Historical Reference ET for Northern Colorado Front Range

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Background

The Northern Colorado Water Conservancy District (District) maintains a network of weather stations throughout its service area to provide calculated reference evapotranspiration data to water users. The evapotranspiration (ET) data can be used to facilitate irrigation management for agricultural production as well as maintaining urban landscapes. Historical data is useful in planning water requirements, but it will not accurately reflect daily changes that could be significantly different than the average for a particular date.

Process

Data was used from 7 weather stations owned and operated by the District. Each station uses quality instruments to measure solar radiation, wind speed, temperature, relative humidity and rainfall. The stations are sited, as best as possible, in "reference" locations, meaning that they are in open areas surrounded by large areas of irrigated fetch either in alfalfa fields or turfgrass plots. The sites selected are located in Fort Collins, Loveland, Longmont, Gilcrest, Johnson's Corner, Greeley and Eaton. The data used to calculate the historical average covered the years of 1995 through 2006 for the growing season of April 1 to October 31. For the years 1995-1997 the 1982 Kimberly-Penman equation was used to calculate alfalfa reference evapotranspiration or ET_R and a .80 factor was used to convert to ET_O grass reference. For the years 1998-2006 the ASCE Standardized Penman-Monteith equation was used to calculate grass reference for a well-irrigated and maintained cool season grass that is 12 cm (@ 5 inches) tall. Cool season grasses include Kentucky bluegrass, tall fescue and perennial ryegrass that are all commonly used in most urban lawns.

Results

The average of the ten years used to calculate historical reference evapotranspiration or ET rates for cool season grass (ET_O) are shown in the following table along with historical rainfall.

Inches of Historical ET_O and Rainfall for the Front Range of Northern Colorado

	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
ET_O	4.14	5.11	6.13	6.69	5.57	4.09	2.80	34.53
Rain	1.82	2.03	1.64	1.24	1.22	1.17	.92	10.04

The years of 1995, 1997 and 1999 had significantly higher rainfall while the years of 2000, 2002 and 2006 were considerably less than the historical average. See Figure 1 for a comparison of the calculated evapotranspiration and rainfall for the Front Range of Northern Colorado for the twelve-year period. Figure 2 shows the monthly historical evapotranspiration rates with percentages of the peak demand month of July that could be used for programming irrigation controllers.

Figure 1.

