Water and Nutrient Management in Delta Crops

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Presentation Outline

Overview of Delta research projects related to water and nutrient management:

- Salinity management and leaching
- Crop consumptive use
- Summer cover cropping

Salinity Management and Leaching

Background: Environmental conditions in the Delta (e.g. low permeability soils, shallow groundwater), coupled with water-saving management (e.g. conversion to drip irrigation), limit growers' ability to manage salts.

Furthermore, State Water Resources Control Board adopts water quality objectives for the protection of agriculture in the Delta. The salinity objectives are currently under reconsideration.

Objective: Understand soil salinity profiles in Delta tomato and alfalfa fields to help inform salinity management.

Introduction to Salinity

Salt problems occur on approximately one-third of all irrigated land in the world.

Why do salts exist in soil?

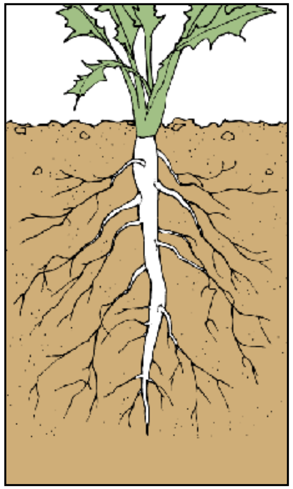
- Parent material weathers to form salts
- Salts are carried in irrigation water
- Soil amendments may contain salts
- Presence of shallow, saline groundwater

Effects of Salinity on Plant Growth

- Osmotic stress

  (*Most common means by which salt impairs plant growth*)
- Specific ion toxicities

  (Na^+, Cl^-, B)
- Degraded soil conditions that limit plant water availability



Leaching

Leaching must be practiced when soil salinity has the potential to impact yield.

It occurs when water is applied in excess of soil moisture depletion due to evapotranspiration (ET).

Leaching may occur during the rainy season or whenever an irrigation event occurs.

- During the season, leaching may not be advised because of the potential for nutrients to be lost.

Salinity of Drip Irrigated Tomato Field

(Silty Clay Loam)

Electrical Conductivity, ECe (dS/m)

Spring 2013

Depth (cm)	Bed Center ↓			Furrow ↓
0 - 10	0.84	0.74	1.24	
10 - 20	0.93	0.84	0.75	0.72
20 - 30	0.81	0.84	0.92	0.74
30 - 40	0.94	0.84	0.73	0.76
40 - 50	0.67	0.92	0.74	0.79
50 - 60	0.64	0.76	0.74	0.79
60 - 70	0.68	0.79	0.75	0.71
70 - 80	0.82	0.77	0.79	0.71
80 - 90	0.83	0.77	0.74	0.73
90 - 100	0.81	0.80	0.78	0.66

Fall 2015

Depth (cm)	Bed Center ↓							Furrow ↓
0 - 10	2.50	2.51	2.97	2.34	2.67	2.27	2.76	2.69
10 - 20	1.37	1.17	1.12	1.02	1.05	0.96	2.51	4.49
20 - 30	0.85	0.85	0.85	0.86	0.90	1.08	0.81	1.04
30 - 40	0.87	0.94	0.99	0.92	0.95	0.87	0.74	0.76
40 - 50	1.12	0.89	1.26	1.15	0.99	0.86	0.85	0.71
50 - 60	1.06	1.05	1.37	1.08	0.89	0.84	0.61	0.71
60 - 70	0.94	0.96	1.52	1.16	1.09	0.88	0.71	0.87
70 - 80	0.83	0.94	1.32	1.49	1.21	1.11	1.01	0.87
80 - 90	1.15	1.17	1.46	1.51	1.58	1.56	1.43	1.21
90 - 100	1.47	1.75	1.66	1.68	1.67	1.68	1.68	1.51

Legend*				
2.5	3.5	5.0	7.6	13.0

*Ayers and Westcot, 1985

(Project Leaders: B. Aegerter and M. Leinfelder-Miles)

Salinity of Furrow Irrigated Tomato Field

(Silty Clay Loam)

