State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
San Joaquin District

ESTIMATED CROP EVAPOTRANSPIRATION IN THE COACHELLA VALLEY, CALIFORNIA[1/]

February 1981

This report presents estimated monthly and growing season total evapotranspiration (ET) rates for 18 crops grown in the Coachella Valley. Based upon a recent land use survey (8), the aggregated acreage for those 18 crops represents over 90 percent of the total crop acreage in the Valley.[2/]

A method for estimating effective precipitation is suggested and effective precipitation for each crop for the "average" rainfall year was calculated. Methods used for estimating crop ET and effective precipitation are described below.

Locally Measured Crop ET

ET rates for two locally important crops, date palms and vineyard, have been measured in the Coachella Valley (2 and 11). An annual ET rate of 72.4 inches for Deglet Noor dates has been reported (2). That ET rate was based upon soil sampling of a field plot during 1936-38. More recently, an annual ET rate for Khadrawy palm trees was determined to be 63 inches (11). That ET estimate was based upon gravimetric sampling of a field plot in the early 1950's. For this report, the annual ET rate for date palms was estimated as 68 inches -- the average of results from the two field plots (see Tables 1 and 2).

Monthly ET rates determined from gravimetric sampling of Thompson seedless grapes in the Coachella Valley have been published (2 and 11). For the April through October growing season, ET amounted to 39.3 inches and total annual ET was 43.6 inches. For this report, growing season ET (based upon that field study) was estimated as 39.9 inches (Tables 1 and 2).

Measured Crop ET for Other Desert Areas

Reliable crop ET rates have been determined for several field crops in the Imperial Valley. Robert D. Le Mert, Carl F. Ehlig, and Burl D. Meeks, with the

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1/ ET rates estimated by N. A. MacGillivray, Department of Water Resources, San Joaquin District, Water Utilization Section, January 12, 1981.
2/ Numbers in parentheses refer to references listed.

TABLE 1

SUMMARY OF ESTIMATED GROWING SEASON EVAPOTRANSPIRATION AND EFFECTIVE PRECIPITATION FOR SEVERAL CROPS IN THE COACHELLA VALLEY

Crop	Assumed Growing Season	Estimated Growing Season ET (inches)	Estimated Effective Precipitation (inches) 1/
Field Crops			
Alfalfa	1/01 - 12/31	80.6	1.4
Cotton	4/15 - 10/15	40.9	0.8
Forage Sorghum	4/15 - 11/15	50.5	0.6
Grain Sorghum	7/01 - 10/31	24.4	0.6
Grain Sorghum	4/01 - 7/31	30.2	0.1
Onions	11/01 - 5/15	26.0	1.4
Pasture	1/01 - 12/31	81.1	2.8
Truck Crops			
Asparagus	3/01 - 12/15	65.4	1.5
Carrots	8/15 - 12/15	16.3	0.8
Carrots	10/15 - 3/15	14.9	1.5
Carrots	1/01 - 5/15	23.9	0.7
Green Onions	9/15 - 1/31	13.6	1.4
Lettuce	9/15 - 12/31	12.6	0.9
Melons	2/01 - 6/30	34.3	0.3
Peppers	11/01 - 5/31	33.5	1.4
Sweet Corn	8/01 - 12/01	21.1	0.8
Sweet Corn	1/15 - 5/15	24.2	0.6
Sweet Corn	2/15 - 6/15	31.7	0.3
Tomatoes	1/15 - 5/15	22.1	0.5
Watermelons	1/01 - 5/31	25.4	0.7
Trees and Vines			
Citrus	1/01 - 12/31	46.7	2.8
Dates	1/01 - 12/31	68.0	2.8
Vineyard	3/01 - 10/31	39.9	1.3

1/ Based upon average of long-term precipitation at Indio Date Garden, Mecca Fire Station, and Thermal FAA - AP (15).

