Management Strategies to Cope with Drought- Southern California

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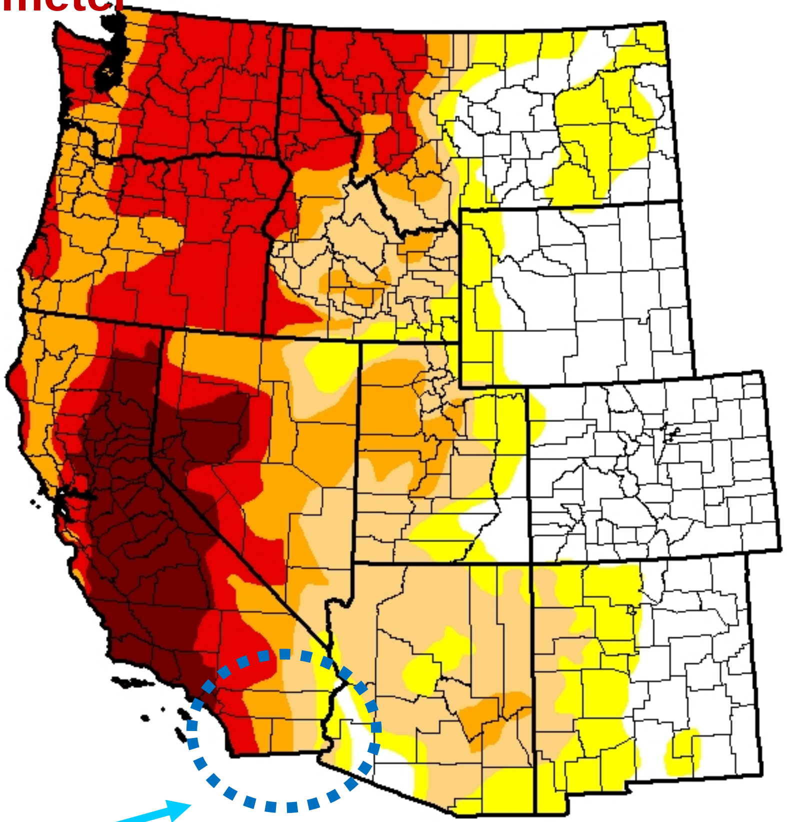
Units:
1 Hectare is ~ 2.5 acres
1 ac-ft is ~ 1,233 cubic meter
1 ft is 0.3048 m

U.S. Drought Monitor
West

August 25, 2015
(Released Thursday, Aug. 27, 2015)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	25.90	74.10	59.37	42.52	27.60	7.62
Last Week 8/18/2015	26.53	73.47	58.91	42.01	23.69	7.62
3 Months Ago 5/26/2015	25.37	74.63	57.03	35.92	17.59	7.94
Start of Calendar Year 12/30/2014	34.76	65.24	54.48	33.50	18.68	5.40
Start of Water Year 9/30/2014	31.48	68.52	55.57	35.65	19.95	8.90
One Year Ago 8/26/2014	27.50	72.50	58.91	41.45	20.62	8.90

Intensity:
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Anthony Artusa
NOAA/NWS/NCEP/CPC

http://droughtmonitor.unl.edu/

Study Area
Southern California

Colorado River Basin

- Annual allocation: 20.34 BCM

Higher than the 100-year average annual inflow into Lake Powell: 18.62 BCM

- Storage Capacity: 74 BCM

Annual Flow: highly variable from year to year

- Current water level in Lake Mead: below 49% of capacity (August 2015)

