WEATHER STATION SITING AND CONSUMPTIVE USE ESTIMATES[a]

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ABSTRACT: The environment of a weather station site is important in estimating consumptive use by irrigated crops. Consumptive use may be overestimated when air temperature and vapor pressure data from a weather station with an arid local environment are used without modification. To document the effect of weather station aridity on consumptive use estimates, three sites in irrigated areas and two sites in nonirrigated, arid rangeland in southern Idaho were instrumented with weather stations during 1981. Air temperatures were higher and vapor pressures were lower at the arid sites. Use of air temperatures and dewpoint estimates from arid sites caused an overestimation of ET, by 17% (210 mm) over the irrigation season. Results indicate the importance of weather site evaluation and adjustment of siting effects and weather before consumptive use estimates are made. A procedure is outlined for adjusting historical temperature data to reflect an irrigated condition.

INTRODUCTION

Irrigation of arid regions contributes to substantial modification in local climate, resulting in cooling and humidification, and reduced turbulence of air masses advancing from nonirrigated to irrigated areas. Potential evaporative power and the corresponding potential or reference evapotranspiration estimated using meteorological data are decreased. Consumptive use from large irrigation projects is often less than consumptive use predicted using weather measured before the project was initiated or from weather measured at adjacent, arid, nonirrigated sites. It is important, when estimating consumptive use for planning or operation of large irrigation projects, for irrigation scheduling or for determining water rights, that weather measurements are representative of an irrigated condition or are adjusted for the aridity of the weather site.

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Siting and aridity effects on air temperature and vapor pressure have been studied and analyzed by many researchers. Holmes (8) recorded during August, 1968 decreases of 3.0° C and 2.0° C, respectively, in temperature of air traveling from virgin prairie to a large lake, and to an irrigated region in Alberta, Canada. Air temperature at 20 m elevation increased 2.0° C as air moved back to virgin prairie. Surface radiation temperatures measured over irrigated land averaged 10.0° C lower than over uncultivated prairie at 1,430 hr during this same period.

Hanks, et al. (6) studied temperature, vapor pressure, and wind speed gradients along borders between dry land and irrigated fields of grain sorghum during August at Akron, Colorado. They determined that border advection, manifested by horizontal temperature and vapor pressure gradients, occurred over most of the irrigated plot, but was most evident from 0 m–40 m from the upwind edge. Hanks, et al., measured air temperature differences of 2.5° C at 40 cm, and 1.0° C at 2 m above ground surface between the dry land and irrigated plots. Vapor pressure at 2 m average 1.5 mb (14%) higher over the irrigated plots as compared to dry land. Measured evapotranspiration (ET) rates averaged 5.1 mm/day from the irrigated sorghum, and 3.2 mm/day from the dry land sorghum.

Burman, et al. (3) measured decreased air temperature, increased vapor pressure, and decreased wind speed along a transect extending from dry sagebrush land into the center of a large irrigated area in southern Idaho during August, 1972. Air temperatures averaged 1.0° C–3.0° C lower over irrigated sites than over desert. Vapor pressures at 2 m above ground surface ranged from 2 mb greater over irrigated areas during nightime hours to over 10 mb greater over irrigated areas during afternoon hours, as compared to desert locations. Wind speed was reduced about 40% within the irrigated areas, mostly due to stability effects on momentum transfer over irrigated land. Calculated reference ET (potential) average 8 mm/day in the center of the irrigated area surrounding Kimberly, Idaho, and 10 mm/day at the desert sites.

Hashemi and Habibian (7) compared temperature, humidity, and wind measurements at dry land and irrigated sites in southwestern Iran. Air temperatures during April, May, June, July, and August averaged 2.0, 1.5, 2.5, 1.8, and 2.0° C higher over dry land than over irrigated areas. Relative humidity measurements were 5% lower over dry land, and measured wind speed was 50% higher. Calculated reference ET using dry land weather averaged 1.3 mm/day greater than ET computed using weather measurements over irrigation.