TABLE 2

SUMMARY OF ESTIMATED MONTHLY EVAPOTRANSPIRATION
FOR TREES AND VINEYARDS IN THE COACHELLA VALLEY
(inches)

Month	Citrus	Dates	Vineyard
Jan	1.3	2.7	0.4
Feb	1.8	3.2	0.5
Mar	3.2	4.3	1.5
Apr	4.2	5.8	3.4
May	5.5	7.4	6.0
Jun	6.8	7.8	8.0
Jul	6.6	8.5	7.7
Aug	5.9	9.4	6.4
Sep	4.8	8.1	4.4
Oct	3.4	5.1	2.5
Nov	1.9	3.4	1.2
Dec	1.3	2.3	0.7
Total	46.7	68.0	42.7

U. S. Department of Agriculture, Imperial Valley Conservation Research Center at Brawley, have measured the ET rates for alfalfa, barley, cotton, sugar beets, and wheat. Two of those crops, alfalfa and cotton, are important in the Coachella Valley. Together they amount to over 16 percent of the total cropped acres (8). Estimates of potential ET in the Coachella Valley calculated for this report are very similar to potential ET in the Imperial Valley. Therefore, monthly ET for alfalfa and cotton measured in the Imperial Valley were, with very slight adjustments for differences in growing season, used for the Coachella Valley (Tables 1 and 3).

L. J. Erie of the U. S. Department of Agriculture, Agricultural Research Service, and his colleagues, working in Arizona, have measured ET rates for a large number of crops (10). Comparison of ET rates for crops measured in both Arizona and the Imperial Valley have shown reasonable agreement. Therefore, ET determined for several crops in Arizona was either used for the Coachella Valley or used as a check on ET rates estimated by other methods (see Tables 1, 2, 3, and 4).

Estimated Crop ET

There were no ET measurements made in desert climates for many of the crops grown in the Coachella Valley, therefore ET for those crops was estimated from climatological data. Generally, regional ET estimates made by the Department of Water Resources are based upon either observed atmometer evaporation or observed evaporation from a U. S. Weather Bureau Class 'A' pan located in a large, well-managed irrigated pasture (3). Neither suitable pan nor atmometer evaporation data were available in the Coachella Valley (5 and 14).

The Food and Agricultural Organization (FAO) of the United Nations has recently published a paper that describes a method for estimating crop ET from measured or estimated ET of a grass reference crop (9). The grass crop must have a smooth surface, be sufficiently large in size to minimize local advective effects, provide 100 percent ground cover, and be adequately supplied with soil moisture to prevent plant moisture stress. ET of grass meeting those criteria is defined as potential ET (PET). The FAO publication also describes methods for estimating PET from climatological data.

Table 5 shows five estimates of PET for the Coachella Valley made by various methods. Annual total PET estimates were within 8 percent or less of the average for the five methods. The five estimates of monthly PET were averaged and values from a smoothed curve of those averages were selected to characterize PET in the Coachella Valley. PET for the Coachella Valley thus determined is considered to be in good agreement with estimates of PET for the Imperial Valley and for the southeastern California desert (Table 5).

Local climatological data used in making the PET estimates are shown in Table 6.

Monthly ET for a number of important crops in the Coachella Valley were estimated from PET and crop coefficients shown in the FAO report (9).

TABLE 3

SUMMARY OF ESTIMATED MONTHLY EVAPOTRANSPIRATION
FOR MAJOR FIELD CROPS IN THE COACHELLA VALLEY
(inches)

Month	Alfalfa	Cotton	Grain Sorghum		Dry Onions	Forage Sorghum	Irrigated Pasture
			Spring	Summer			
Jan	2.6				2.5		2.6
Feb	3.0				3.5		3.5
Mar	6.2				5.9		5.9
Apr	7.0	3.0	2.7		7.0	2.3	7.6
May	9.3	4.9	9.0		4.0	7.5	10.0
Jun	10.9	6.0	12.5			11.4	11.4
Jul	12.2	7.8	6.0	3.3		5.0	11.0
Aug	8.8	8.1		7.8		10.8	9.8
Sep	9.2	6.9		8.8		4.0	8.0
Oct	5.8	2.9		4.5		5.6	5.6
Nov	3.7	1.3			1.4	3.9	3.4
Dec	1.9				1.7		2.3
Total	80.6	40.9	30.2	24.4	26.0	50.5	81.1