Capacity 32.2 BCM at 1219.6’ elevation

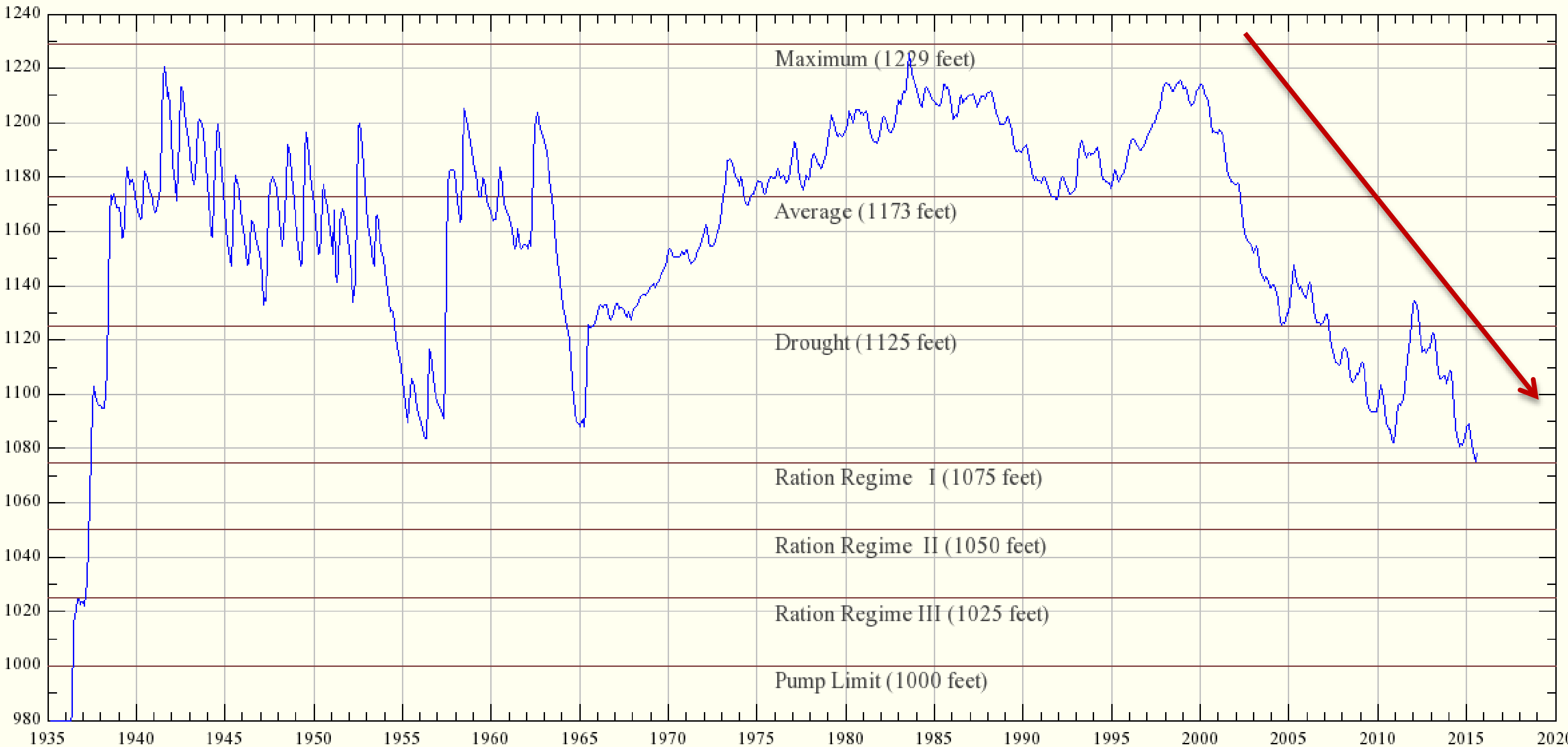
Currently (Aug.24, 2015) 15.8 BCM at 1078.07’ elevation

BCM: billion cubic meter

Lake Mead Water Levels — Historical and Current

June 2015: 1075.08’ July 2015: 1078.15’

Last time below 1075’ elevation was in April 1937



Source: http://www.arachnoid.com/NaturalResources/

Lake Mead Water Levels — Historical and Current

July 2010

Lake Mead Water Levels — Historical and Current

July 2015

Lake Mead Water Levels — Historical and Current

Current conditions at Lake Mead (July 2015)

37m drop in elevation since July 2010

July 2010

July 2015

The **Colorado River Compact** is a 1922 agreement among the seven states

Upper Basin, 9.25 BCM/year

Colorado	52%	4.76 BCM/year
Utah	23%	2.11 BCM/year
Wyoming	14%	1.28 BCM/year
New Mexico	11%	1.04 BCM/year

Lower Basin, 9.25 BCM/year

California	**59%**	**5.43 BCM/year**	(Imperial Valley 3.82 BCM/year)
Arizona	37%	3.45 BCM/year	
Nevada	4%	0.37 BCM/year	

Mexico

1.8 BCM/year

BCM: billion cubic meter

Irrigation and Management Strategies for Irrigated Agriculture in Arid and Semi-arid Regions

- Land fallowing (no crop/irrigation for one to two years)
- New cropping systems (low water use crops, organic vegetables and crop rotation-from two crops to one crop)
- Summer Deficit Irrigation (Alfalfa) vs. Land Fallowing
- Subsurface Drip Irrigation (SDI) on field crops
- Automation of Surface Irrigation Systems

- Potential reuse of saline and drainage water (moderately tolerant to salinity; ~3-7 dS/m)- not discussed in details here

Case Study:
Imperial Valley (Southern California)

- Irrigated area: ~ 200,000 ha

- Potential reduction in water available to agriculture from the long term average of 1850 mm per year to:

  - 1,500 mm/year (currently 18% reduction from the long term average)
  - Water transfer from agriculture to urban areas (Southern California- Los Angeles and San Diego)
  - More reduction is expected in the future (supply/demand) ?
  - 15 year drought (Colorado River Basin)

Imperial Valley

- **Rainfall: less than 75 mm/year**

- Surface Irrigation: ~ 80 to 90% of irrigated area
  (changing fast- more sprinkler and drip irrig.)