In an effort of estimate actual ET from arid regions in North America, Morton (9–11) compared estimates of potential ET calculated using arid weather data, to estimates of potential ET calculated using weather measurements expected in a humid environment. Results of his studies indicate that differences between estimates of calculated potential ET are related to differences between potential ET calculated using humid weather data and actual regional ET in the arid area.

WEATHER STATION DESCRIPTION

Four weather-sensing stations were located in the Bruneau Plateau area in southern Idaho during 1981 to measure and record hourly and daily

TABLE 1.—Names, Locations and Weather Information Collected at Sites in Southern Idaho during 1981

Name (1)	Elevation, in meters (2)	Location (3)
1. Grindstone Butte Mutual Irrigation Project hourly solar radiation, air temperature, relative humidity, windrun and direction	960	T7S, R10E, s21
2. Grindstone Butte Desert daily maximum and minimum air temperature occasional relative humidty (dewpoint)	980	T8S, R10E, s11
3. Bell Rapids Mutual Irrigation Project hourly solar radiation, air temperature, relative humidity and windrun	1,050	T7S, R13E, s30
4. Bell Rapids Desert daily maximum and minimum air temperature occasional relative humidty (dewpoint)	1,050	T7S, R11E, s23
5. Kimberly USDA-ARS hourly solar radiation, air temperature, dewpoint, windrun and soil temperature	1,200	T10S, R18E, s21

weather, as outlined by Allen (1). Two sites were in irrigated areas and two sites were in nonirrigated, arid rangeland. Names, locations, and weather parameters recorded at the stations are listed in Table 1. Also included is a description of a station located at and operated by the USDA-ARS research center at Kimberly, Idaho, during the same period. The period of measurement for all stations was April 8–October 22, 1981. Locations of sites are shown in Fig. 1.

FIG. 1.—Locations of Weather Sites during 1981 Irrigation Season

The two irrigated weather sites on the Bruneau Plateau were located in alfalfa fields near the center of two irrigation projects. The site at Bell Rapids (site 3) was located in a sprinkler-irrigated alfalfa hay field harvested about June 10, July 20, September 1, and October 15. The site was adequately watered, well fertilized, and was surrounded by irrigated alfalfa or grass pasture on all sides for over 500 m. The Bell Rapids Irrigation Project is 15,000 ha surrounded by arid rangeland.

The Grindstone irrigated site (site 1) was located in a sprinkled alfalfa field grown for seed production. This site was under-irrigated from mid-July through October to facilitate seed production and to discourage vegetative growth. The result of this under-irrigation on air and dewpoint temperature is reviewed. The Grindstone Irrigation Project is 5,000 ha surrounded by arid rangeland.

Weather stations at the Grindstone and Bell Rapids irrigated sites (sites 1 and 3) consisted of microprocessor-based controller/recorder units with cassette storage. Air temperature, relative humidity, solar radiation, and wind speed and direction were measured using electronically activated sensors mounted at 2 m above ground surface. Hourly estimates of dewpoint temperatures at the two irrigated sites were calculated using average hourly values of recorded air temperature and relative humidity. Dual relative humidity sensors were located at sites 1 and 3 throughout the study for the purpose of data integrity.

Weather stations at the Grindstone and Bell Rapids desert sites (sites 2 and 4) consisted of mechanical thermographs equipped with 30-day, circular charts located at 2 m above ground surface. These stations were sited in areas of grass/sagebrush vegetation with no irrigation or cultivation within 4 km in any direction.

The weather station at Kimberly (site 5) was of a similar type as sites 1 and 3, with the exception that dewpoint, rather than relative humidity, was measured using an aspirated electronic dewpoint sensor. The Kimberly sensors were located at 2 m above clipped turf grass. Kimberly is located near the center of an irrigated area of 150,000 ha in size, about 70 km southeast of the Bruneau sites.

COMPARISON OF WEATHER AT IRRIGATED SITES

Ten-day running averages of solar radiation, wind run, maximum and minimum air temperature, and dewpoint temperature are shown in Figs. 2–5 for the Grindstone, Bell Rapids, and Kimberly irrigated sites (sites 1–3). The 10-day averages dampen daily fluctuations within parameters and allow variations among sites to be observed. Seasonal averages of weather parameters from irrigated sites are summarized in Table 2.