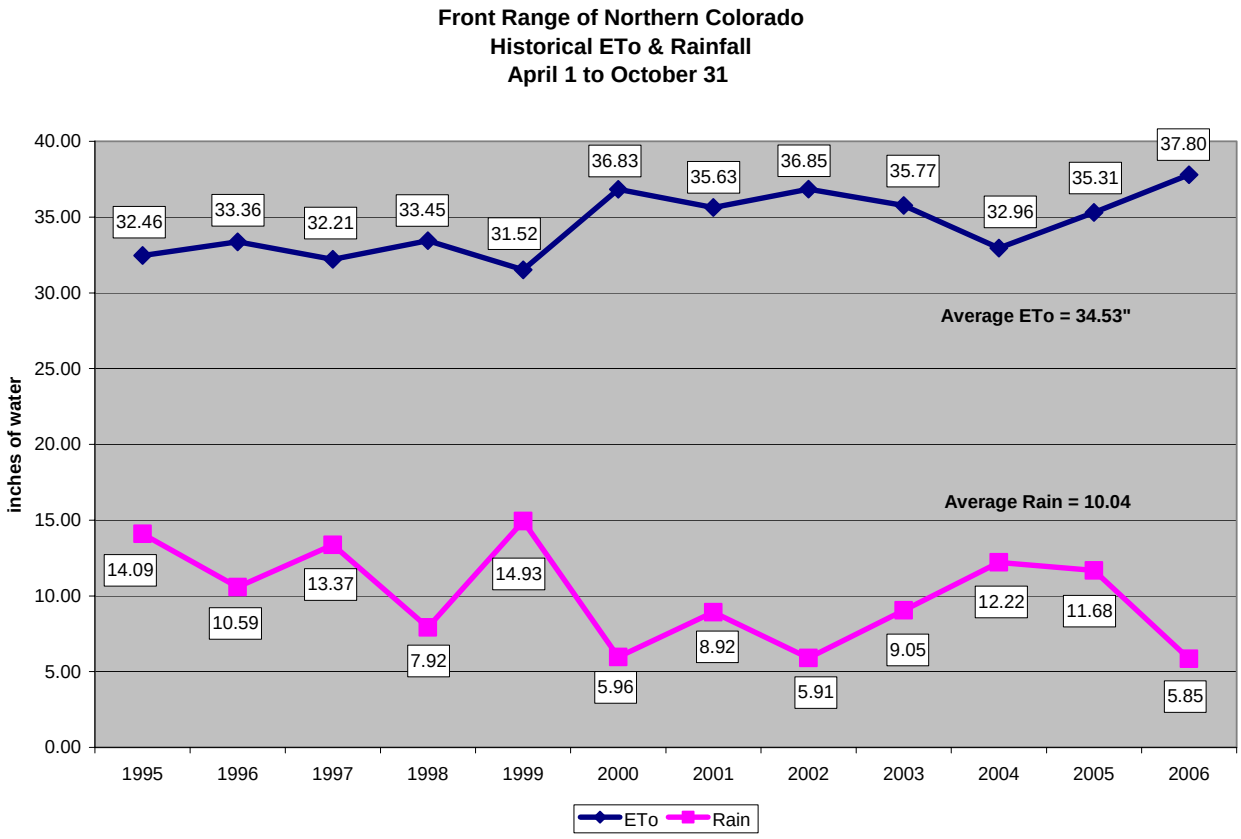
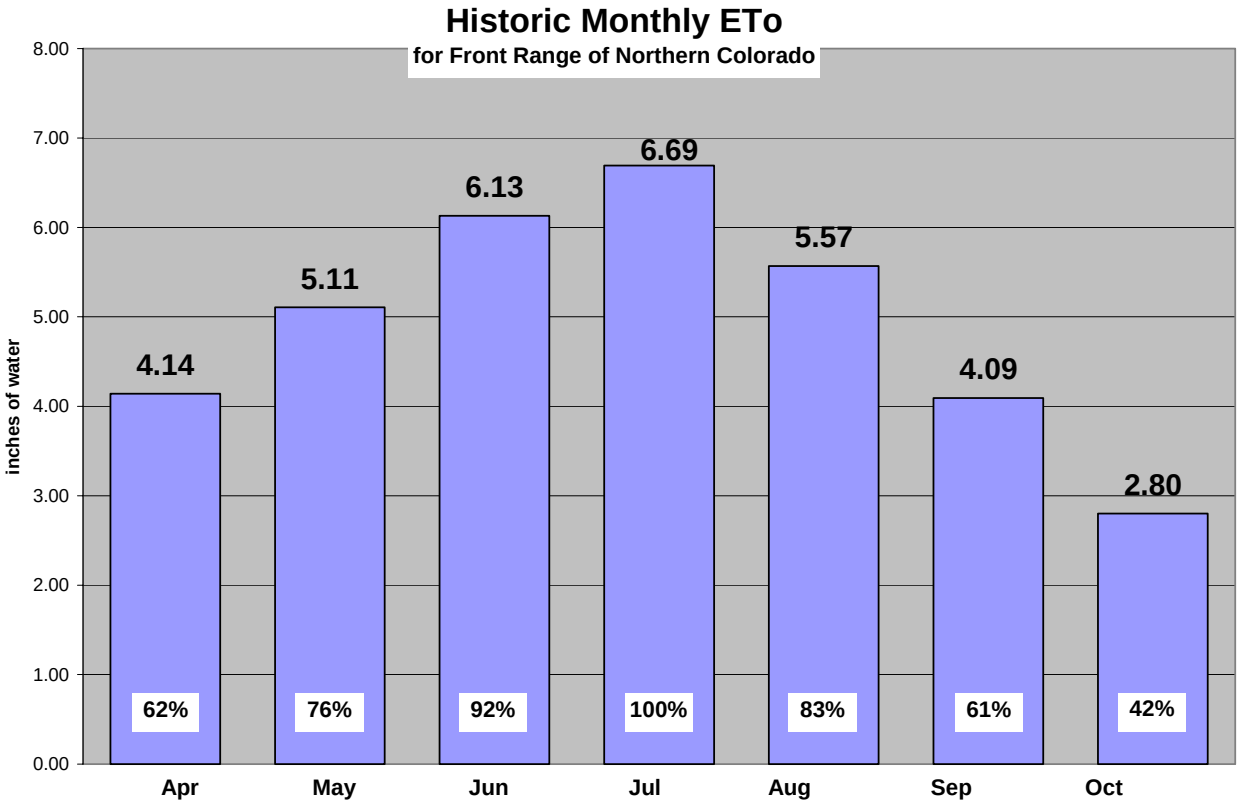


Figure 2.



Application of Information

The historical ET_O can be used for planning purposes by engineers, planners, developers, municipalities and landscape water mangers to determine the amount of water a typical landscape would require during the growing season.

Not all landscapes have the need for an equal amount of water. What the landscape is used for or the required aesthetics will also impact the amount of water required to maintain the landscape for the intended purposes. Correctly determining the amount of water required by the landscape is the one of the steps in irrigation management and is necessary to create irrigation schedules.

When creating irrigation schedules, the ET_O should be modified to more closely approximate the amount of water required to meet the plant's actual water requirement. A turfgrass lawn that is mowed at 2-3 inches in height compared to the reference height that is nearly 5 inches tall will require less water. A common method to modify the calculated water requirement is to apply a crop coefficient to the reference ET. The crop coefficient can also take into consideration the quality of the lawn to meet the needs for which it was planted. The following tables show the amount of additional water to be applied via irrigation for a Kentucky bluegrass lawn area that is used in different situations and has different quality requirements. The amount of water to be applied is expressed in inches as well as gallons per square foot to facilitate the creation of landscape water budgets.