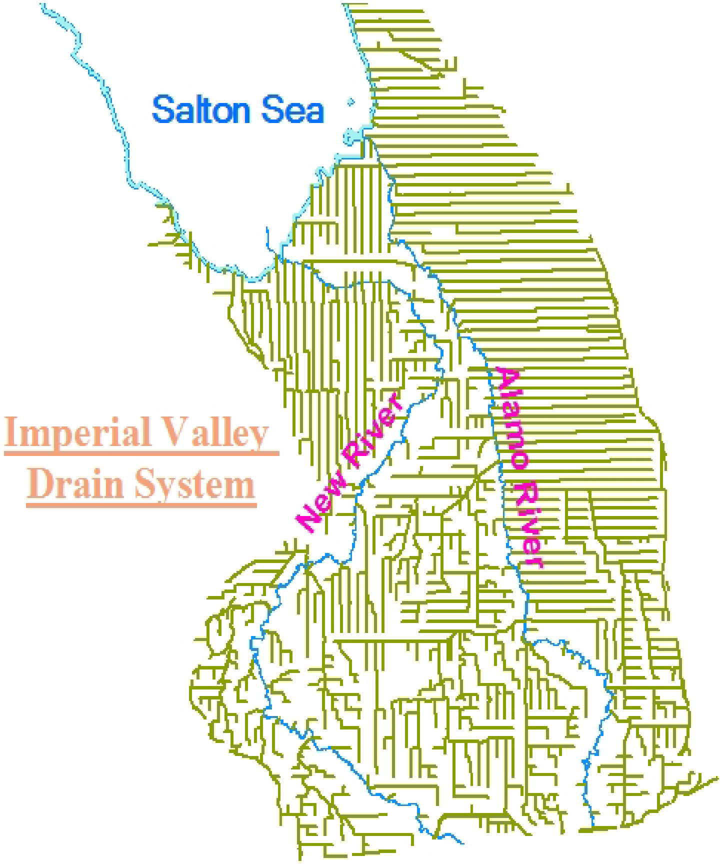
- Surface & subsurface drainage: ~30-35%
  (declining)

- Ag. flow to Salton Sea ~ 1/3 of applied water
  (declining)

Irrigation system

~2,250 km of irrigation canals

~2,250 km of open drainage channels



Imperial Valley Agriculture- 2013

Commodity	Harvested Acres	Value
Livestock		$617,371,000
Field Crops	332,727	$470,461,000
Vegetable and Melon Crops (40% of total value)	**121,371**	**$865,401,000**
Fruit and Nut Crops	7,793	$100,019,000
Seed and Nursery Crops	68,037	$100,557,000
Apiary Products		$4,708,000
Total	565,372	$2,158,517,000

Source: Imperial County Agricultural Crop & Livestock Report-2013
1 ha ~ 2.5 acres

Cropping Systems

- New commercial crop in the region: Olives
- Relatively low potential water use (0.6-0.9 m/year)
  - Spacing, variety, irrigation system, etc
- Establishment: 3-4 years before viable yield
- Potential reuse of drainage water (moderately tolerant to salinity; ~3-7 dS/m)
- FAO Kcs (0.55 to 0.65 for 40 to 60% ground coverage)?
- Potential savings: 30 to 40% of current applied water

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- Super High Density and Drip Irrigation

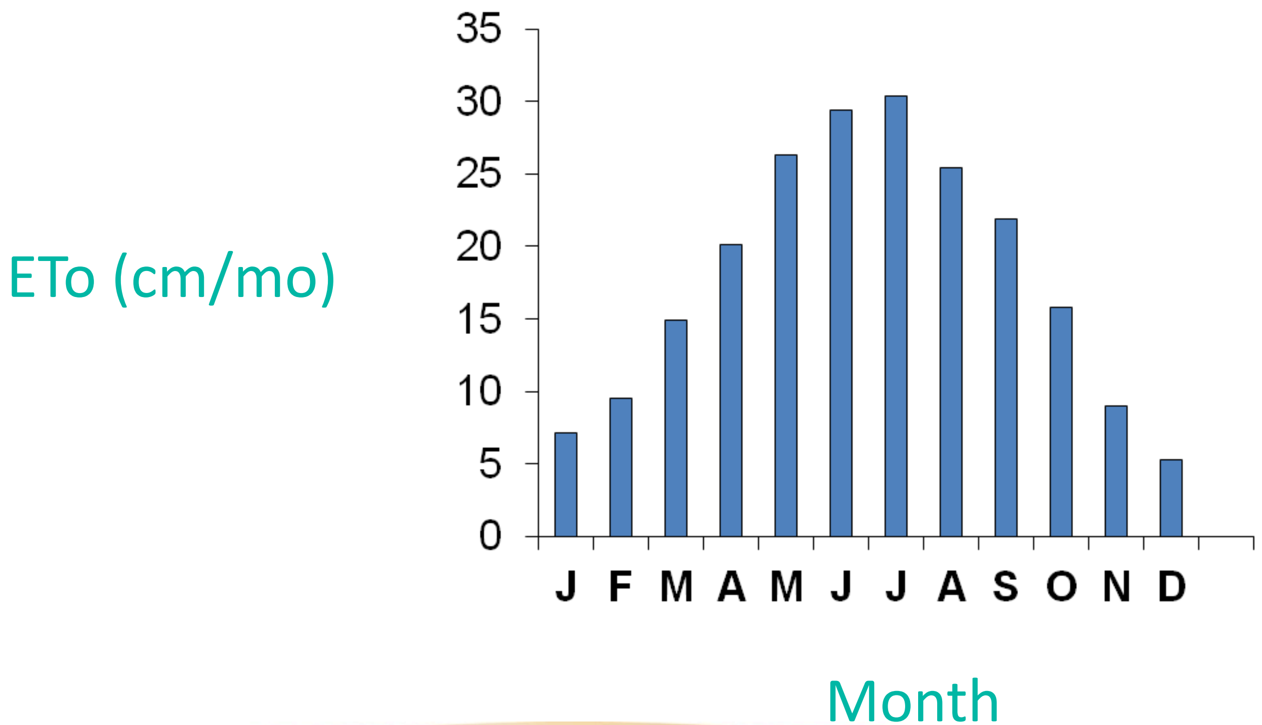
Imperial Valley Vegetable Crop Growing Season-