As shown in Fig. 2, solar radiation measurements during 1981 at Kimberly, Grindstone Butte, and Bell Rapids are nearly identical, especially after June 1. Ten-day averages of wind run, shown in Fig. 3, indicate wind run measured at Kimberly to be less than wind run measured at the Bruneau Plateau irrigated sites, which are nearer to the desert, throughout the 1981 irrigation season. Wind run at Kimberly averaged 25% lower than at Bell Rapids (site 3), and 33% lower than at Grindstone Butte (site 1). The higher values of wind run measured in the Bruneau area may be attributed to thermally produced turbulence in the desert

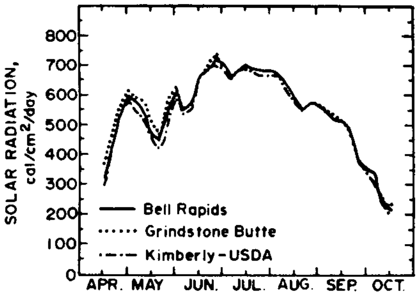

FIG. 2.—Ten-Day Average Solar Radiation Measured at Bell Rapids, Grindstone Butte, and Kimberly during 1981

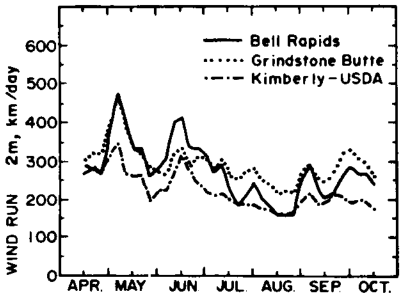

FIG. 3.—Ten-Day Average Wind Run Measured at Bell Rapids, Grindstone Butte, and Kimberly during 1981

regions surrounding the Grindstone and Bell Rapids irrigated sites. Strong heating of air at the arid desert surfaces is known to increase thermal updraft and corresponding turbulent transport of air masses. Since the distance from irrigated site 1 and 3 to the desert edge was 1–6 km in an upwind (westerly) direction, the effect of desert wind would likely be sensed.

Maximum daily air temperature at the Bell Rapids irrigated site was

TABLE 2.—Average Seasonal Values of Measured Weather Parameters and Estimated Reference Evapotranspiration, April 8–October 22, 1981

Parameter (1)	Grindstone (site 1) (2)	Bell Rapids (site 3) (3)	Kimberly (site 5) (4)
Solar radiation, Langleys per day	545 (+4%)[a]	539 (+3%)	524
Windrun, miles per day	182	171	138
kilometers per day	292 (+33%)	275 (+25%)	220
Maximum air temperature, in degrees Fahrenheit (Celsius)	78.7 25.9 (+2.1)[b]	76.0 24.5 (+0.7)	74.9 23.8
Minimum air temperature, in degrees Fahrenheit (Celsius)	47.5 8.6 (+0.9)	46.8 8.2 (+0.5)	45.9 7.7
Dewpoint temperature, in degrees Fahrenheit (Celsius)	42 5.7 (+0.8)	44 6.7 (+1.8)	41 4.9
Reference evapotranspiration			
millimeters per day	7.4	6.5	6.2
millimeters per season	1,390	1,230	1,170
inches per season	54.8 (+19%)	48.6 (+5%)	46.1

[a] Percent difference from measurements at Kimberly (site 5).
[b] Difference in degrees Celsius from measurements at Kimberly.

