

PRECIPITATION IN THE EDWARDS AQUIFER REGION

The Edwards Aquifer Authority (EAA) monitors precipitation throughout the region using a network of 75 real-time rain gauges. Rainfall data is used as input for watershed computer models that can provide estimates of monthly recharge to the aquifer. Collected over several years or decades, the extensive database of rainfall information can also be useful for monitoring climate trends, evaluating relationships between rainfall and aquifer levels, or for understanding how global-scale phenomena such as “El Nino” (which refers to above-average sea surface temperatures in the equatorial region of the Pacific Ocean) may affect rainfall in Central Texas.

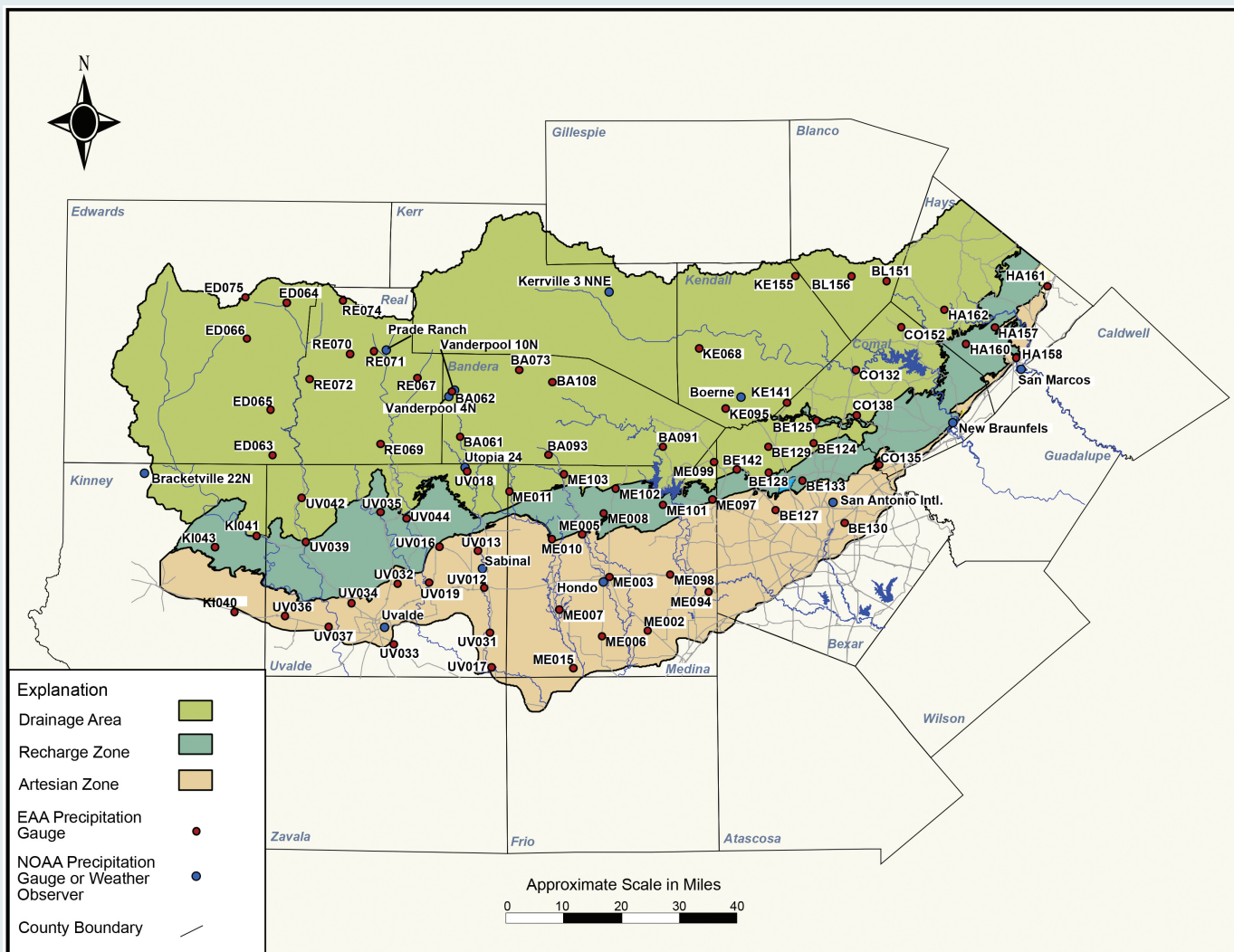


Fig. 1

The locations of the EAA rain gauges are shown in Figure 1. In general, rain gauges are not always reliable indicators of total rainfall over a region. Rainfall can vary greatly over relatively short distances and a gauge only reflects rainfall at a specific point. Additionally, gauges are susceptible to occasional malfunctions. NEXRAD (Next-Generation Radar) data from the National Weather service provides a potential solution to the limitations of individual rain gauges because it provides

continuous coverage of the entire region based on overlapping coverage from NEXRAD Doppler radar stations in Brackettville, Corpus Christi, New Braunfels, and Granger, Texas. However, NEXRAD measures reflectivity of precipitation near ground level and not the actual amount of precipitation as measured by rain gauges. For this reason, EAA takes a two-step approach to rainfall data by using the operational rain-gauge data as a “ground-truth” to calibrate the NWS NEXRAD data. The resulting product is a dataset of hourly rainfall totals for a grid of 16-km² pixels over the entire region of interest that extends back to January 1, 2003.