Temperature and ET (September to March)

Planting: September to December

Harvesting: Late November to late March

Crop Water use: 600 to 900 mm (ETc: 300 to 450 mm)



Traditional (past) irrigation practices on Lettuce and other vegetable crops

- 1 m beds (furrows)
- Two rows of lettuce per bed
- Sprinkler irrigation for germination then Flood (furrow) irrigation
- Water use ~ 900 mm

Current Practices on lettuce and other vegetable crops

- 2 m beds (furrows)
- Six rows of lettuce per bed (50% increase in crop density)
- Sprinkler irrigation for germination /entire growing season

  Flood (furrow) irrigation is not practical for 2-m beds
- Reduction in water use per acre (water use 600 to 750 mm)
- Higher water and fertilizer use efficiency (no runoff, more crop per drop)
- Lower production cost and lower water use per box (more crop per drop)

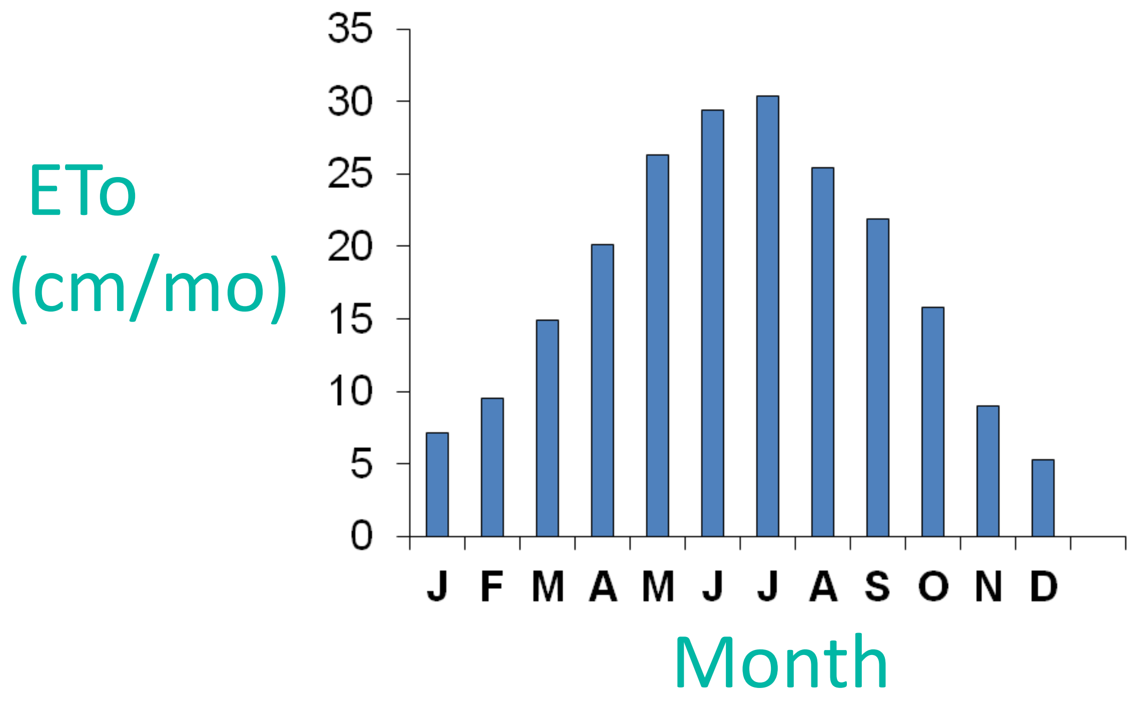
Organic Vegetables and Water Conservation

- Standard Rotation (Vegetable then field crop)
  two crops per year
- Three year wait to convert to organic (high demand)
- Fallow land for two years (conserve water & $$$)
- Convert to organic after only one year
- Organic (one crop per year, no crop rotation due to land preparation)
- Water savings (high return)

Advantages/savings:
Water, fertilizers, labor, TMDL

Summer Deficit Irrigation- Alfalfa

- No irrigation in July, August, and September
- High water use, lower quality hay/yield
- Low water use efficiency (kg/cubic meter of applied water)