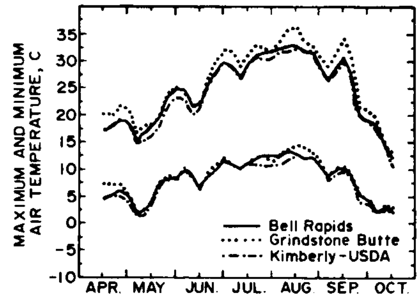

FIG. 4.—Ten-Day Average Maximum and Minimum Air Temperature Measured at Bell Rapids, Grindstone Butte, and Kimberly during 1981

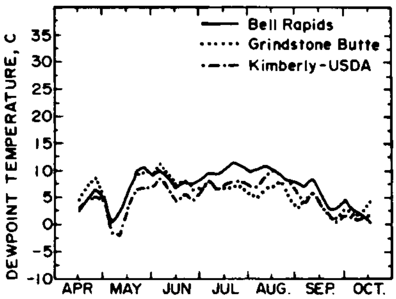

FIG. 5.—Ten-Day Average Dewpoint Temperatures Calculated for Bell Rapids, Grindstone Butte, and Kimberly during 1981

equal to maximum temperature at Kimberly, except for the period from mid-May to early June (Fig. 4). After mid-June, maximum daily air temperature at Grindstone was greater than at both Bell Rapids and Kimberly. It was during this time that the alfalfa crop at the Grinstone site was under-irrigated. Average departure of maximum air temperature from Kimberly during the irrigation season was 2.1° C at Grindstone, and 0.7° C at Bell Rapids (Table 2). Essentially no difference in minimum daily air temperature was detected among the irrigated sites except during late July and early August (Fig. 4).

Ten-day running averages of dewpoint temperature at 0800 hr, shown in Fig. 5, indicate higher dewpoint temperatures (higher vapor pressures) at the Bell Rapids irrigated site than at the Grindstone irrigated site from July–September. This difference is attributed to under-irrigation of the dry seed alfalfa crop at the Grindstone location. Dewpoint averaged 1.0° C higher at Bell Rapids than at Grindstone over the season.

Recorded dewpoint temperatures were lower at Kimberly during April, May, and June, and fluctuated between Bell Rapids and Grindstone measurements during July and August. The weather site at Kimberly was located adjacent to moisture stress trials at the USDA research center during 1981. This may have influenced vapor pressure and air temperature at the site, although this effect is not apparent in the maximum air temperature data plotted in Fig. 4. Dewpoint was measured directly at the Kimberly site; whereas it was calculated from air temperature and relative humidity measured at the Grindstone and Bell Rapids sites. Equipment bias in the dewpoint sensor at the Kimberly site or in the relative humidity sensors at the Bell Rapids and Grindstone sites is possible.

Reference Evapotranspiration Estimates for Irrigated Sites.—Daily estimates of reference evapotranspiration, ET_r, were calculated for the Grindstone, Bell Rapids, and Kimberly sites using a modified Penman combination equation and procedure adapted to Idaho conditions by Wright (13). This equation combines energy balance and mass transport theory in estimating evapotranspiration from an adequately watered, erect, disease-free alfalfa crop. Procedures for applying the Wright combina-

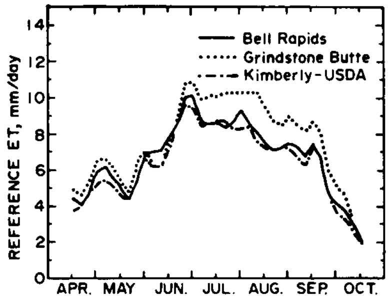

FIG. 6.—Ten-Day Average Alfalfa Reference Evapotranspiration Calculated for Bell Rapids, Grindstone Butte, and Kimberly during 1981 Using Wright (13)

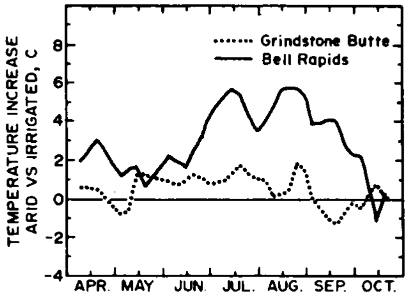

FIG. 7.—Ten-Day Average Increase in Recorded Maximum Daily Air Temperatures between Desert and Irrigated Sites at Grindstone Butte and Bell Rapids during 1981

tion equation were reported by Wright (13) and Burman, et al. (4). Consumptive use by agricultural crops can be estimated by multiplying reference ET by crop coefficients developed by Wright (4,12,13). Ten-day running averages of reference evapotranspiration, ET_r, are plotted in Fig. 6. Estimated ET_r at Bell Rapids is very similar to ET_r estimated for Kimberly during 1981, with Kimberly ET_r being occasionally lower. Lower wind movement at Kimberly was apparently countered by the greater vapor pressure deficits (lower dewpoint) estimated for Kimberly as compared to Bell Rapids. Estimated ET_r at Bell Rapids was about 5% (60 mm) greater than ET_r estimated at Kimberly over the 1981 irrigation season.