Electrical Conductivity (dS/m)
Fall 2015

Field top

depth	BED CENTER ↓							FURROW ↓
0 - 4"	5.2	2.1	1.8	1.4	2.2	2.0		
4 - 8"	1.1	0.8	0.9	0.9	0.8	0.6	1.3	4.1
8 - 12"	0.9	0.8	0.8	0.7	0.7	1.0	0.9	0.9
12 - 16"	1.2	0.9	0.7	0.8	0.7	0.8	0.9	0.8
16 - 20"	1.0	0.9	0.8	0.8	0.7	1.0	0.9	0.9
20 - 24"	1.2	1.4	1.0	0.8	0.8	0.8	1.0	1.0
24 - 28"	1.7	1.2	1.4	1.0	1.0	1.0	1.1	1.1
28 - 32"	1.4	1.1	1.2	1.0	2.0	1.0	1.0	1.0
32 - 36"	1.6	1.2	1.0	1.0	0.9	1.0	1.1	1.1
36 - 40"	1.7	1.5	1.5	1.2	1.0	1.0	1.2	1.4

Field bottom

depth	BED CENTER ↓							FURROW ↓
0 - 4"	8.0	2.8	2.7	2.6	2.0	2.3		
4 - 8"	2.1	2.0	2.2	1.5	1.0	0.8	1.8	3.6
8 - 12"	1.9	1.9	1.8	1.1	0.8	1.2	1.5	1.7
12 - 16"	2.4	2.3	2.1	1.5	1.3	1.8	2.3	1.8
16 - 20"	3.1	3.2	3.2	2.4	2.2	2.4	2.8	2.2
20 - 24"	3.6	3.9	3.2	3.1	2.6	2.6	2.7	2.5
24 - 28"	3.8	3.8	3.5	3.7	3.1	3.3	3.5	3.5
28 - 32"	5.6	6.0	5.5	5.3	4.7	4.6	4.4	4.5
32 - 36"	4.6	4.6	4.8	5.6	4.5	5.3	5.8	4.8
36 - 40"	3.9	3.6	3.8	3.8	3.2	3.1	2.9	3.6

