

Updates on Evapotranspiration Adjustment Factor Project

Principal Investigators:

David Fujino, (California Center for Urban Horticulture, UC Davis), Janet Hartin (UC Cooperative Extension), and Loren Oki (UC Davis)

Project Cooperators:

Karrie Reid (UC Cooperative Extension) and Chuck Ingels (UC Cooperative Extension)

Project Contractor:

William Baker & Associates, LLC

*This project was funded by the California Department of Water Resources

The objective of the ETAF Study was to examine the potential for reducing applied water, as measured by a 0.7 ETAF, while maintaining a healthy and attractive landscape. The performance and appearance of landscape plants grown under a variety of species mixes, landscape irrigation technology and irrigation practices, microclimates, and densities in several climatic zones within California were documented throughout six geographic regions. The six regions include the Central Valley, Central Coast, South Coast, Los Angeles Basin, Inland Empire, and Desert.

A total of thirty-one sites began recording water usage during 2014 by utilizing either water meters (twenty-two sites) or water sensors (nine sites). Water usage was recorded monthly for a period of at least twenty-four months depending on the month the meter or sensor was fully operational. Each site was given a monthly water budget (Maximum Applied Water Allowance), which utilized historical ETo data from a CIMIS weather station. The MAWA formula used to compute the monthly water budget was: $(ETo) (0.7 ETAF) (LA - Landscape Area) (0.62 - \text{conversion factor, which converts square feet to gallons})$.

Each site during the length of the study had quarterly inspections, where a report was generated collecting the following information:

1. An irrigation maintenance inspection was conducted to make sure all systems were operating properly.
2. Action items were documented, which consisted of the system static and dynamic pressures, water pressure at the sprinkler, a base water flow from the valve in gallons per minute, correct valve operation, recording rotation times of rotary sprinklers, and measuring the soil moisture depth using a probe. Catch can tests were performed on all turfgrass sites to measure sprinkler distribution uniformity and the precipitation rate. Repair items encountered at the sites were broken sprinklers, arc adjustments, plugged nozzles or emitters, leveling uneven or titled sprinkler bodies, and trimming sprinkler bodies that had sprays deflected by grass or plants.

3. Plant observations were made quarterly to assess plant health and attractiveness associated with the amount of water being applied, and comparing it to the 0.7 ETAF water budget. Non-irrigation factors including both biotic and non-biotic disorders were documented, and noted about the impact they had on the landscape. Photographs were taken of the plants and landscape during each visit, and the plant canopy was estimated during each inspection.

4. Water usage for all thirty-one sites was recorded monthly, and compared to the 0.7 ETAF water budget. In 2014, sites that had landscapes using water above the 0.7 water budget, were requested to lower their usage amounts. For 2015, state-wide water restrictions were mandatory, and the average water usage for all thirty-one sites was considerably lower than the 0.7 ETAF water budget.

The combined water usage for all six regions decreased from 4,301,132 gallons applied in 2014 to 3,827,798 gallons used in 2015/2016, for a reduction of 473,334 gallons (11%). The combined actual ETAF in 2014 was 0.78, and lowered to 0.59 in 2015/2016. The total square feet irrigated was 249,748 or 5.7 acres, with turfgrass counting for 154, 146 sq. ft., and shrub beds totaling 95,622 sq. ft. During 2014 turfgrass sites used 3,039,132 gallons or 20 gallons per sq. ft., compared to shrubs sites which used 1,262,000 gallon or 13 gallons per sq. ft. In 2015/2016 turfgrass sites applied 2,463,752 gallons or 16 gallons per sq. ft., which contrasted the shrub usage of 1,364,064 gallons, or 14 gallons per sq. ft.

The following summarizes the combined water use (Turfgrass and Shrubs) for six regions in 2014 through 2016:

ETAF Water Use Totals (Gallons) for Six Regions – 2014 through 2016

Central Valley Region	Water Usage	ETAF	Square Feet	Gals./Sq.ft.
Central Valley (2014)	1,973,499	0.67	127,332	15
Central Valley (2015/2016)	2,006,435	0.74	127,332	16
Change between Years	32,936	0.07	N/A	1
Percentage Difference	1.7% Increase			
Central Coast Region	Water Usage	ETAF	Square Feet	Gals./Sq.ft.
Central Coast (2014)	157,873	1.16	5,678	28
Central Coast (2015/2016)	138,157	1.02	5,678	24
Change between Years	19,716	0.16	N/A	4
Percentage Difference	12% Reduction			

<u>South Coast Region</u>	<u>Water Usage</u>	<u>ETAF</u>	<u>Square Feet</u>	<u>Gals./Sq.ft.</u>
South Coast (2014)	231,687	0.95	14,557	16
South Coast (2015/2016)	140,409	0.49	14,557	10
Change between Years	91,278	0.46	N/A	6
Percentage Difference	39% Reduction			

ETAF Water Use Totals (Gallons) for Six Regions – 2014 through 2016

<u>Los Angeles Basin Region</u>	<u>Water Usage</u>	<u>ETAF</u>	<u>Square Feet</u>	<u>Gals./Sq.ft.</u>
Los Angeles Basin (2014)	908,318	0.58	55,482	16
Los Angeles Basin (2015/2016)	711,470	0.38	55,482	13
Change between Years	196,848	0.20	N/A	3
Percentage Difference	22% Reduction			