As shown in Fig. 6., ET_r at the Grindstone irrigated site increased over ET_r at Bell Rapids and Kimberly after about July 1. This increase in ET_r resulted from an increase in maximum daily air temperature and a decrease in dewpoint temperature caused by under-irrigation of the seed alfalfa crop. As a result of under-irrigation, the seed crop experienced moisture stress, and transpiration was reduced, resulting in increased conversion of radiant energy to sensible heat (air temperature), and decreased conversion to latent heat. Estimated ET_r for the season at Grindstone was 19% greater (220 mm) than at Kimberly (Table 2). However, actual ET by alfalfa at the irrigated Grindstone site was considerably less than at Kimberly.

These results illustrate the potential for overestimation of ET_r and consumptive water use when weather parameters are not measured over an adequately watered, actively growing alfalfa or grass crop located within an irrigated area. Results also indicate that proximity of weather sites to large, nonirrigated areas has little effect on solar radiation, air temperature, or dewpoint temperature, provided the weather site is located an adequate distance (200 m) from the nonirrigated boundary. Wind speed, however, may decrease with distance into an irrigated area as far as 70 km.

Effects of Irrigation on Air Temperature.—Figures 7–8 are graphs showing the 10-day average increase in maximum and minimum air temperaures measured over arid rangeland (sites 2 and 4), as compared

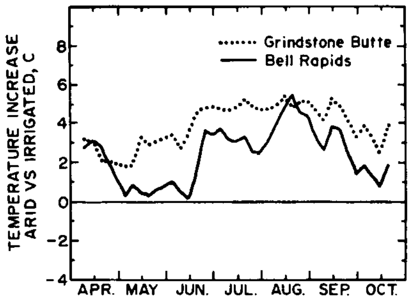

FIG. 8.—Ten-Day Average Increase in Recorded Minimum Daily Air Temperatures between Desert and Irrigated Sites at Grindstone Butte and Bell Rapids during 1981

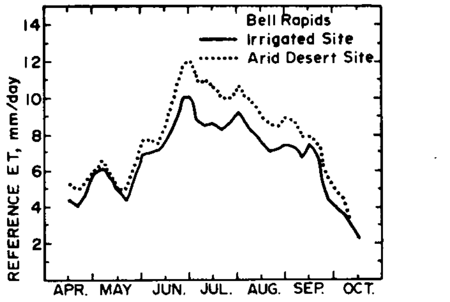

FIG. 9.—Ten-Day Average Alfalfa Reference Evapotranspiration Calculated for Bell Rapids during 1981 Using Wright (13)

to maximum and minimum air temperatures measured over irrigated alfalfa (sites 1 and 3). Maximum temperatures at the Grindstone irrigated site (site 1) were higher than maximum temperatures recorded at Bell Rapids (site 3) due to irrigation effects as previously reviewed. Therefore, departure of maximum air temperature at the Grindstone desert site from the irrigated site would be expected to be less than for Bell Rapids, as is shown in Fig. 7. However, departures of minimum air temperature at the Grindstone irrigated site relative to minimum temperature at the rangeland site were similar to departures measured at Bell Rapids. This is most likely due to sufficient transpiration by the seed alfalfa during nighttime hours which effectively lowered nighttime air temperatures to levels measured at Bell Rapids.