Because sprinkler systems are unable to evenly distribute the water to the landscape, additional water is required to compensate for the lack of uniformity. The distribution uniformity (DU) of a sprinkler system can be measured using catch cans. Experience shows that a system with an acceptable DU of 70% will require about 20% more water to compensate for the lack of uniformity within the turf area. It should be noted that many sprinkler systems have distribution uniformity less than 70% and would require even more water to apply sufficient water to the dry areas. They should be fixed, modified or upgraded to improve their performance in delivering water more evenly and thus reducing water demand caused by dry spots.

Key to Tables:

ET_o = Historical Grass Reference evapotranspiration for the growing season of April 1 to October 31

K_c = Crop coefficient for cool season turfgrass mowed at 2.0 to 3.0 inches and depending upon the various uses of the lawn

ET_{lawn} = Water requirement for the lawn $ET_O \times K_C$

Rain = Historical rainfall

Eff. Rain = Effective rainfall 100% for April, 50% all other months

Water Need = ET_{lawn} - Effective Rainfall

I. E. = Irrigation efficiency which includes sprinkler system performance and management capability

IWR = Irrigation Water Requirement in inches. IWR = Water Need / I.E.

1. **High Performance Lawn** describes a lawn that is heavily used such as sports fields or high-use parks or requires a very high aesthetic appearance because of surrounding uses.
2. **Traditional Lawn** describes the type of lawn found in most residential neighborhoods, parks, businesses, shopping centers etc. where foot traffic and uses are not excessive.
3. **Low Maintenance Lawn** describes a lawn that is seldom used for activities but is used to cover the ground to control erosion, or weed infestation or serve as a firebreak. Traffic medians, greenbelts, detention ponds or even home lawns could be in this category. Typically these lawns require less mowing and fertilizer as well as less water.

Inches of water per month for

High-Performance Lawn

	Apr	May	Jun	Jul	Aug	Sep	Oct	Year Total
ET_O	4.14	5.11	6.13	6.69	5.57	4.09	2.80	34.53
K_c	.90	.90	.90	.90	.90	.90	.90	
ET_{lawn}	**3.73**	**4.60**	**5.52**	**6.02**	**5.01**	**3.68**	**2.52**	**31.08**
Rain	1.82	2.03	1.64	1.24	1.22	1.17	.92	10.04
Eff. Rain	1.82	1.02	.82	.62	.61	.59	.46	5.94
Water Need	**1.91**	**3.58**	**4.70**	**5.40**	**4.40**	**3.09**	**2.06**	**25.14**
I.E.	.80	.80	.80	.80	.80	.80	.80	
IWR	2.39	4.48	5.88	6.75	5.50	3.86	2.58	31.44
Gal / s.f./mo.	1.5	2.8	3.7	4.2	3.4	2.4	1.6	19.6
Inches / Week	.58	1.01	1.37	1.52	1.24	.90	.58	

Inches of water per month for

Traditional Lawn

	Apr	May	Jun	Jul	Aug	Sep	Oct	Year Total
ET_O	4.14	5.11	6.13	6.69	5.57	4.09	2.80	34.53
K_c	.81	.81	.81	.81	.81	.81	.81	
ET_{lawn}	**3.35**	**4.14**	**4.96**	**5.42**	**4.51**	**3.31**	**2.27**	**27.96**
Rain	1.82	2.03	1.64	1.24	1.22	1.17	.92	10.04
Eff. Rain	1.82	1.02	.82	.62	.61	.59	.46	5.94
Water Need	**1.53**	**3.12**	**4.14**	**4.80**	**3.90**	**2.72**	**1.81**	**22.02**
I.E.	.80	.80	.80	.80	.80	.80	.80	
IWR	1.91	3.90	5.18	6.00	4.88	3.40	2.26	27.53
Gal / s.f.	1.2	2.4	3.2	3.7	3.0	2.1	1.4	17.0
Inches / Week	.45	.88	1.21	1.40	1.14	.79	.51	

Inches of water per month for

Low-Maintenance Lawn

	Apr	May	Jun	Jul	Aug	Sep	Oct	Year Total
ET_O	4.14	5.11	6.13	6.69	5.57	4.09	2.80	34.53
K_c	.72	.72	.72	.72	.72	.72	.72	
ET_{lawn}	**2.98**	**3.67**	**4.41**	**4.82**	**4.01**	**2.94**	**2.02**	**24.85**
Rain	1.82	2.03	1.64	1.24	1.22	1.17	.92	10.04
Eff. Rain	1.82	1.02	.82	.62	.61	.59	.46	5.94
Water Need	**1.16**	**2.65**	**3.59**	**4.20**	**3.40**	**2.35**	**1.56**	**18.91**
I.E.	.80	.80	.80	.80	.80	.80	.80	
IWR	1.45	3.31	4.49	5.25	4.25	2.93	1.95	23.63
Gal / s.f.	.9	2.0	2.8	3.3	2.6	1.8	1.2	14.6
Inches / week	.34	.75	1.05	1.19	.96	.68	.44	