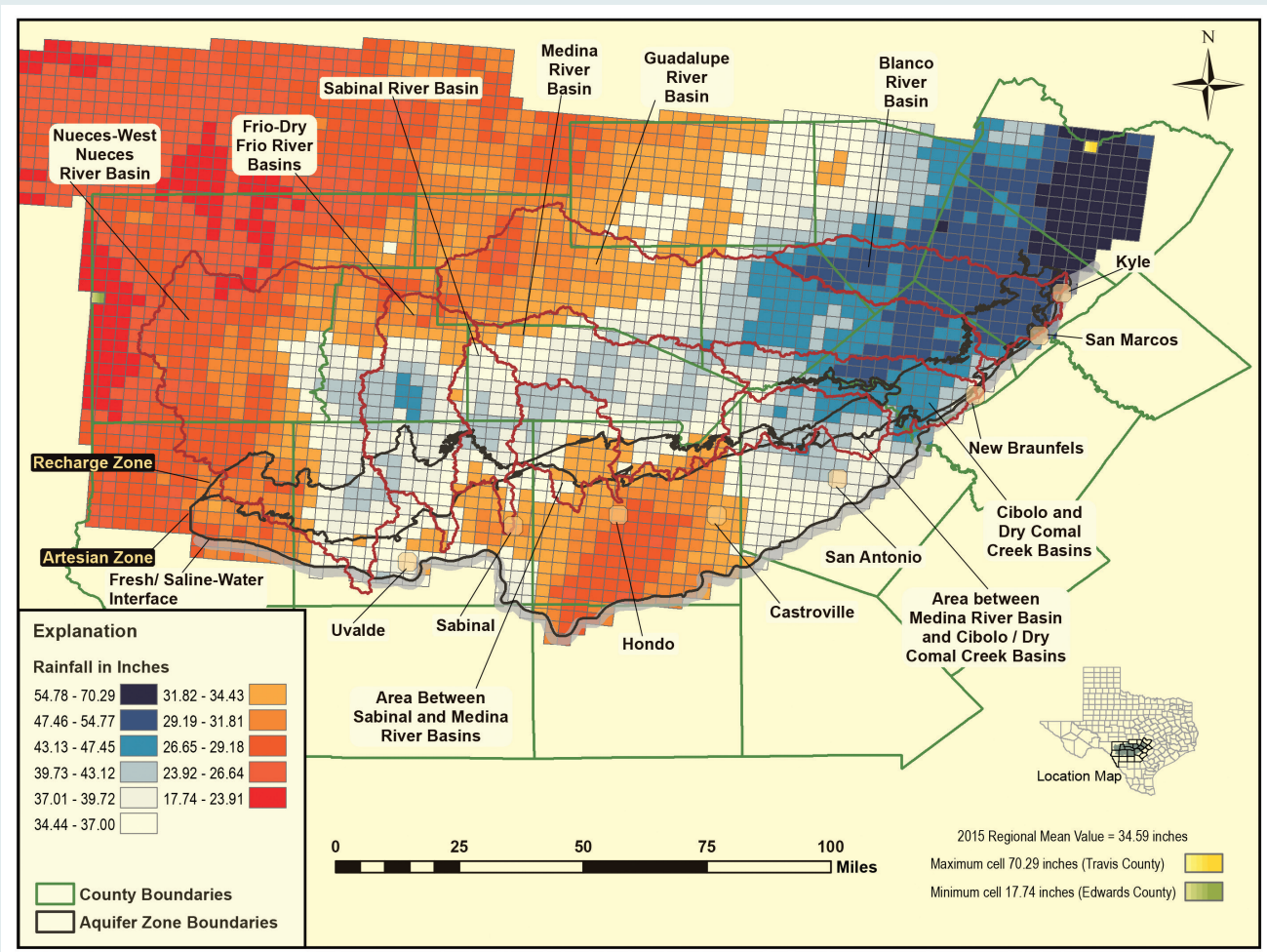


Fig. 2

Figure 2 shows the calibrated NEXRAD coverage area with a color map indicating total 2015 rainfall for each 16-km² pixel. The high degree of spatial variability in rainfall totals can be seen, with the highest rainfall total of 70.3 inches in Travis County at the northeast edge of the coverage area and the lowest total of 17.7 inches in Edwards county on the western edge of the coverage area. Figure 2 also shows delineations of the nine watershed catchment areas that contain streams that cross the Edwards Aquifer recharge zone.

The rainfall over these watersheds is of particular interest because their catchment areas convey water to the Edwards Aquifer recharge zone and the data can be used as input to the EAA's HSPF (Hydrologic Simulation Program—Fortran) models as one method to estimate recharge. Table 1 provides the 2015 area-averaged rainfall total for each of the nine watersheds obtained from the calibrated NEXRAD data. Figures 3 through 12 illustrate the distribution in time of rainfall for each watershed area. It can be seen that the month of May provided much of the cumulative rainfall throughout the region, followed by dry summer months and relatively wet conditions from late October through December.

2015 RAINFALL TOTALS FOR NINE DELINEATED CONTRIBUTING ZONE WATERSHEDS	
GAUGE	2015 AREA AVERAGE RAINFALL (INCHES)
Nueces–West Nueces River Basins	31.2
Frio–Dry Frio River Basins	37.1
Sabinal River Basin	36.9
Area Between Sabinal and Medina River Basins	36.2
Medina River Basin	37.2
Area Between Medina and Cibolo River Basins	40.4
Cibolo and Dry Comal Creek Basins	43.6
Guadalupe River Basin	37.7
Blanco River Basin	48.8