TABLE 4

SUMMARY OF ESTIMATED MONTHLY EVAPOTRANSPIRATION
FOR MAJOR TRUCK CROPS IN THE COACHELLA VALLEY
(inches)

Month	Asparagus	Carrots			Corn - Market			Lettuce	Melons 1/	Green Onions	Peppers	Tomatoes Market	Watermelons
		Summer	Fall	Winter	Summer	Winter	Late Winter						
Jan	0.8		2.9	1.7		0.8				2.6	2.6	0.8	1.3
Feb	1.0		3.8	3.2		2.8	1.0		2.3		3.7	2.4	2.4
Mar	1.8		2.7	6.5		6.5	4.7		4.7		6.2	6.2	5.6
Apr	4.2			8.0		8.7	8.4		7.6		8.0	8.7	7.6
May	8.6			4.5		5.4	11.5		10.0		9.5	4.0	8.5
Jun	10.3						6.1		9.7				
Jul	11.0												
Aug	9.8	3.4			3.9								
Sep	8.0	5.2			7.2			2.8		1.7			
Oct	5.6	5.0	1.3		6.4			4.5		3.6			
Nov	3.1	2.7	2.0		3.6			3.1		3.4	1.8		
Dec	1.2		2.2					2.2		2.3	1.7		
Total	65.4	16.3	14.9	23.9	21.1	24.2	31.7	12.6	34.3	13.6	33.5	22.1	25.4

1/ Mostly honeydews and casabas.

TABLE 5

ESTIMATED NORMAL POTENTIAL EVAPOTRANSPIRATION
IN THE COACHELLA VALLEY
(inches per month)

Month	Blaney-Criddle 1/	Modified Blaney-Criddle 2/	Radiation 3/	Radiation 4/	USBR Jensen-Haise 5/	Average 6/	Estimated Coachella Valley 7/	Bulletin 113-3 SE Desert 8/	Estimated Imperial Valley 9/
Jan	2.9	2.8	2.7	3.3	1.9	2.7	2.6	2.7	2.6
Feb	3.8	3.5	3.3	3.9	2.6	3.4	3.5	3.6	3.4
Mar	5.8	6.8	5.9	6.9	4.8	6.0	5.9	5.9	5.8
Apr	7.6	8.5	8.0	9.0	7.4	8.1	7.6	7.6	7.6
May	10.0	10.8	9.5	10.8	8.7	10.0	10.0	10.1	9.8
Jun	10.8	12.0	10.2	11.5	10.5	11.0	11.4	11.4	11.3
Jul	12.1	10.9	9.1	9.7	11.4	10.6	11.0	11.6	10.9
Aug	10.7	10.0	8.1	9.0	10.7	9.7	9.8	9.6	9.7
Sep	8.1	8.1	6.8	7.4	8.3	7.7	8.0	8.5	7.9
Oct	5.9	5.8	5.1	5.7	5.5	5.6	5.6	6.3	5.6
Nov	3.5	3.7	3.1	3.7	2.8	3.4	3.4	3.5	3.4
Dec	2.5	2.7	2.4	3.0	1.7	2.5	2.3	2.0	2.2
Total	83.7	85.6	74.2	83.9	76.3	80.7	81.1	82.8	80.2

1/ Calculated by Blaney-Criddle method using Coachella Valley temperature data and monthly crop coefficients (K's) determined from L. Erie's observed ET-alfalfa in Arizona. Smoothed to adjust for variations in mowing and regrowth (1 and 10).

2/ Blaney-Criddle method modified for effects of humidity, wind, and sunshine hours as described in UN-FAO No. 24 (9).

3/ Calculated from radiation observed at Coachella 1SE using method described in UN-FAO No. 24 (9).

4/ Calculated using radiation method described in UN-FAO No. 24 with radiation from four southeast desert locations (6 and 9).