Legend*				
2.5	3.5	5	7.6	13

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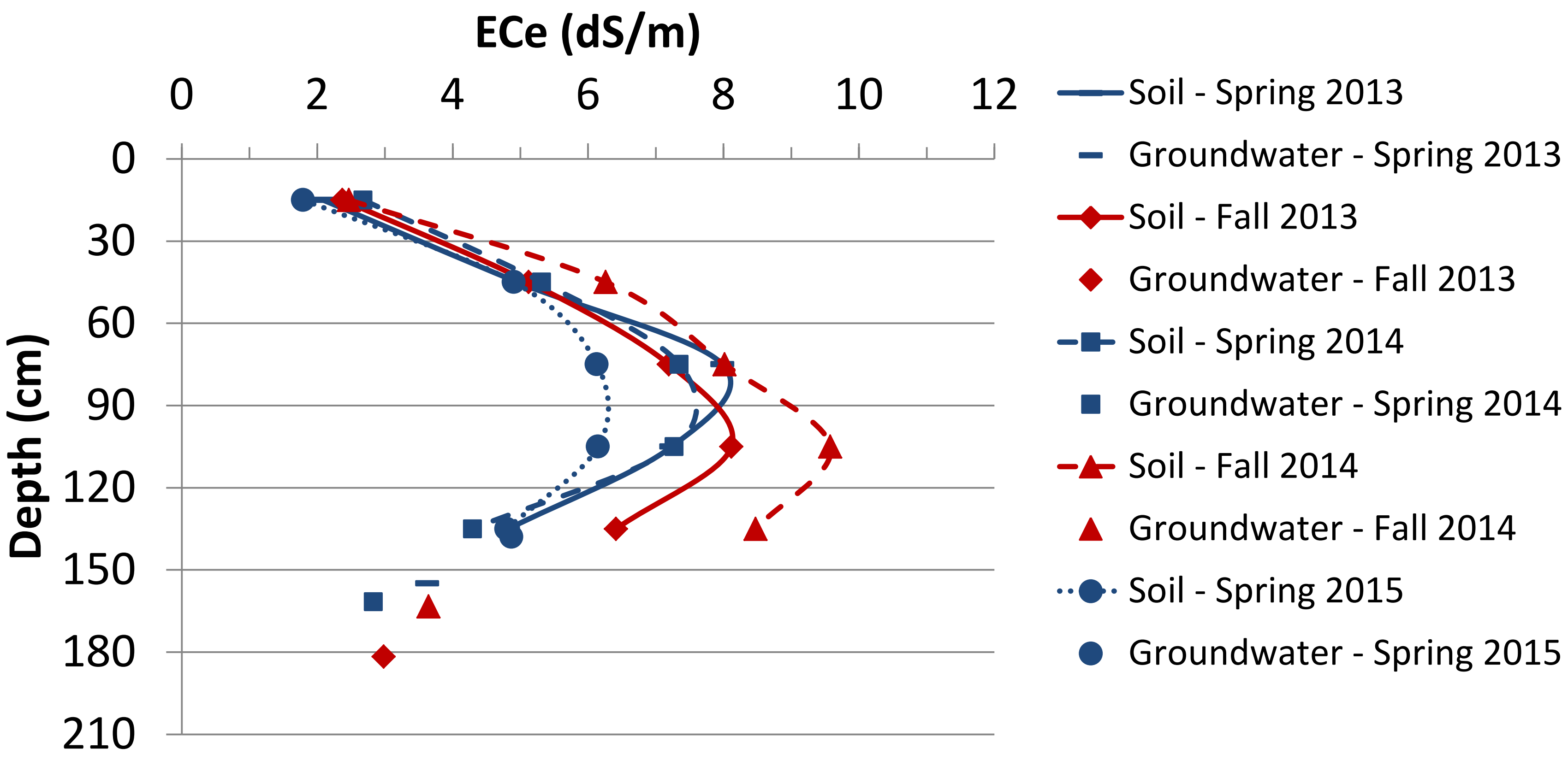