Table 1

2015 DAILY AND CUMULATIVE RAINFALL FOR THE WATERSHED AREA OF NUECES AND WEST NUECES RIVER BASINS

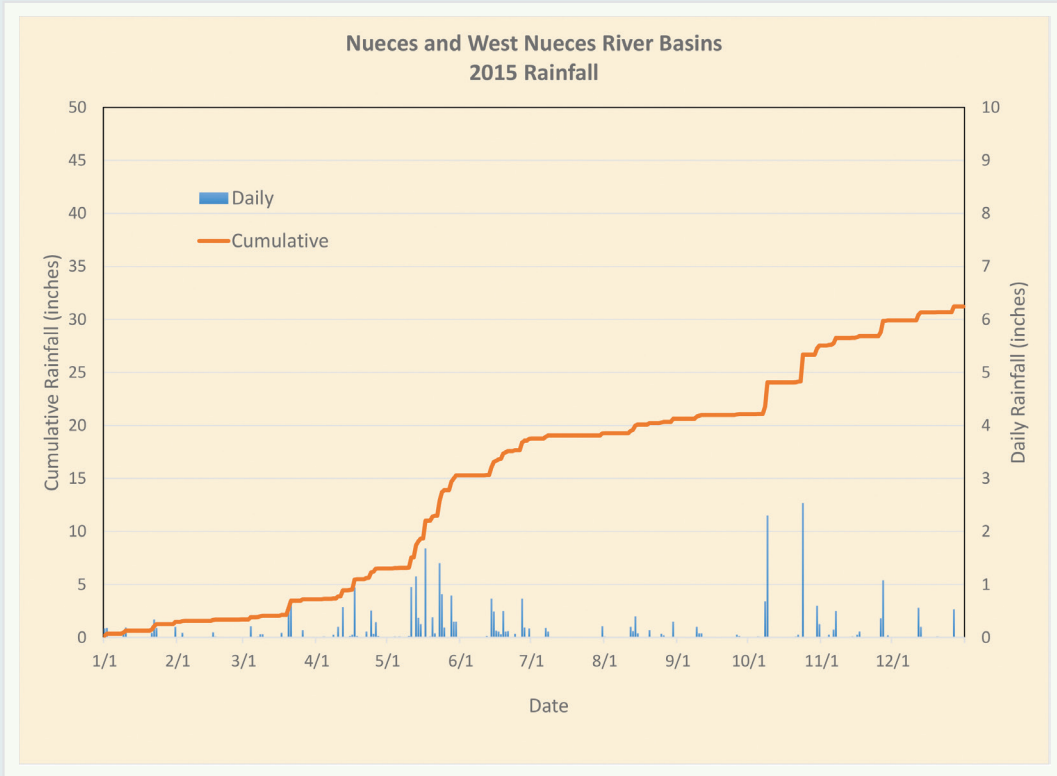


Fig. 3

2015 DAILY AND CUMULATIVE RAINFALL FOR THE WATERSHED AREA OF FRIO AND DRY FRIO RIVER BASINS

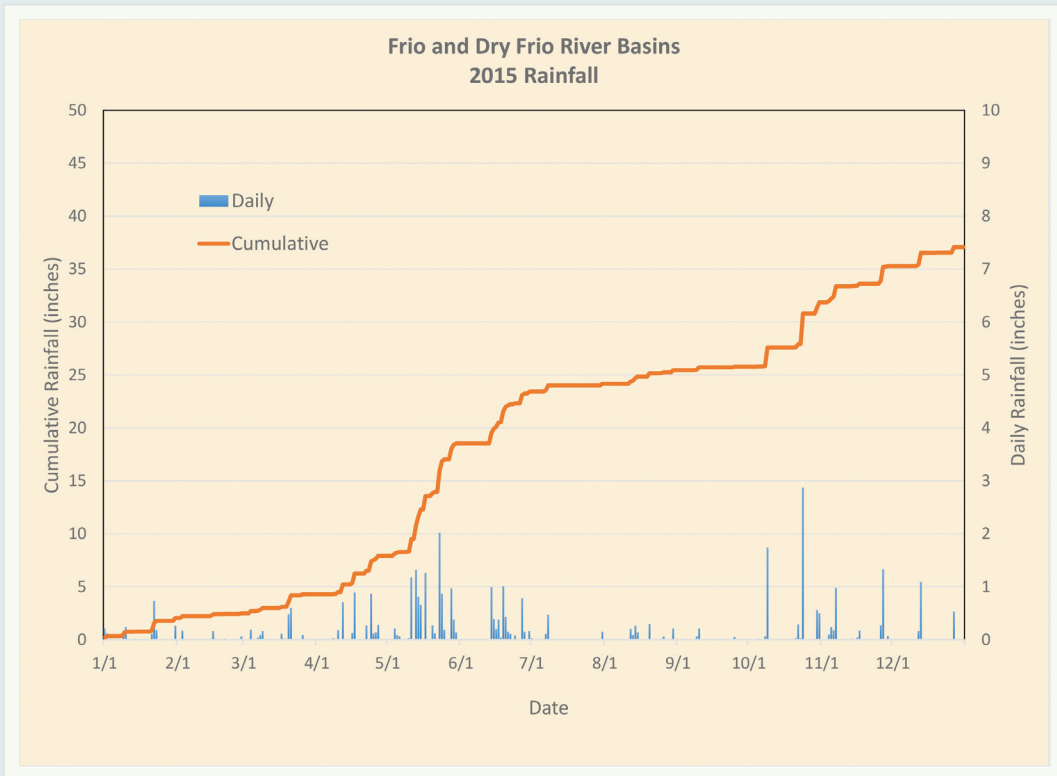


Fig. 4



2015 Daily and Cumulative Rainfall for the Watershed Area of Sabinal River Basin

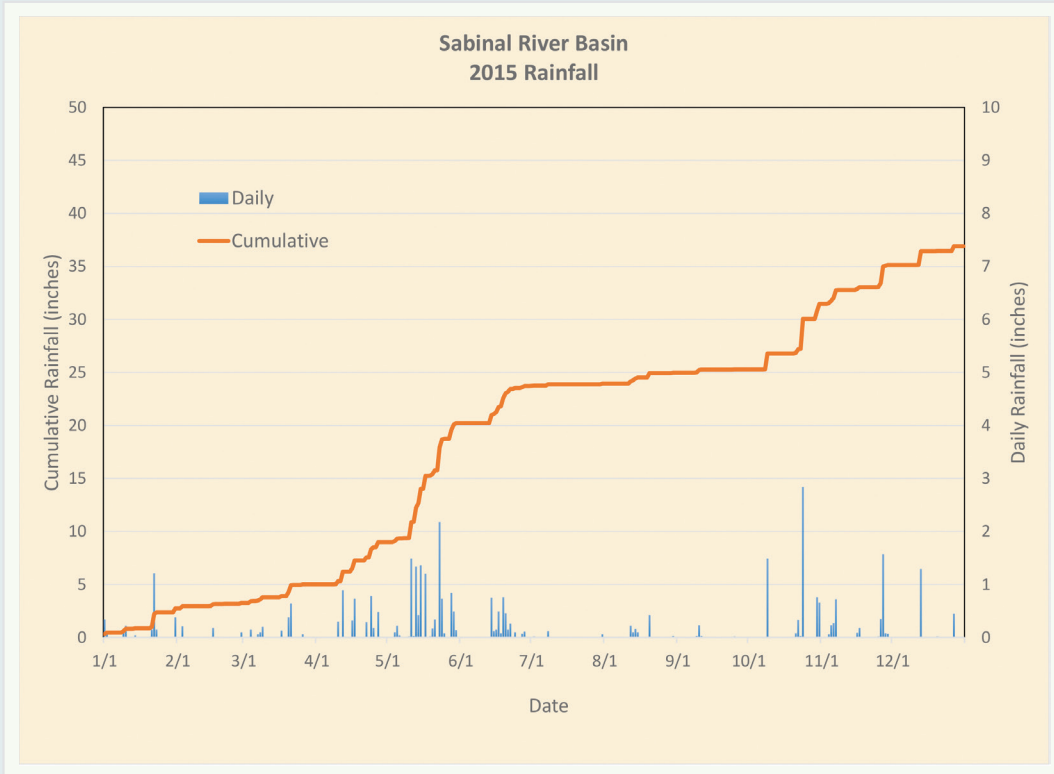


Fig. 5

2015 Daily and Cumulative Rainfall for the Watershed Area Between Sabinal and Medina River Basins

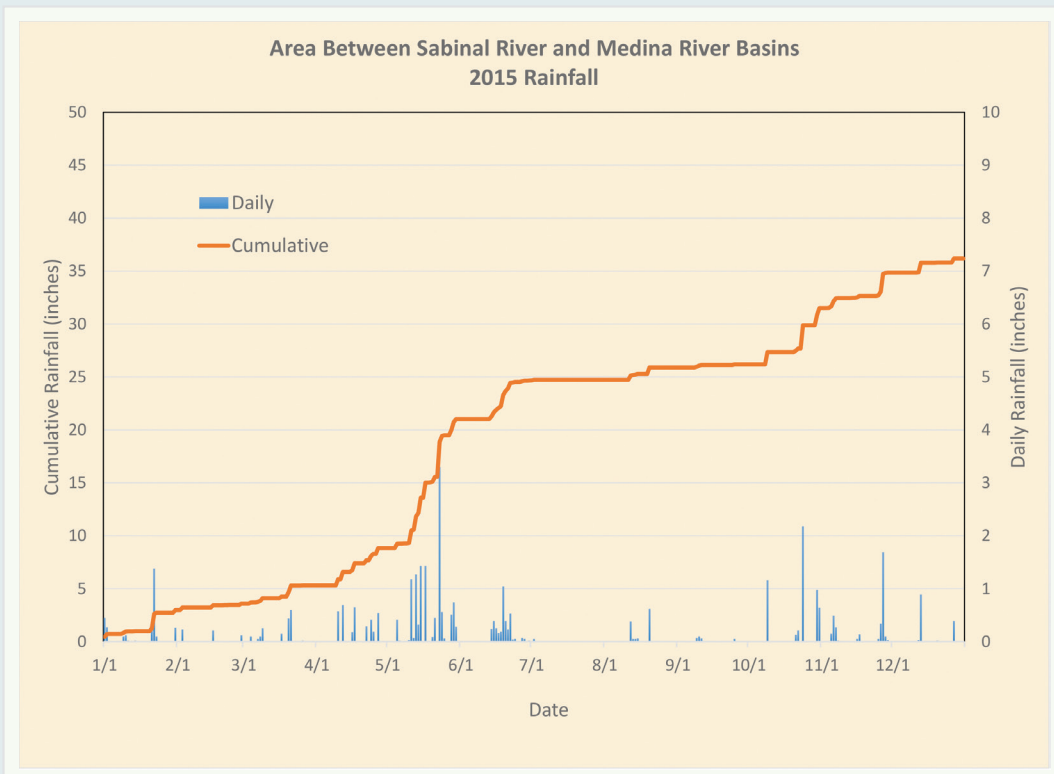


Fig. 6



2015 Daily and Cumulative Rainfall for the Watershed Area of Medina River Basin

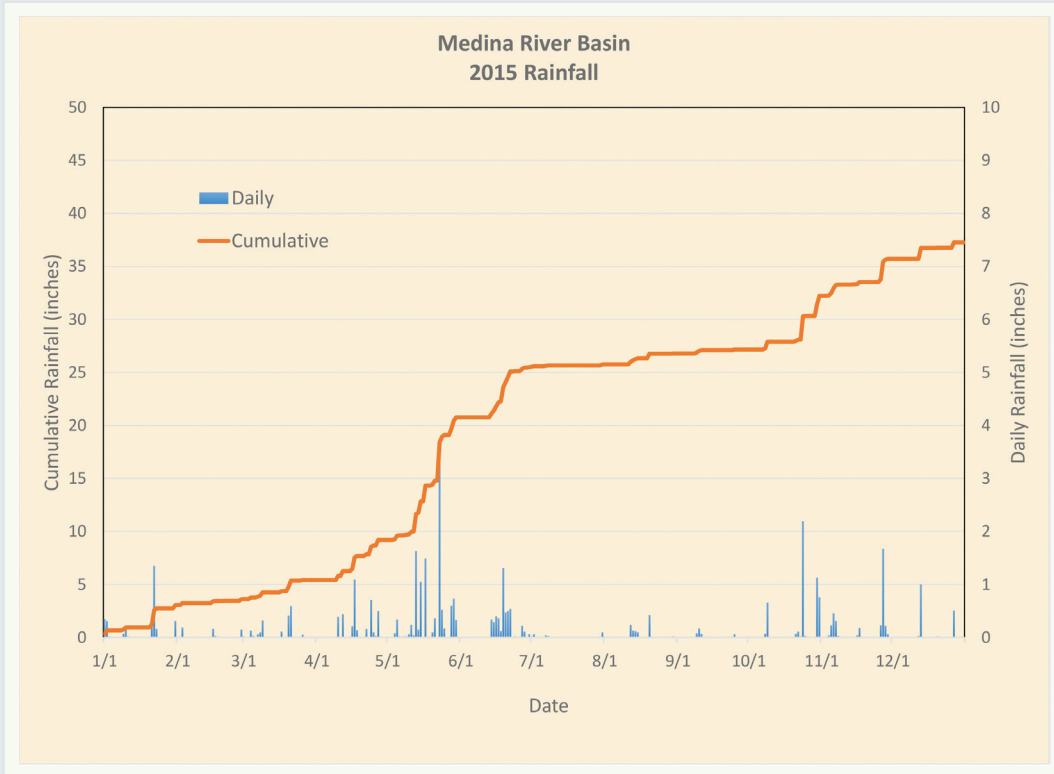


Fig. 7

2015 Daily and Cumulative Rainfall for the Watershed Area Between Medina River and Cibolo Creek Basins

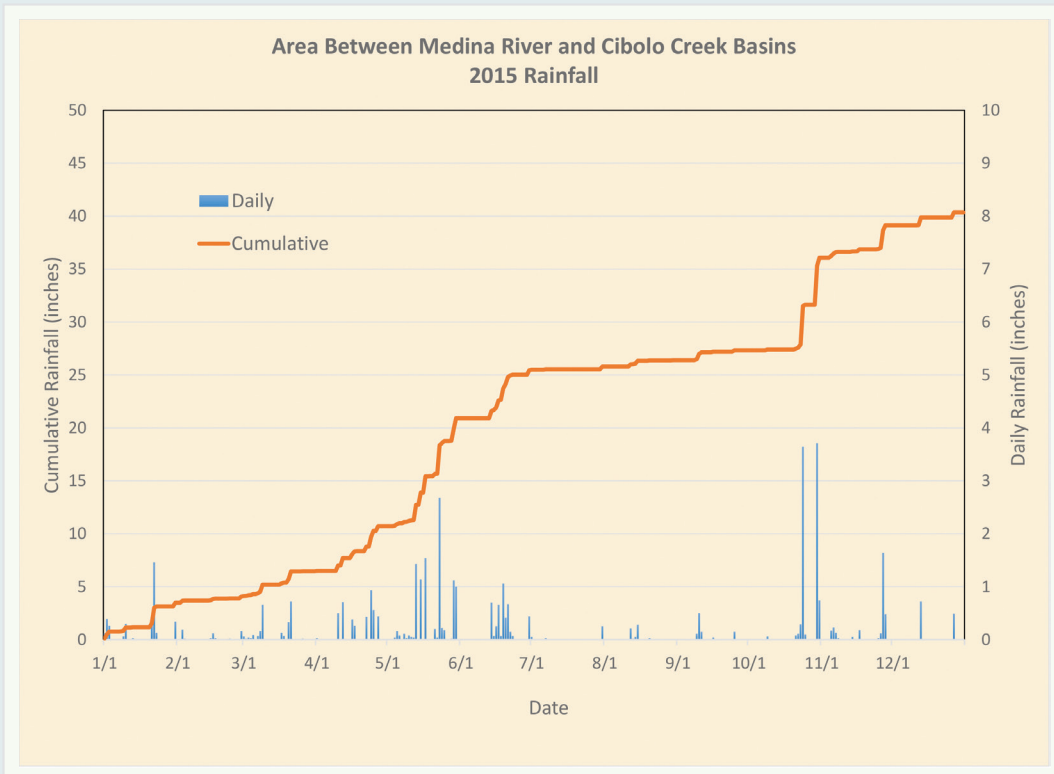


Fig. 8



2015 Daily and Cumulative Rainfall for the Watershed Area of Cibolo Creek and Dry Comal Creek Basins