California

- Alfalfa is California's single largest agricultural water user

  - About 400,000 ha of alfalfa

  - About 5 to 7 BCM of water per year

- Surface (flood) irrigation is the primary method of irrigation for alfalfa and other field crops in California

- Imperial Valley:
  - 55,000 ha
  - Water use 1.85 to 2.1 m/year

Water Use Efficiency

Imperial Valley (flood, 2 irrigations/cutting)

Summer WUE= 0.66 kg/cubic meter applied

Imperial Valley WUE= 0.89 kg/cubic meter

Imperial Valley Subsurface Drip Irrigation(SDI)
Up to 1.48 kg/cubic meter

Deficit Irrigation on Alfalfa flood vs. SDI

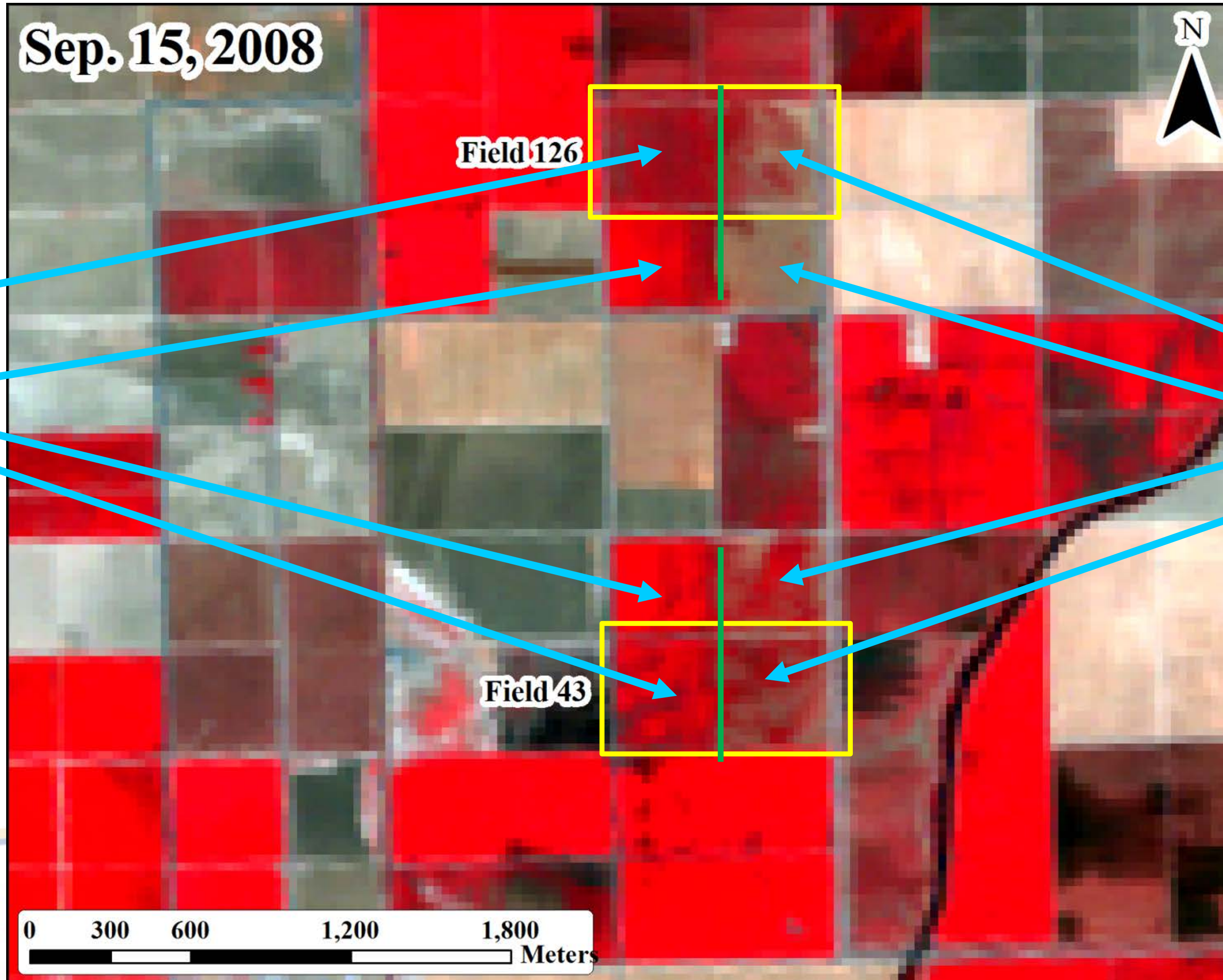
- **Flood:** Termination of irrigation in July-September on alfalfa
- Potential savings: up to 6-9 irrigations- 0.6 m
- Issues: Salinity, yield reduction, stand loss, weeds

SDI: regulated deficit irrigation
Ability to apply small amounts of water to maintain stand

Palo Verde sites

Landsat false-color image: Red color represent surface reflectance in near-infrared waveband, which is directly proportional to vegetation biomass.