<u>Inland Empire Region</u>	<u>Water Usage</u>	<u>ETAF</u>	<u>Square Feet</u>	<u>Gals./Sq.ft.</u>
Inland Empire (2014)	286,060	0.89	9,623	30
Inland Empire (2015/2016)	171,392	0.51	9,623	18
Change between Years	114,668	0.31	N/A	12
Percentage Difference	40% Reduction			

<u>Desert Region</u>	<u>Water Usage</u>	<u>ETAF</u>	<u>Square Feet</u>	<u>Gals./Sq.ft.</u>
Desert (2014)	743,695	0.44	37,076	20
Desert (2015/2016)	659,935	0.37	37,076	18
Change between Years	83,760	0.07	N/A	2
Percentage Difference	11% Reduction			

Six Combined Regions	Water Usage	ETAF	Square Feet	Gals./Sq.ft.
Six Regions (2014)	4,301,132	0.78	249,748	17
Six Regions (2015/2016)	3,827,798	0.59	249,748	15
Change between years	473,334	0.19	N/A	2
Percentage Difference	11% Reduction			

The following results associated with turfgrass sites during the two year ETAF Study are as following:

- Fourteen turfgrass sites had an average 13% increase in distribution uniformity by switching from spray to rotating nozzles, performing regular sprinkler maintenance during audits, replacing rotary sprinklers that were turning slower than the manufacturer specifications, replacing worn out rotating nozzles with new nozzles, matching the nozzle to the pressure and spacing, and installing matching nozzles to all sprinklers.
- All fourteen turfgrass sites lowered their individual water consumptions at each location. The combined usage of all sites was 3,039,132 gallons in 2014, and lowered to 2,463,752 gallons in 2015/2016. The water savings was 575,380 gallons, or a 19% reduction in water usage.
- Turfgrass sites in 2014 had a combined actual ETAF of 1.28, and the actual ETAF lowered to 0.89 during 2015/2016. The total square feet of grass at the fourteen sites was 153,125 square feet, and in 2014, 20 gallons were used per square foot. In 2015 the amount of water was reduced to 16 gallons per square foot. Eight of the fourteen turf sites had grass conditions just meeting acceptable standards due to water reductions.
- Turfgrass in both years was not able to meet the evapotranspiration adjustment factor of 0.7. Although the 0.7 ETAF was not met, a significant reduction in water usage was achieved between 2014 and 2015/2016. The most significant reasons were mandatory state water restrictions in 2015/2016, and an irrigation system maintenance program that was executed during the two years of quarterly inspections. Improved sprinkler distribution uniformity contributed to the lower amounts of water applied in 2015/2016.

The following results associated with shrub sites during the two year ETAF Study are as following:

- The twenty-four sites, which had landscape beds containing shrubs, used considerably less water compared to turfgrass. In 2014, water consumption was 1,262,000 gallon or 13 gallons per sq. ft., compared to 20 gallons per sq. ft. for grass. During 2015, water usage actually increased for shrubs to 14 gallons per sq. ft., but still below the budgeted ETAF of 0.7. The total amount of water used was below the

water budget for both years, with 2014 irrigating with an actual ETAF of 0.58, and increasing to 0.61 in 2015/2016.

- Fourteen out of the twenty-four shrub locations actually reduced water consumption in 2015/2016. The 102,000 gallon water increase in 2015/2016 was due to three sites, which had valves stuck in the open position for extended periods of time. Also, one site had three different managers during the study period, with little emphasis placed on efficient water applications between supervisors.
- As a group the shrub sites watering at a 0.58 ETAF did not experience any adverse effects to the plant material. Nine of the sites had drip irrigation, and in 2014 they watered at a 0.35 ETAF. In 2015/2016 the irrigation was further reduced as water applications were lowered to a 0.29 ETAF.

In closing, what was learned from the two year ETAF Study?

- Turfgrass is still an important plant in the landscape, but in order to meet the 0.7 ETAF water requirement the quantity of grass will need to be reduced, and replaced with low water use shrubs.
- Distribution uniformity in turf and landscape sites can most often be increased without major redesign and installation efforts by switching from spray to rotary sprinkler heads. Increasing the distribution uniformity will result in lower amounts of water being applied.
- New landscape designs should utilize the efficiency and uniformity of drip irrigation systems. There was a significant reduction in water use, and the quality of the landscape did not suffer.
- Irrigation maintenance inspections and water audits that are accomplished on a quarterly basis can save significant water usage. If quarterly audits cannot be accomplished biannual audits should be integrated with the sites irrigation maintenance program.
- Mandatory water restrictions lowered water usage in 2015/2016, but in many cases it had a negative impact on the health and appearance of turfgrass.
- Properly designing landscapes utilizing low water use plants along with high efficient and uniform irrigation systems will enable plants to survive in low water applications.

Attached to this synopsis is our backup documentation in the form of spreadsheets and power point presentations.

Final Report (#2 - #6 not included due to confidentiality)

1. Text Summary – Evapotranspiration Adjustment Factor Study (2014 – 2016)
2. ETAF Turf Sites Distribution Uniformity Chart
3. Final Report – Comparisons for Sites over Two Year Period
4. Site Actions for End of Study Report
5. Cool Season Turf Power Point
6. Warm Season Turf Power Point

Quarterly Report - (not included due to confidentiality)

1. ETAF 2016 Quarterly Report – December – Text Summary
2. 2016 Quarterly Report December – Water Use Totals For Sites
3. December 2016 Quarterly Report