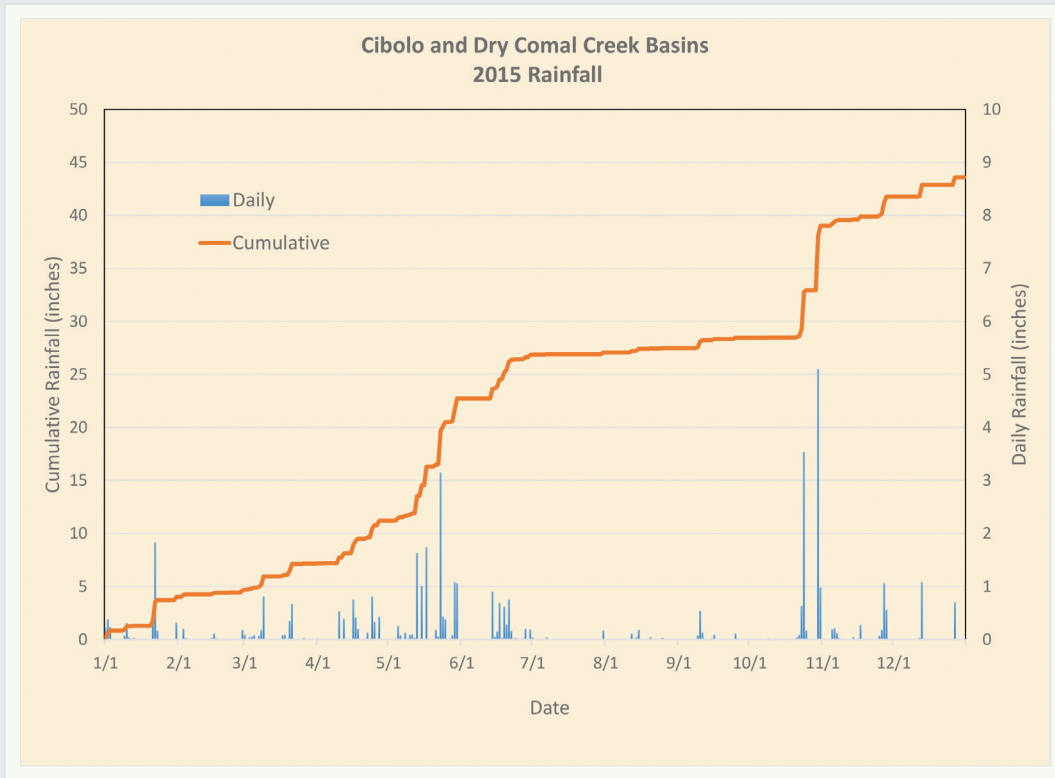


Fig. 9

2015 Daily and Cumulative Rainfall for the Watershed Area of Guadalupe River Basin

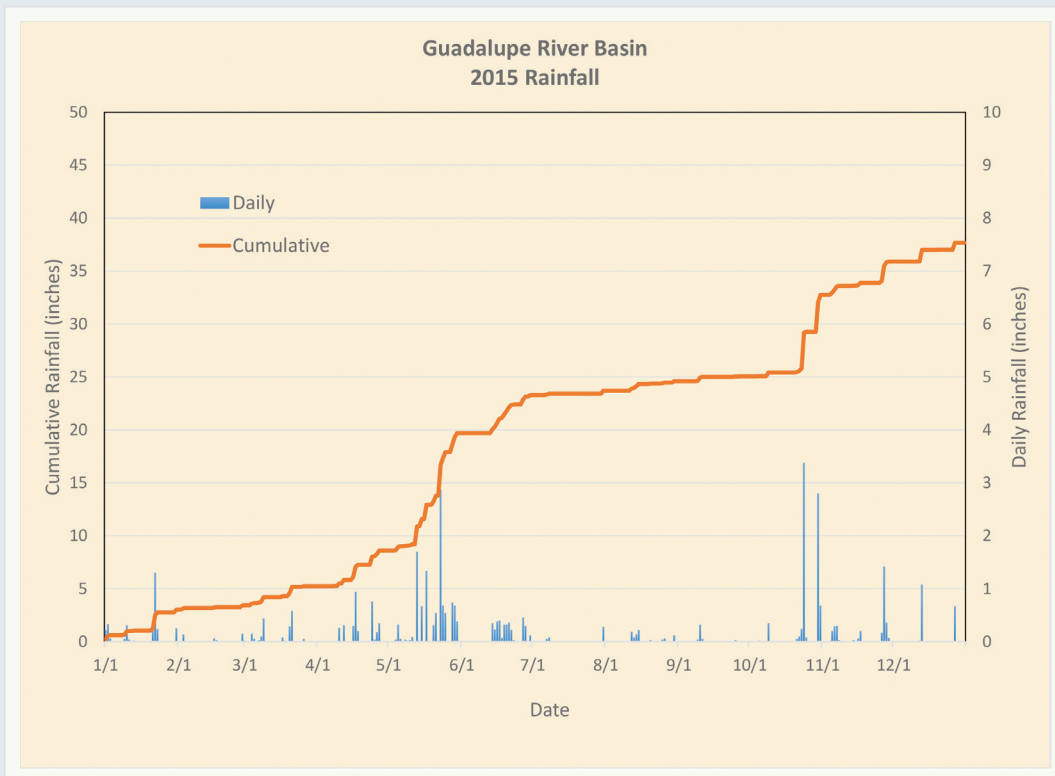


Fig. 10

2015 Daily and Cumulative Rainfall for the Watershed Area of Blanco River Basin

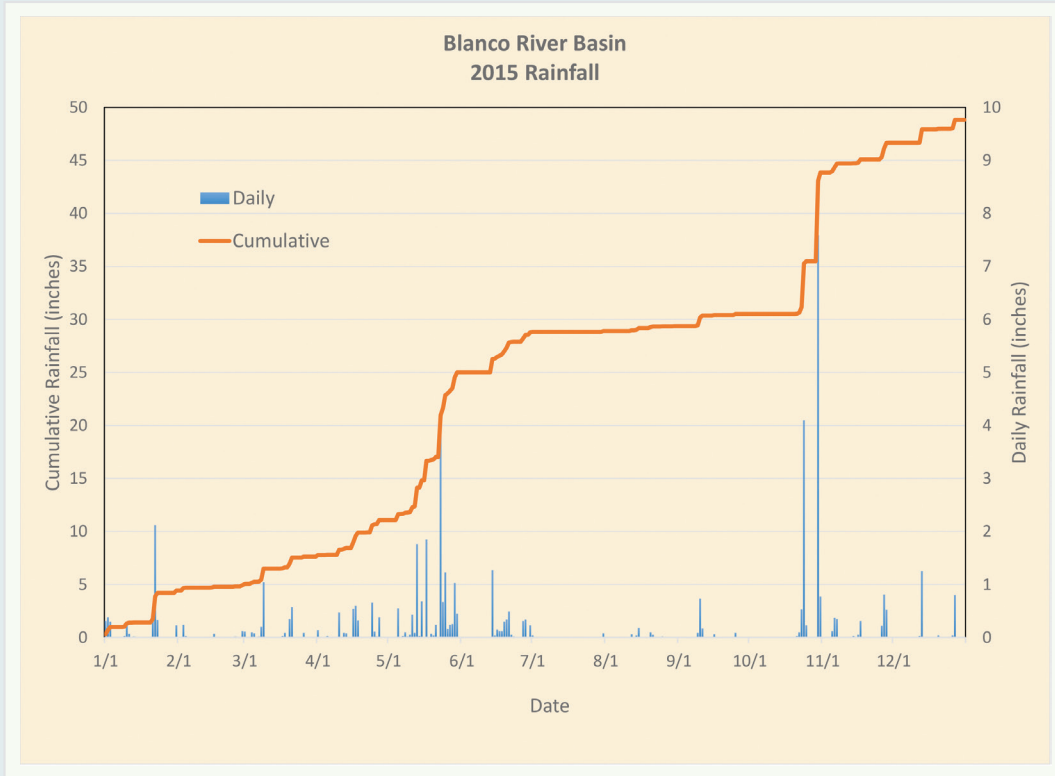


Fig. 11

Because the timeframe covered by EAA's calibrated NEXRAD rainfall data does not begin until year 2003, it is not yet suited for evaluating long term historical trends in annual rainfall. For this type of analysis, we rely on data at individual rain gauges that have been in place for many decades. Table 2 shows how the 2015 annual rainfall for several selected gauges across the region compares to the long-term average rainfall. It can be seen that above-average rainfall was observed at all of these locations in 2015.

2015 DEVIATION FROM MEAN RAINFALL VALUES

GAUGE	COUNTY	LONG-TERM AVERAGE	2015 TOTAL	DEVIATION FROM AVERAGE
San Antonio Intl. Airport	Bexar	30.49	42.22	11.37
New Braunfels	Comal	32.88	43.45	10.57