5/ From Table 16, page 93, "Use of Water on Federal Irrigation Projects". U. S. Bureau of Reclamation (now Water and Power Resources Service), September 1961 (13). (ET-grass calculated using Jensen-Haise method).

6/ Average of five estimates of PET.

7/ Average of five estimates of PET with monthly values smoothed.

8/ Estimate of PET for Southern California desert. From Table 6, DWR Bulletin 113-3 (3).

9/ From Table 1, "Estimated Crop Evapotranspiration in the Imperial Valley, California" (7).

TABLE 6

CLIMATOLOGICAL DATA USED FOR ESTIMATING
POTENTIAL EVAPOTRANSPIRATION IN THE
COACHELLA VALLEY

Station	Air Temp.	Wind Movement	Humidity	Solar Radiation	Daytime Cloud Cover, %	Precipitation
Brawley 2SW	-	-	-	5/	-	-
Coachella Valley CWD	-	2/	4/	6/	4/	-
El Centro 7NW	-	-	-	7/	-	-
Indio - Date Garden	1/	3/	-	-	-	9/
Mecca Fire Station	1/	-	-	-	-	9/
Palm Springs	1/	-	-	-	-	-
Salton Sea	-	-	-	8/	-	-
Thermal FAA - AP	-	-	4/	-	4/	9/

1/ Long-term average mean monthly air temperatures, Table 1, "Climatological Data - Annual Summary - 1979", Volume 83, No. 13, NWS (15).
2/ Unpublished monthly wind record, January 1973 - June 1974.
3/ Monthly wind record, January 1966 - December 1975. NWS "Climatological Data, various volumes (15). WPRS (formerly USBR) reports anemometer was at approximately 75-foot height until late 1966 when it was lowered to 16 feet above ground (13).
4/ Humidity and cloud cover record from Coachella Valley CWD 1966-1967; humidity from Thermal 1968 and 1969; cloud cover from Thermal 1968. Appendix A, "Use of Water on Federal Irrigation Projects". USBR, September 1971 (13).
5/ Ten-year average, January 1962 - December 1971. Table 3, DWR Bulletin 187 (6).
6/ Average January 1966 - July 1973. Table 3, DWR Bulletin 187 (6).
7/ Average January 1963 - December 1976. Table 3, DWR Bulletin 187 (6).
8/ Average March 1967 - December 1968. Table 3, DWR Bulletin 187 (6).
9/ Long-term average. Table 2, "Climatological Data - Annual Summary - 1979", Volume 83, No. 13, NWS (15).

Crop growing seasons were obtained from a University of California publication (12) and from a representative of the Riverside County Agricultural Commissioner's Office.1/

Crop-growing seasons used are shown in Table 1. Monthly estimates of crop ET are listed in Tables 2, 3, and 4. Growing-season total ET is shown for the 18 selected crops in Table 1.

Effective Precipitation

Records for three locations in the Valley (see Table 6) were used to determine average precipitation (15). The long-term average annual rainfall for the agricultural area of the Valley is 2.8 inches. The precipitation record for Palm Springs was not used as that location is not within the major agricultural area of the Valley (4).

Although the rainfall is sparse and unpredictable as to time of occurrence, there is some contribution toward meeting the ET demand of many crops. For this report, only rainfall occurring during crop-growing seasons is considered to be effective; that is, there is no appreciable carryover of precipitation as stored soil moisture from rains falling before the crops are planted. For the rain falling during the crop-growing seasons, 100 percent was considered effective for crops at full ground cover. For the period between planting and the attainment of full cover, 50 percent of the rain was considered to be effective. The estimated amounts of effective precipitation are shown in Table 1.

Both crop ET and effective precipitation are needed to calculate crop irrigation requirements. These are shown in Table 1. Also needed are estimates of leaching requirements and irrigation application efficiencies. These last two items have not been included in this report.

1/ Telephone conversation with Mr. Ruben Arias, Riverside County Agricultural Commissioner's Office, October 10, 1979.

References

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