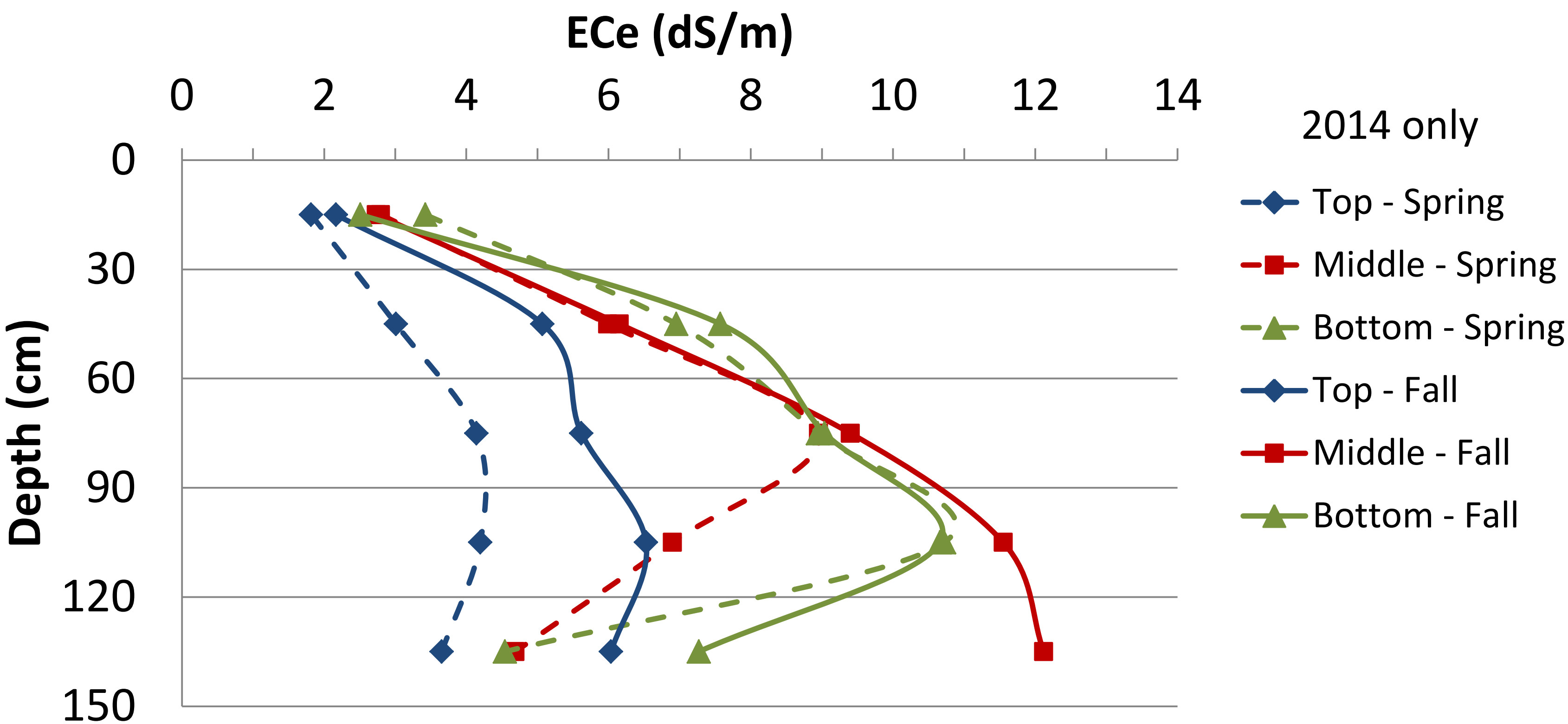
Salinity of Flood Irrigated Alfalfa Field