Standard Irrig.

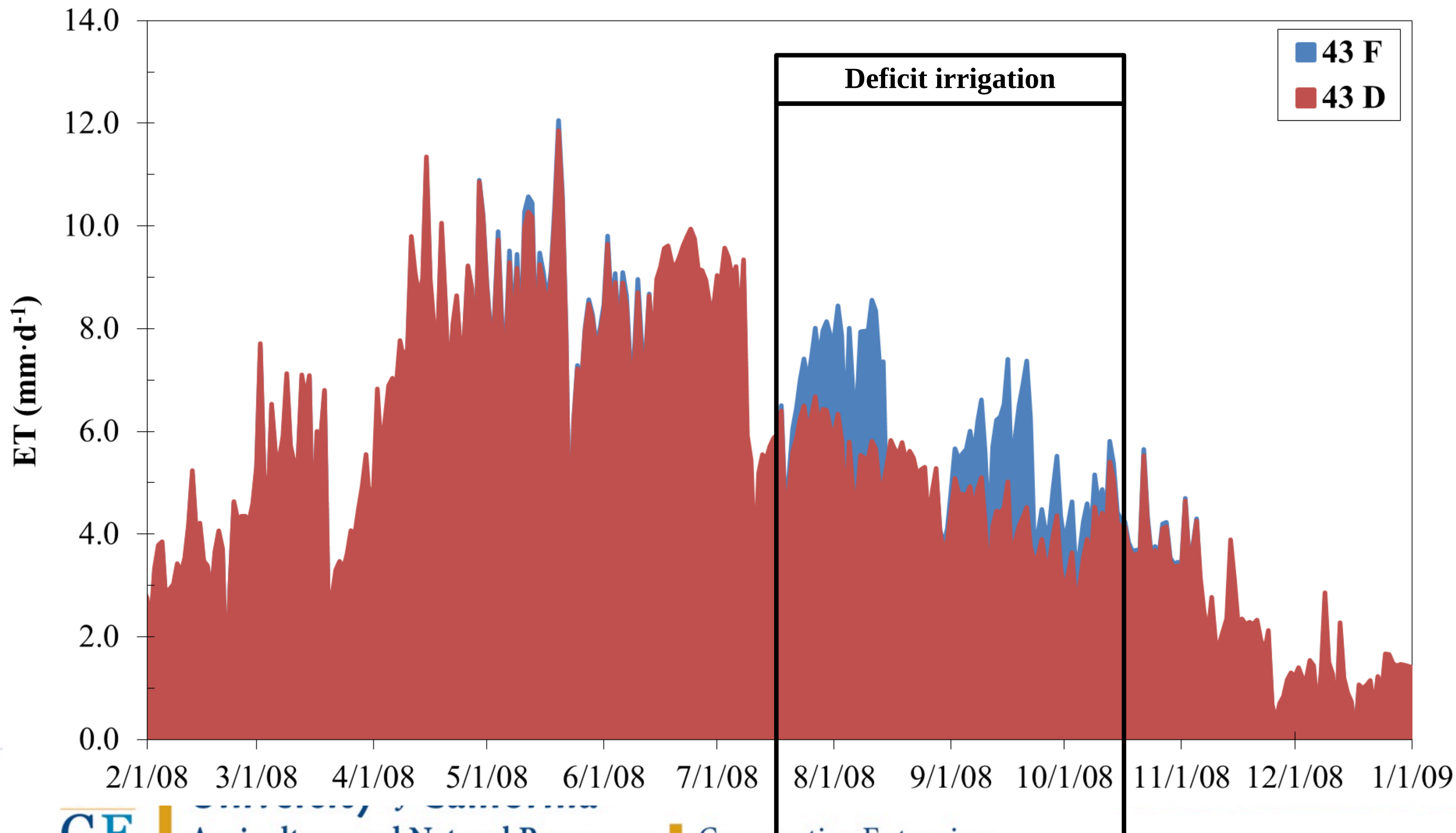


Deficit Irrig.