San Marcos	Hays	34.08	52.29	18.21
Hondo*	Medina	28.62	32.90*	4.28*
Sabinal	Uvalde	24.02	41.62	17.60
Boerne	Kendall	34.14	50.09	15.95
Brackettville	Kinney	21.73	26.20	4.47

Table 2

* Incomplete data set, actual totals may be greater. (Rainfall amounts shown in inches)

Table 3 lists the annual rainfall totals for these gauges going back to 1934. These rainfall records indicate how variable rainfall can be at a particular location from year to year. For example, the lowest annual rainfall total observed at San Antonio Airport rain gauge was 13.7 inches in 1954, while the highest was 52.3 inches in 1973. Although these records show extended periods of above-average or below-average rainfall, there does not appear to be any significant trend of increasing or decreasing annual rainfall totals in the region over the long term.

The long-term records for these rain gauges and many other weather stations throughout the region can be obtained online from the National Centers for Environmental Information (formerly the National Climatic Data Center) at <http://www.ncdc.noaa.gov/cdo-web/search>. Data from the EAA's rain gauge network or calibrated NEXRAD database may be obtained from EAA upon request.

**1934–2015 Annual Precipitation for Selected Rain Gauges
in the Edwards Aquifer Region (in inches)**

YEAR	BRACKETTVILLE	UVALDE	SABINAL	HONDO	SA	BOERNE	NB	SM
1934	---	16.70	18.07	23.97	27.65	26.78	30.80	35.67
1935	---	41.17	48.21	58.73	42.93	52.93	41.67	41.09
1936	22.34	24.53	26.53	35.27	34.11	47.59	30.41	33.48
1937	16.85	17.88	9.57a	22.93	26.07	32.81	29.19	26.03a
1938	19.97	13.12	15.39	27.56	23.26	24.14	28.32	28.17
1939	18.38	25.30	13.98 b	23.14	18.83	26.20	13.35	18.59
1940	22.43	27.66	27.51	28.13	30.79	32.29	38.11	43.57
1941	21.52	31.79	33.74a	44.07	26.34	41.60	42.99	48.41
1942	21.01	19.01	11.37a	34.83	38.46	31.12	42.08	44.65
1943	23.39b	20.63	17.21	31.43	20.51	26.33	29.93	25.45
1944	24.76	32.76	27.62a	32.46	33.19	42.98	43.14	47.42