(Fine Sandy Loam)



Salinity of Flood Irrigated Alfalfa Field

(Fine Sandy Loam)



*Management may improve leaching at this site because the coarser-textured soil has better water infiltration.

Research Summary:
Salinity and Leaching

- Project results illustrate the inherent low permeability of certain Delta soils, shallow groundwater, a build-up of salts in the soil to levels that have the potential to affect crop yields, and low leaching fraction.
- The Delta's unique growing conditions put constraints on growers' ability to manage salts.
- ***Winter rain appears to provide our best leaching in normal rainfall years.***
- ***Enhance leaching during the off-season by leveraging rainfall with irrigation water to wet profile before a rain event.***

Crop Consumptive (Water) Use

Background: The recent drought made us critically aware of our water resources. In 2016, the Water Board developed regulations for water rights holders to report diversions.

Given environmental conditions of the Delta (e.g. below sea level, shallow groundwater), water diversions may not accurately reflect crop water use.

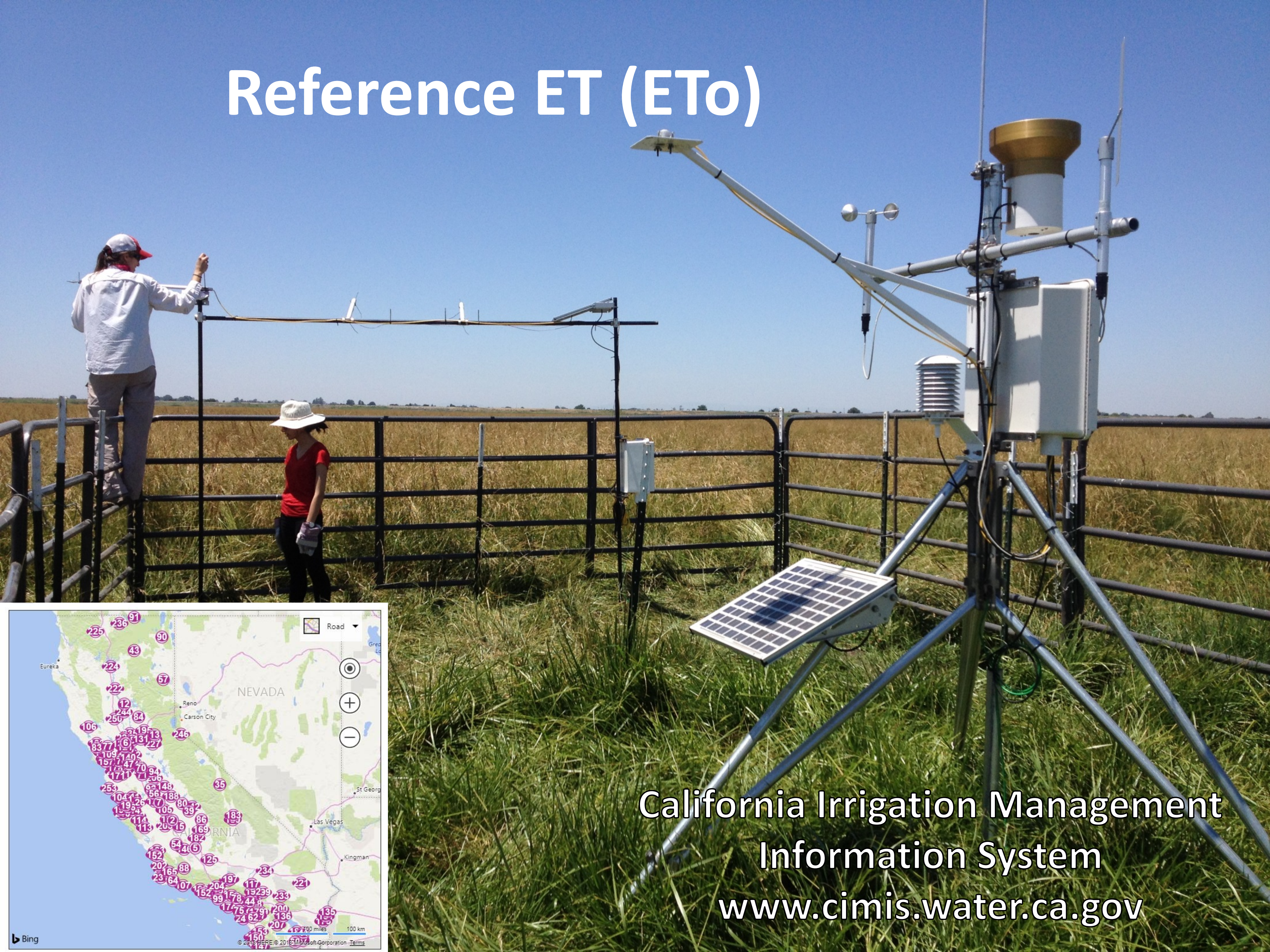
Objective: Provide crop water use estimates for the Delta to support state and local water management.

Introduction to Consumptive Use

(a.k.a. Evapotranspiration, ET)

- ET = evaporation + transpiration
- Evaporation is the movement of water from the soil and leaf surfaces.
- Transpiration is the movement of water through the plant.
- ET indicates how much water is needed by (non-stressed) plants as rain or irrigation.
- We can use ET to guide irrigation scheduling.