Average departure of air temperatures at the Bell Rapids desert site from temperatures at the Bell Rapids irrigated site are summarized in Table 3 on a monthly basis. Departure of arid temperature from irrigated temperature in May is low due to precipitation during late April and early May and the corresponding cooling effect of evapotranspiration from the rangeland areas. Averages in Table 3 should be representative of decreases in average air temperature occurring when an arid site in southern Idaho is converted to irrigation. The aridity column (column 4) in Table 3 is the result of smoothing monthly differences in the arid and irrigated data (column 3 of Table 3). This aridity effect was used by Allen and Brockway (2) during a study of consumptive use requirements to adjust historical air temperature data from 90 National Oceanic and Atmospheric Administration (NOAA) stations in Idaho to reflect irrigated sensor environments.

Effect of Weather Station Aridity on ET_r Estimates.—Ten-day running averages of ET_r estimated for the Bell Rapids irrigated site were compared to ET_r estimated for the Bell Rapids desert site to show the effects of site aridity on consumptive use estimates. Alfalfa reference ET was calculated using solar radiation, air temperature, wind run, and dewpoint temperature measured at the Bell Rapids irrigated site (site 3). Alfalfa ET_r at the desert site was estimated using solar radiation and

TABLE 3.—Average Monthly Departure of Air Temperatures over Arid Areas from Air Temperatures over Irrigated Areas in Southern Idaho during 1981 (from Allen (1))

	Temperature Departure				Desert Precipitation	
Month (1)	Maximum, in degrees Celsius (2)	Minimum, in degrees Celsius (3)	Average, in degrees Celsius (4)	Aridity, in degrees Celsius (5)	1981, in millimeters (6)	Long term, in millimeters (7)
April	2.7[a]	2.4	2.5	1.0[b]	29	23
May	1.3	0.6	0.9	1.5	28	28
June	2.4	1.8	2.1	2.0	5	22
July	4.8	2.9	3.8	3.5	1	3
August	5.2	4.3	4.7	4.5	5	8
September	3.3	2.7	3.0	3.0	6	11
October	0.3	1.6	0.9	0.0	24	13

[a] Difference between average of desert sites 2 and 4 and average of irrigated sites 1 and 3.

[b] Aridity effect used to adjust mean air temperature data from NOAA stations, degrees Celsius. Values were calculated by smoothing average departure values listed in column 4.

wind run from the Bell Rapids irrigated site, and measured air temperature and estimated dewpoint temperature data for the Bell Rapids desert site (site 4). Use of air and dewpoint temperatures from the arid site caused an overestimation of ET_r of 17% (210 mm) over the season, and 21% (56 mm) for the peak month of July (Fig. 9). Reference evapotranspiration averaged 10.5 mm/day during July when air and dewpoint temperatures from the arid site were used, and averaged 8.7 mm/day where air and dewpoint temperature data from the irrigated site were used. The difference in estimated ET_r, 1.8 mm/day, resulting from use of consumptive use methods with arid site weather data, would encourage excessive application of irrigation water when an irrigation scheduling program is followed, oversizing of irrigation delivery and application systems, and the resulting waste of energy for pumping.

When the FAO-Blaney-Criddle (FAO-BC) grass reference ET equation (5) was applied to the desert and irrigation data, results were similar to those obtained using the Wright Method. Grass reference ET (ET_o) estimated for the desert site exceeded ET_o estimated for the irrigated alfalfa by 21% (220 mm) over the season. Grass reference ET estimated using the FAO-BC was converted to an alfalfa reference using ratios developed by Allen and Brockway (2). These reference ratios are necessary to adjust for overestimation by the FAO-BC at southern Idaho sites during June, July, and August, and to convert from a grass to an alfalfa reference. The reference ratios were based upon ET calculations using the Wright method (13), and 14 years of National Weather Service Office daily weather information for Kimberly maintained on file on the USDA-ARS computer system at Kimberly, Idaho.