1945	15.69	22.37	26.60	29.57	30.46	33.50	39.38	31.74b
1946	19.10	26.41	14.16a	29.65	45.17	45.62	61.60	52.24
1947	22.92b	22.67	---	18.98	17.32	21.89	27.52	27.53
1948	20.02a	18.31	---	28.82	23.64	23.77	19.88b	21.27a
1949	31.32	34.41	---	39.90	40.81	41.15	43.21	36.22
1950	17.70	18.27	15.28a	24.91	19.86	24.94	21.13	21.10
1951	14.71	16.07	15.63	24.05a	24.44	18.76	24.84	30.88
1952	12.26	18.24	23.16	25.56	26.24	37.54	33.87	39.91
1953	10.12	18.34	21.44	20.61	17.56	21.42	30.06	33.39
1954	19.38	15.60	14.72	11.92	13.70	10.29	10.12	13.42
1955	26.55	18.36	20.87	21.21	18.18	19.27	23.12	26.44
1956	7.58	9.29	11.29	15.54	14.31	12.05	18.41	18.37
1957	34.21	39.30	40.03	35.09	48.83	52.55	51.88	46.51
1958	45.37	39.03	41.18	41.60	39.69	40.94	36.40	39.08
1959	27.51	31.51	27.02	30.68	24.50	35.64	40.45	43.47
1960	19.12	23.98	26.24	32.37	29.76	32.55	34.28	45.48
1961	17.91	26.26	27.24	27.36	26.47	25.45	15.70a	30.02
1962	10.87	14.12	13.58	17.85	23.90	25.26	27.40	28.47
1963	15.07	16.70	18.99	18.90	18.65	20.66	23.41	19.90

Table 3

[Cont.]