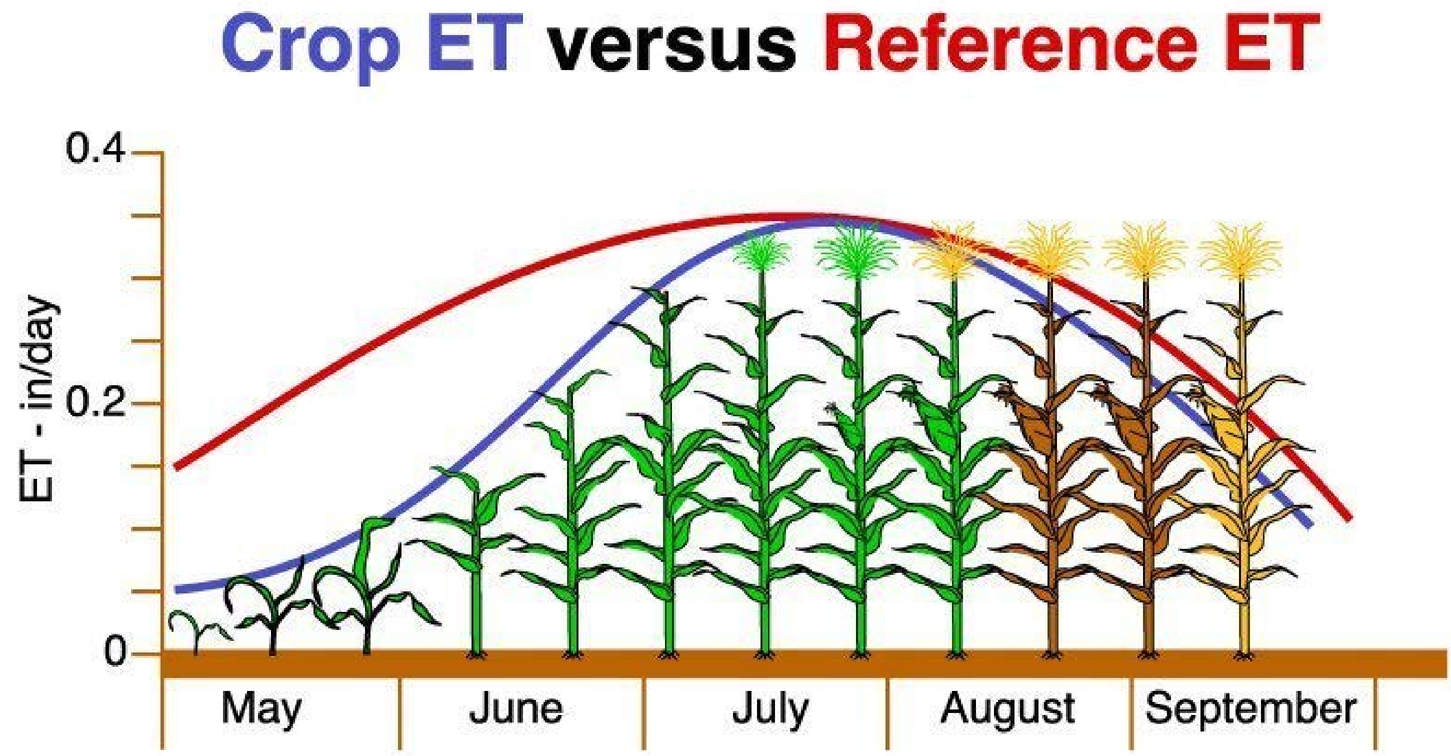
Reference ET (ETo)