UC CE

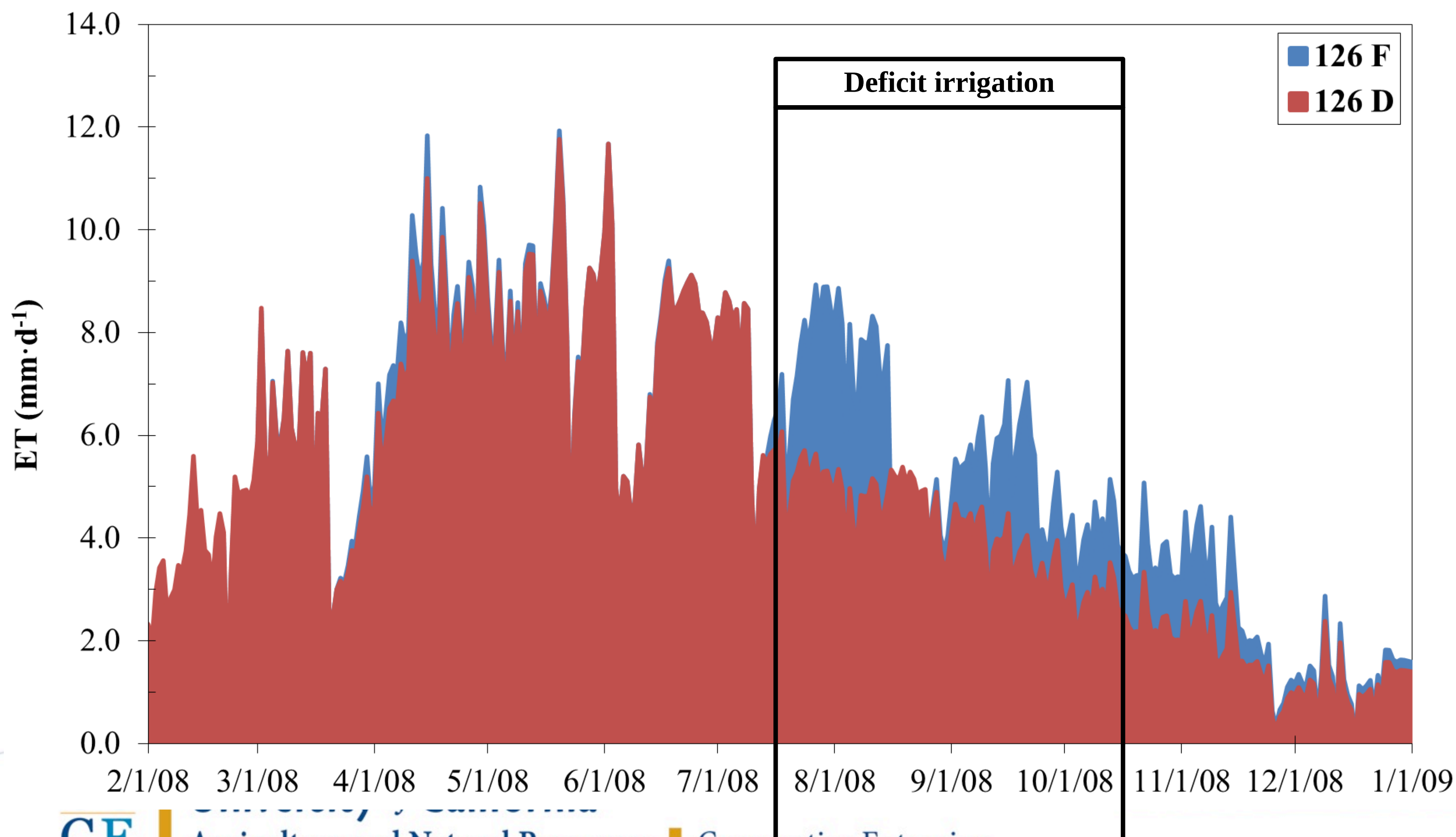
SEBAL results (Saleh Taghvaeian, Oklahoma State Univ. and Khaled Bali, UCCE)

Field 43: Deficit irrigation was applied from Jul 14 to Oct 11, 2008.
The difference in ET is due to a combination of irrigation treatments and cutting.



SEBAL results (Saleh Taghvaeian, Oklahoma State Univ. and Khaled Bali, UCCE)

Field 126: Deficit irrigation was applied from Jul 18 to Oct 10, 2008.
The difference in ET is due to a combination of irrigation treatments and cutting.



Value of Conserved Water

Palo Verde Valley (Southern California)

Average value of conserved water

Value of conserved water	Hay price ($/ton)			
	$100/ton	$150/ton	$200/ton	$250/ton
$/cubic meter of conserved water	$0.09	$0.14	$0.18	$0.23
$/ha (0.58 m of water)	$540	$810	$1,080	$1,350

Subsurface Drip Irrigation Alfalfa

Economics (1st& 2nd year hay)

➢

Gross profit @ $140/ton hay (long term avg.)

(current prices: $240-260/ton)

7% profit (drip)

		DRIP		FLOOD	
		Total	Per Acre	Total	Per Acre
Water Use Efficiency (Crop per Drop)					
	Acre Feet water used	2,464	6.50	3,608	9.52
	Gallons water used	802,733,939	2,118,032	1,175,696,476	3,102,102
Tons hay per acre foot water		2.38		1.21	

Units:
1 Hectare is ~ 2.5 acres
1 ac-ft is ~ 1,233 cubic meter
1 ft is 0.3048 m

Automation of Surface Irrigation Systems

Automation of Surface Irrigation Systems

- Irrigators typically work in 24-hr shifts

- Make decisions on when to turn the water off based on a number of variables (flow rate, advance rate, crop height, etc)

- Automation: smart decisions based on accurate and real-time data (flow rate, advance rate, automated gates, ETc , and other variables)

Optimization (Automation of surface irrigation systems)

- The process of considering all flood irrigation variables to improve on-farm irrigation efficiency

- Adjust irrigation time to allow for changing crop roughness (height and density of the crop)

- Adjusting border/set length to allow for variable soil type across the field

- Adjusting flow rate to an irrigation set (one or more border/land) to improve efficiency

- Computer simulation models are needed

- Accurate measurements during irrigation events (flow rate and advance rate)

Optimization

- Soil type 114 & 115 (heavy soils)- lower flow rate or high flow rate will work depending on the time of the year (considerations: erosion rate & scalding)
- Soil type 106 or 110 (lighter soil)- higher flow rate to increase efficiency
- Soil type 115 & 106 (change flow rate during the irrigation event)

Soil Web via Gmaps!