**1934–2015 Annual Precipitation for Selected Rain Gauges
in the Edwards Aquifer Region (in inches)**

YEAR	BRACKETTVILLE	UVALDE	SABINAL	HONDO	SA	BOERNE	NB	SM
1964	20.75	22.30	23.78	28.29	31.88	27.36	30.65	30.27
1965	21.48	26.21	29.41	30.80	36.65	42.41	45.16	45.00
1966	21.63	20.87	21.54	29.46	21.44	29.05	25.98	27.12
1967	21.95	20.10	23.89	30.33	29.26	26.75	31.74	26.41
1968	17.26	25.20	29.88b	31.91	30.40	35.14	35.97	37.13
1969	28.53	33.38	33.05	32.30	31.42	38.07	33.01	36.59
1970	16.50	13.59	22.13	30.96	22.74	27.79	35.23	32.30
1971	29.46	31.01	31.00	32.96	31.80	45.24	29.43	31.10
1972	21.21	15.49	21.10	25.43	31.49	35.09	42.02	31.90
1973	30.61	30.85	35.14b	47.82	52.28	50.93	51.66	47.91
1974	18.25	30.94	20.93b	36.41b	37.00	41.80	42.85	37.28a
1975	26.62	24.92	23.65	25.84a	25.67	33.49	35.82	48.64
1976	34.40	46.04	40.82	45.21	39.13	45.24	49.06	47.46
1977	15.06	19.90	17.06	19.40	29.64	32.43	24.83	29.69
1978	19.04	18.48	21.28	24.64	35.99	35.17	36.35b	33.08
1979	16.34	32.35	31.44	28.83	36.64	39.97	36.72	38.74
1980	18.33	23.05	22.67	21.27	24.23	39.02	33.69	29.56
1981	28.73	26.24	30.19	27.40	36.37	41.05	43.23	49.62
1982	19.10	23.35	18.44	21.99	22.96	27.64	21.04	22.47b
1983	19.35	24.45a	23.33	20.92b	26.11	34.60	34.13	36.95
1984	16.24	15.33b	20.67	21.19a	25.95	26.97	20.90	8.26b
1985	18.93	5.76a	23.67	21.94	41.43	37.77	37.26	33.54
1986	27.44	29.86b	29.62b	36.01b	42.73	43.52	47.14	42.20
1987	39.45	36.39	38.36	40.09	37.96	39.86	37.33a	37.94
1988	12.08	15.20	13.52	9.81b	19.01	19.49	16.27b	21.50
1989	16.98	18.65	17.26	16.10	22.14	25.14	20.99	25.46
1990	38.24b	24.73	30.06	27.01	38.31	42.51	24.58a	35.14b
1991	23.11	21.77	31.12	34.55	42.76	48.22	56.55	51.07
1992	22.22	27.85a	37.73	45.34	46.49	64.17	38.84b	40.33b
1993	15.18	9.32c	13.20	16.60	32.00	24.02	19.54b	24.01b

Table 3

[Cont.]

1934–2015 Annual Precipitation for Selected Rain Gauges in the Edwards Aquifer Region (in inches)

YEAR	BRACKETTVILLE	UVALDE	SABINAL	HONDO	SA	BOERNE	NB	SM
1994	22.85a	39.61	29.32	22.38b	40.42	40.98	35.76a	40.85
1995	25.87	19.47	27.55	24.55	23.20	30.29	23.29	32.57
1996	20.32b	16.20	14.20	15.50	17.80	24.57	19.00	28.20
1997	---	27.77	35.74	37.54	33.94	---	41.65	43.56
1998	24.15	27.40b	20.66b	30.44a	42.10	45.74	52.98	58.51
1999	19.88	19.08	2.55b	16.94	16.63	18.67	21.07	19.38
2000	18.11b	23.84	22.87	32.49	35.86	46.30a	36.34b	40.56
2001	18.40	26.02	25.87	30.59	36.72	53.91	37.91	42.41
2002	---	36.79	35.75	44.70	46.27	63.20	43.60	46.16
2003	25.19c	23.39	24.86	34.70	28.45	28.55	23.42	25.74
2004	40.23	27.76	37.99	44.76	45.32	60.50	50.55	52.68
2005	25.13	16.48	20.24	28.90	16.54	25.31	21.01	22.42
2006	14.62	7.85	11.06	12.15	21.34	24.24	28.51	26.36
2007	39.93	28.89	37.55	57.58	47.25	59.00	45.40	41.59
2008	12.59	11.23	14.66	16.18	13.76	14.74	16.70	15.79
2009	14.26	16.19	20.86	25.00	30.69	32.65	28.10	33.10
2010	23.78	18.86	27.13	27.32	37.39	42.06	37.03	27.58b
2011	12.98	9.91	13.81	15.27	17.58	17.76	19.25	19.39b
2012	20.35a	13.97	18.70	25.96	39.30	29.78	35.49	34.26
2013	21.18a	22.75	22.87	19.48a	31.99	28.95	32.88	31.30
2014	18.92a	21.09	20.62	17.84a	28.20	29.00	23.17	23.84
2015	26.20 a	---	41.62	32.90 a	42.22	50.09	43.45	52.29
Y. OF RECORD	78	81	79	82	82	81	82	82
MEAN	21.76	23.06	24.02	28.62	30.49	34.14	32.88	34.08
MEDIAN	20.34	22.67	23.02	27.85	30.43	32.73	33.69	33.25

Data sources:

U.S. Department of Commerce; Uvalde data: Texas A&M AgriLIFE Extension Service.

a Partial record not included in long-term mean or median; missing one month.

b Partial record not included in long-term mean or median; missing more than one month.

c Change in gauge location from previous years.

--- No data available.

Mean and median values calculated using only years with full records.

Years with partial or missing records discarded from data set.

SA San Antonio

NB New Braunfels

SM San Marcos