California Irrigation Management Information System

www.cimis.water.ca.gov

ET and Irrigation Scheduling



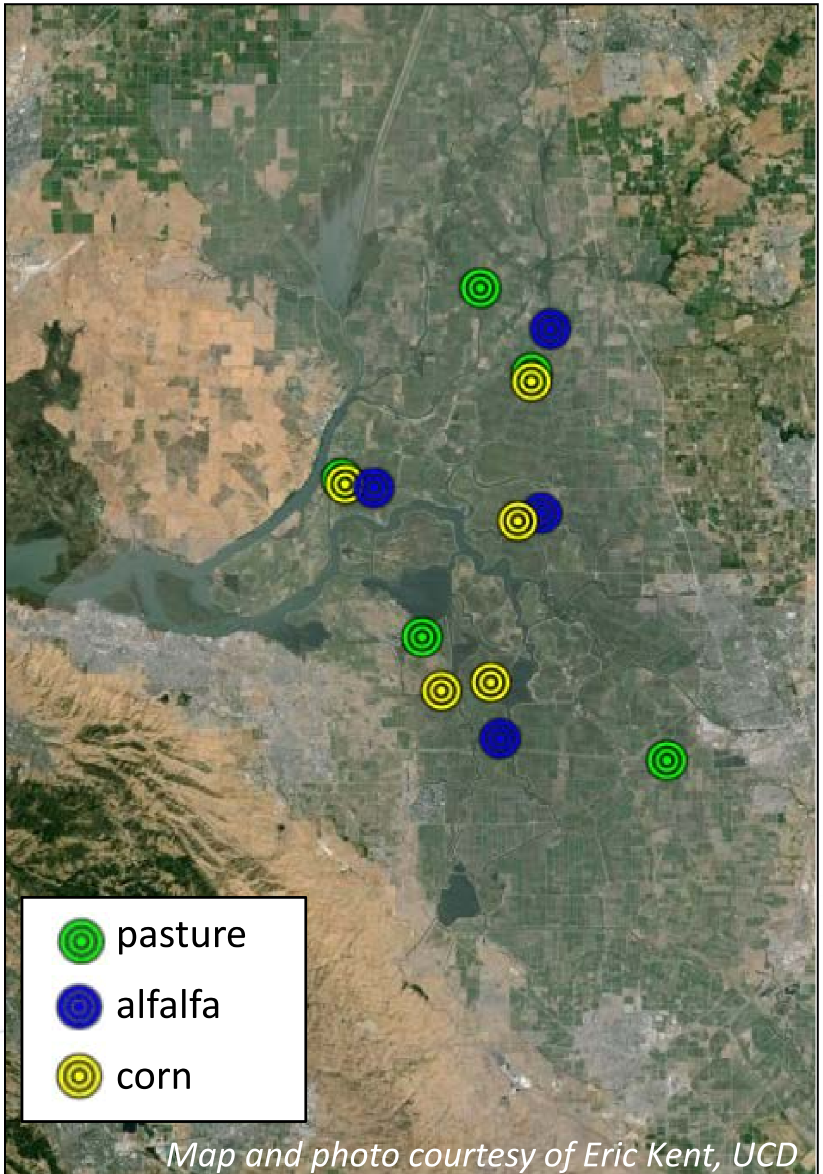
We use a crop coefficient (Kc) to convert reference ET (ETo) to crop ET (ETc).

Crop ET = Reference ET x Crop Coefficient

ETc = ETo x Kc

Image from http://mesonet.k-state.edu/about/evapotranspiration/

Crop Consumptive Water Use



Map and photo courtesy of Eric Kent, UCD

- 5 stations deployed for 1 month in 2015 on fallow fields.
- 14 stations deployed in 2016 in pasture, alfalfa, and corn fields.
- 7 modelling groups evaluated 10 crop classifications (modelling methods included crop coefficient, satellite remote sensing, among other methods).

Research Summary:

Crop Consumptive Use

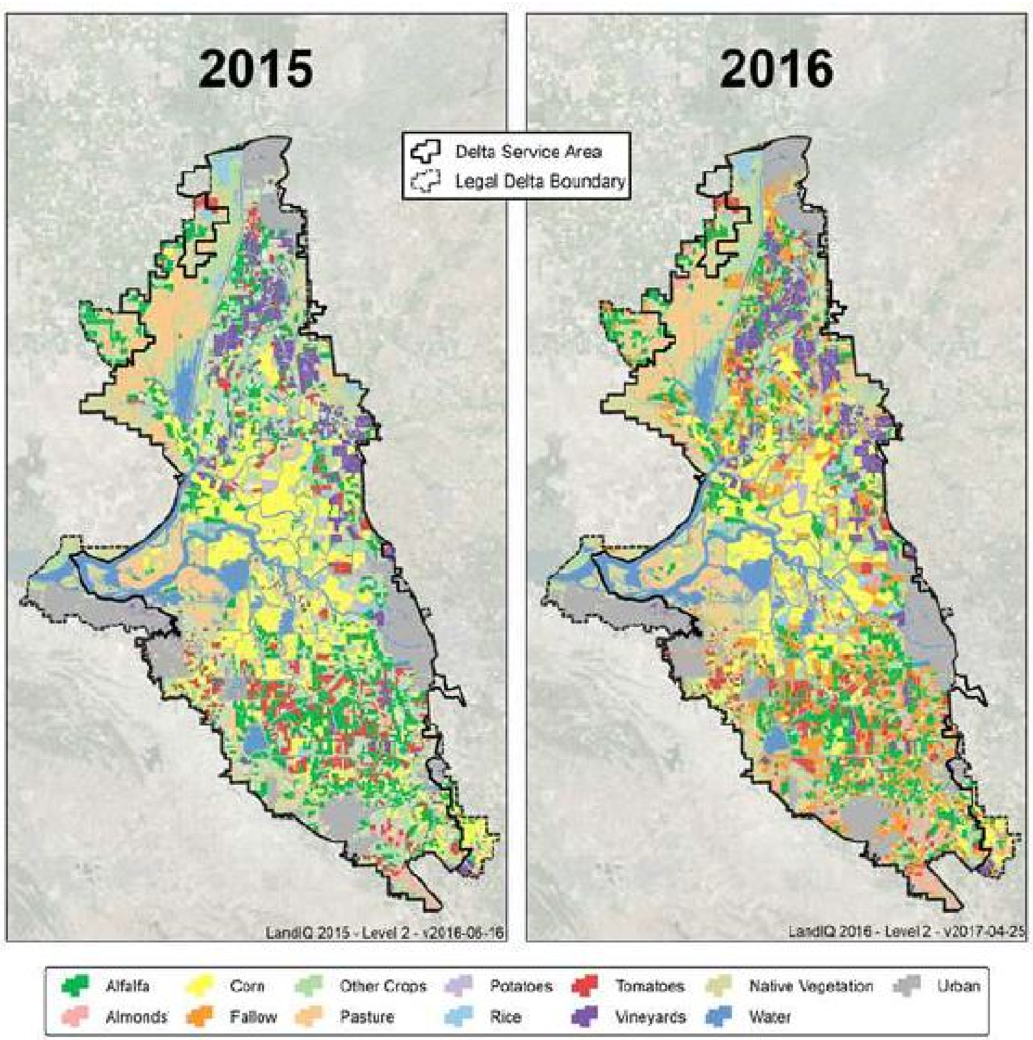


Figure 1. Land use classes in the Delta in 2015 and 2016.

(Figure from full report. See https://watershed.ucdavis.edu/delta-et)

Modelling Results:

- Water use was approximately 1,400 TAF in both years (averaged across methods).
- Pasture, alfalfa, and corn accounted for approximately 40% of the ag land and 60% of the annual ET.
- Most ET occurred from March-September (among 10 crop categories modelled).
- Native vegetation (12% of Delta area) and open water may have higher ET than that of crops, which has implications for restoration projects.

Research Summary:
Crop Consumptive Use

Field Measurements:

- Modelled estimates of ET were higher than field measurements.
- Field estimates of ET were lower for corn, alfalfa, and pasture than for other regions of the state, as influenced by the Delta's microclimates ("Delta breezes").
- Maximum ET for these crops was 6-7 mm/day (0.2-0.3 in/day), and Kc was ≤ 1.
- Need more information from fallow fields: In 2018, 15 stations are deployed across fallow, alfalfa, and tomato fields.

Summer Cover Cropping

Background: CDFA developed the Healthy Soils Program and awards grants for projects that improve soil health and sequester carbon.

Funding provided through California Climate Investments (i.e. cap and trade); thus, greenhouse gas monitoring is integrated into HSP projects.

Objective: Determine how cover cropping or compost impact soil quality, greenhouse gas emissions, and/or crop yield.

Introduction to the Project

- Trial sites in San Joaquin, Merced, and Sutter counties from 2018-2020.
- In SJC, we are growing a summer cover crop between winter cereal crops.
  - 4 acres, 3 blocks, 2 treatments (cover crop vs. none)
  - ‘Red Ripper’ cowpea planted at 50 lbs/acre on 7” row spacing
  - Anticipated benefits: Cowpea needs warm soil conditions for germination, fixes nitrogen, and is moderately tolerant of salinity
  - Anticipated challenges: moisture and pests

Summer Cover Crop Monitoring

Cover crop traits: stand count, biomass measurements

Crop yield of the small grains

Soil tests: bulk density, pH, salinity, total C and N, aggregate stability, infiltration, and active C

- 0-6”, 6-12”, 12-24”, and 24-36”

GHG measurements (N_2O, CH_4) around rain events and management practices

Look for trial results in the coming years!

Thank you!

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http://ucanr.edu/sites/deltacrops/

http://ucanr.edu/blogs/sjcfieldcrops/