The FAO-BC method has been found to require an elevation correction of 10% increase per 1,000 m elevation (2,5). Kimberly alfalfa/FAO-BC reference ratios listed in Table 4 were used for converting grass reference ET estimated by the FAO-BC with elevation correction to an alfalfa ref-

TABLE 4.—Average Alfalfa Reference/FAO-BC for Kimberly, Idaho, 1965–1978 (from Allen and Brockway (2))

Month (1)	Reference ratio (2)
April	1.21
May	1.14
June	1.07
July	1.01
August	1.00
September	1.08
October	1.22

erence (Fig. 10). These reference ratios were shown to apply to sites in western and eastern Idaho (2).

Estimating Irrigation Consumptive Use at Arid Weather Sites.— Weather data are often available only for sites located in arid nonirrigated areas, or for sites in irrigated areas, but with nonirrigated, nonagricultural local environments. The latter type of site often applies to weather stations sited at airports or near residential areas where streets, roads, or adjacent nonirrigated areas cause heating of air to temperatures above those at a nearby agricultural site. Unfortunately, a majority of stations supported by NOAA fall into this category.

Use of a temperature-based ET method, such as the FAO-BC, can allow estimation of consumptive use at the numerous temperature stations supported by NOAA. The FAO-BC, however, does require estimates or measurements of solar radiation, relative humidity, and wind speed (5) for adjustment for local climate. These parameters are referred to as secondary data. This requirement often requires transfer of secondary data from stations outside the area of interest. These stations may or may not be representative of an agricultural setting.

To demonstrate the effects of station aridity on ET estimates, long-term average alfalfa reference ET was estimated for two sites near Twin Falls, Idaho. Twin Falls 2NNE is located within the northeast part of Twin Falls near commercial buildings, asphalt streets, and parking lots.

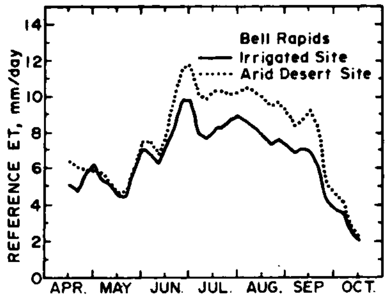

FIG. 10.—Ten-Day Average Alfalfa Reference Evapotranspiration Calculated for Bell Rapids during 1981 Using FAO-Blaney Criddle with Kimberly Alfalfa/FAO-BC Reference Ratios and Elevation Correction

The temperature sensor environment is bare ground. Twin Falls WSO (Kimberly) is located 5 miles (8 km) east of Twin Falls in an irrigated agricultural setting where the temperature sensor environment is irrigated grass.

Long-term monthly averages for solar radiation, minimum daily relative humidity, and daytime wind speed (used with the FAO-BC) are available for the irrigated Twin Falls WSO site. Secondary weather data were also obtained for a weather site at the Pocatello, Idaho Airport, 150 km east of Twin Falls. The Pocatello site is located over dry gravel near asphalt runways with nonirrigated rangeland in the direction of prevailing summer wind. Consequently, minimum relative humidity is lower and daytime wind speeds are higher at Pocatello than at Kimberly.

Monthly consumptive use was estimated for Twin Falls WSO and for Twin Falls 2NNE using secondary data from both Twin Falls WSO (Kimberly) and Pocatello. Estimates of consumptive use are listed in Table 5 and shown in Fig. 11.

Consumptive use was also estimated for Twin Falls 2NNE using Twin Falls WSO secondary data after adjustment of monthly mean air temperatures at the 2NNE site based on the station aridity. Adjustment was made by objectively rating the 2NNE site as being 60% as arid as outlying rangeland. This rating was based on sensor environment and on land use within a 1-km area in the direction of prevailing summertime wind, as outlined by Allen and Brockway (2). Monthly temperatures were

TABLE 5.—Average Monthly Alfalfa Reference ET by FAO-Blaney-Criddle with Kimberly Alfalfa/FAO-BC Reference Ratios for Twin Falls Weather Stations

	Reference Evapotranspiration, in Millimeters per Day				
Month (1)	WSO-WSO (2)	WSO-POC (3)	2NE-WSO (4)	A2NE-WSO (5)	2NE-POC (6)
March	2.0	1.9	2.2	2.2	2.1
April	4.2	4.5	4.7	4.5	5.0
May	6.3	6.2	6.8	6.5	6.7
June	7.6	8.4	8.1	7.7	8.9
July	8.1	9.5	8.6	8.0	10.1
August	6.8	8.0	7.3	6.6	8.4
September	5.3	5.8	5.6	5.1	6.2
October	3.4	3.4	3.6	3.6	3.6
Total, millimeters	1,340 (0%)	1,460 (+9%)	1,440 (+7%)	1,350 (+1%)	1,560 (+16%)

(2) WSO-WSO = WSO Temp w/Kimberly secondary data (irrigated setting).

