monitoring and Maintenance

Prevent Erosion

- Conservation Tillage
- Cover Crops

Enhance Management

- Integrated Pest and Nutrient Management
- Efficient Irrigation Techniques

Efficient Practices

Irrigation Scheduling

Water Quality Practices

Monitoring and Maintenance

Prevent Erosion

- Conservation Tillage
- Cover Crops

Enhance Management

- Integrated Pest and Nutrient Management
- Efficient Irrigation Techniques

Improve Filtration

- Riparian buffers
- Cover crops/Filter strips

Efficient Practices

Irrigation Scheduling

Water Quality Practices

Monitoring and Maintenance

Prevent Erosion

- Conservation Tillage
- Cover Crops

Enhance Management

- Integrated Pest and Nutrient Management
- Efficient Irrigation Techniques

Improve Filtration

- Riparian buffers
- Cover crops/Filter strips

Winter Cover Crops

- Winter Cover Cropping: Growing crops between annual production seasons or perennial tree/vines crops

Aerial photos of orchards with and without cover crops. Courtesy of Andrew Gal, UC Davis.

Winter Cover Crops

		← Confidence Level Based on Availability of Research → Low		High
Water Budget	Inflow	Increased Fog and Dew Capture		Increased Infiltration
	Storage	Increased Percolation	Increased Soil Moisture and Water Storage	
	Outflow		Increased Evapotranspiration (ET)	Decreased Runoff
Water Quality Benefits			Increased Nutrient Scavenging	Decreased Erosion
Management factors determining net water impacts of cover crops			Species Selection	Termination Timing
			Seeding Rate	
			Stacked Practices	

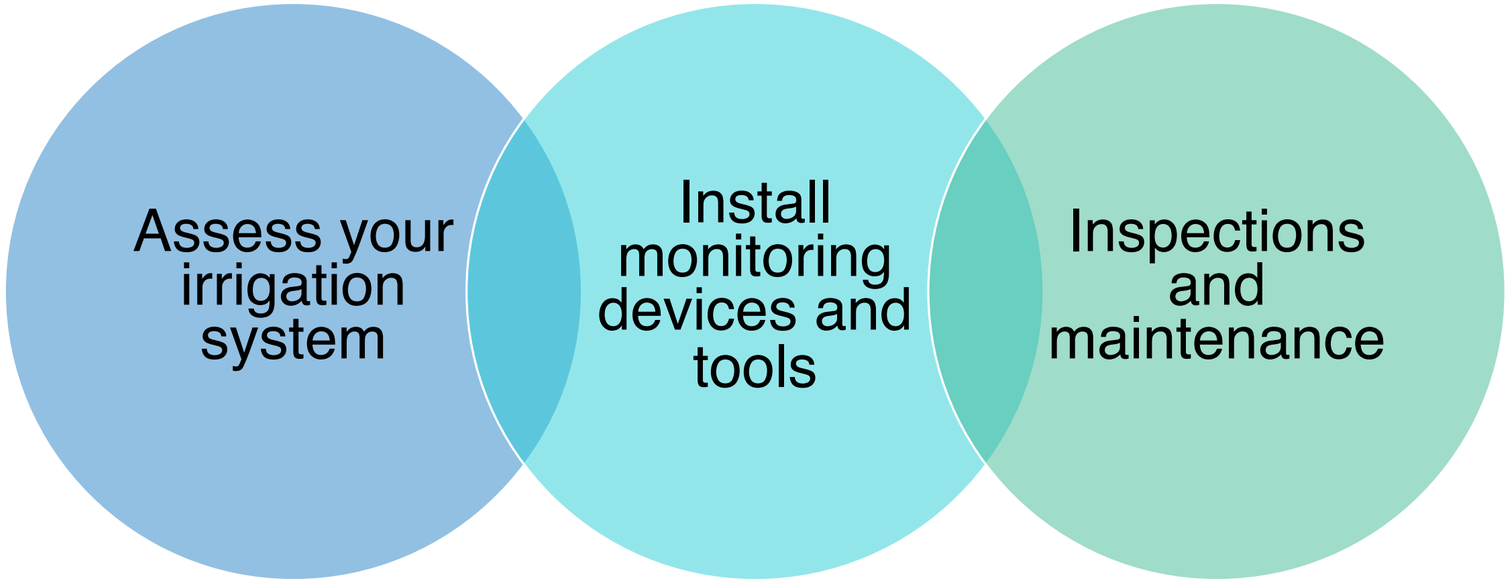
Efficient Practices

Irrigation Scheduling

Water Quality Practices

Monitoring and Maintenance

Monitoring and Maintenance



THANK YOU!

Laura Garza
Water and Climate Change advisor
Mendocino and Lake Counties

legarza@ucanr.edu