Zoom to location: Holtville, CA Go!

Map Unit Legend

Area (Ac)	Map Symbol	Map Unit
75.8	115	IMPERIAL-GLENBAR SILTY CLAY LOAMS, WET, 0 TO 2 PERCENT SLOPES
24.8	110	HOLTVILLE SILTY CLAY, WET
13.1	106	GLENBAR CLAY LOAM, WET
5.4	114	IMPERIAL SILTY CLAY, WET

Automated Surface Irrigation:

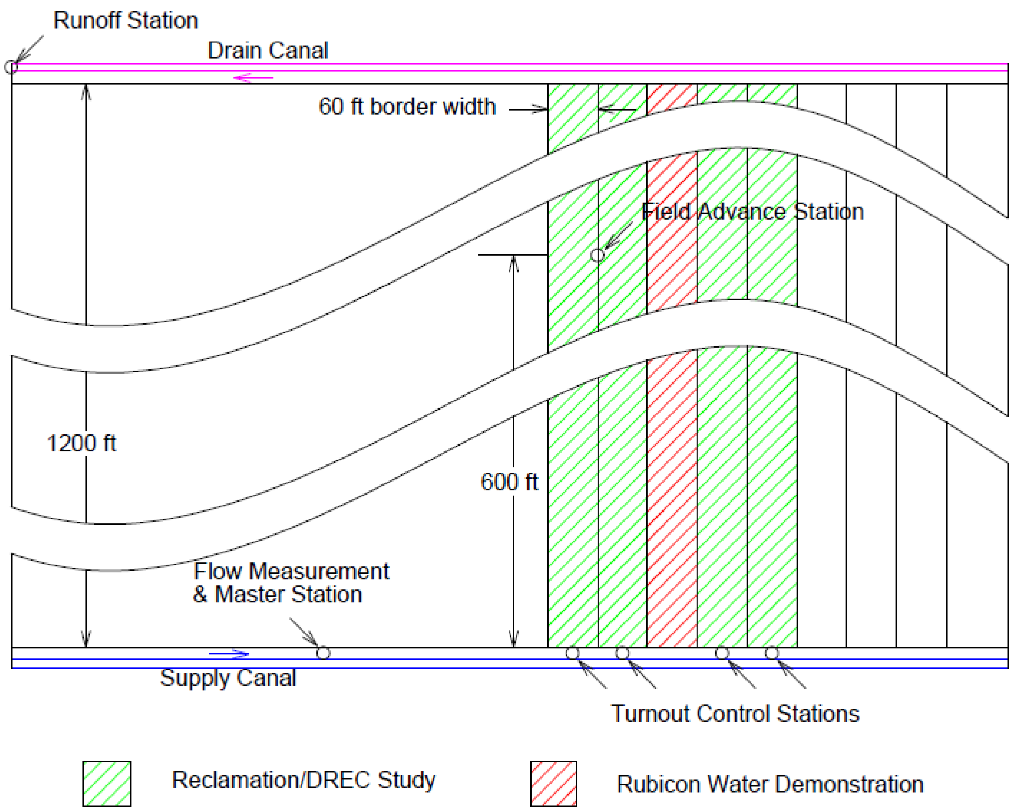
Early attempts on Automation

Automated Surface Irrigation:

Turnout Flow Control Prototypes

Automated Surface Irrigation

Automation Demonstration Layout



Automated Surface Irrigation:

Master Station

Automation of Surface Irrigation Systems

CONCLUSIONS

- Land fallowing has been used as the primary method for water conservation in Southern California (no crop or irrigation for one to two years)

- Regulated summer deficit irrigation is a viable alternative to land fallowing (value of conserved water)

- New efforts for irrigation system improvements-improve application efficiency- automation, subsurface drip irrigation, overhead irrigation, new technologies (Tule, remote sensing, etc)

CONCLUSIONS

- New cropping systems (olives, organic vegetables); have the potential for water conservation when water resources are limited (value of conserved water).

- Multi-state efforts and coordination are needed to reduce demand and manage the supply/demand imbalance for the entire Colorado River basin.

- MORE Reuse and recycling of drainage/wastewater is needed (some reuse of drainage water but more is needed)

- Stakeholders involvement is key factor in water management (agriculture/environment/urban)

Thank You


Food
Grows Where
Water Flows
Your Farm Bureau Neighbors
California Farm Water Coalition

Thank You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