(3) WSO-POC = WSO Temp w/Pocatello secondary data (irrigated temperature data, arid secondary data).

(4) 2NE-WSO = 2NNE Temp w/Kimberly secondary data (arid temperature data, irrigated secondary data).

(5) A2NE-WSO = 2NNE Temp w/Kimberly secondary data and correction for site aridity (adjusted arid temperature data, irrigated secondary data).

(6) 2NE-POC = 2NNE Temp w/Pocatello secondary data without aridity correction (arid temperature data, arid secondary data).

(Twin Falls-WSO is at Kimberly-USDA)

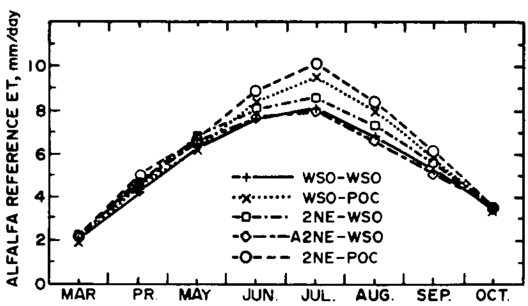

FIG. 11.—Long-Term Monthly Alfalfa Reference ET Estimated for Two Twin Falls Stations Using FAO-BC with Secondary Data from Kimberly (Twin Falls WSO) and Pocatello

adjusted downward by 60% of the smoothed aridity values listed in Table 3. As shown in Table 5 and Fig. 11, adjustment of air temperatures at the arid 2NNE site resulted in better estimates of consumptive use by irrigated alfalfa (represented by ET_r estimates at Twin Falls WSO using Twin Falls WSO secondary data). This phenomenon may explain why the SCS-modified Blaney-Criddle method has been observed to underestimate consumptive use at some irrigated agricultural sites and to give reasonably good estimates at many standard NOAA sites located in arid or residential areas.

There is also a marked increase in consumptive use estimates when secondary data from an arid nonagricultural site is used with the FAO-BC method. A similar result would have occurred if Wright (13) had been used. This example illustrates the potential overestimation of consumptive use by the FAO-BC or most other methods when temperature and secondary data must be used from a typical NOAA station. Use of nonadjusted NOAA data at Twin Falls would result in overestimation of reference ET by 16% (column 6 in Table 5), as compared to the agricultural site at Kimberly. Because good agricultural weather sites are rare in arid regions, some type of objective adjustment of temperature, humidity, and wind data from arid sites should be made when estimating consumptive use.

CONCLUSIONS

Siting of weather station environments is important in estimating consumptive use by irrigated crops. Proximity of the station to nonirrigated areas is less important than the actual sensor environment as long as an irrigated buffer between the station and arid region is maintained. The local station environment should be a well-watered, rough cover crop, such as alfalfa or grass which remains active throughout the irrigation season. If temperature data from a station in an arid region or with an arid local environment must be used, then temperatures should be adjusted downward, based on station aridity. Differences in air temperature between arid and irrigated areas measured during this study were similar to values reported in previous research (4,7). It is recommended that local studies concerning the effects of station site aridity on measured air temperature be conducted for specific climatic regions in arid areas before application of temperature-based consumptive use methods. These studies can evaluate the effects of precipitation and solar radiation patterns and regional wind and humidity on differences in air temperature between irrigated and nonirrigated sites.

Secondary data, most notably wind and relative humidity, if used with the FAO-BC, should be measured at an irrigated site in the midst of an irrigated region.

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