Long-Term Trends of Precipitation, Streamflow, and Barton Springs Discharge, Central Texas

Barton Springs Edwards Aquifer CONSERVATION DISTRICT

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Abstract

Effective management of karst aquifers depends on an accurate understanding of the available water budget. Recent studies have shown an increase in discharge at Barton Springs since the 1960's, attributable, in part, to urbanization increasing recharge (Sharp, 2010). However, similar patterns of increasing streamflow from rivers in the area suggest a potential climatic shift since the 1960's and just after the area's drought-of-record. This poster presents an evaluation of long-term precipitation and streamflow data from stations up to 75 miles from Barton Springs and the potential influence of regional climatic changes on the water budget and springflow. Source data include monthly precipitation totals from nine National Oceanic and Atmospheric Administration weather stations and monthly average streamflow records for ten U.S. Geological Survey gaging stations. In addition, selected temperature and evaporation records were also evaluated. Long-term precipitation trends from Austin (since 1856) and San Antonio (since 1871) show conflicting trends with Austin showing no trend, while San Antonio shows a trend of increasing precipitation. Streamflow records of most perennial rivers with data from the early 1900's to present show a trend of increasing discharge, with a significant increase since the 1960's. Preliminary assessment of the data suggests that increased streamflow may have contributed to increased recharge and therefore increases in Barton Springs. Further evaluation of the precipitation data are needed to understand the potential influence on increasing streamflow trends, and thus climatic influences on the overall water budget of the aquifer.

Purpose and scope

Recent hydrologic studies show an increase in discharge from the Barton Springs segment of the Edwards Aquifer (Figure 1) from 1917 to present. Additionally, studies of historical precipitation measurements indicate that there has been an increase in precipitation across Texas (Nielsen-Gammon, 2008). In order to better understand the available water budget in the Barton Springs segment of the Edwards Aquifer, the Barton Springs/Edwards Aquifer Conservation District initiated a data compilation project to compile local precipitation, streamflow, and springflow data. Efforts focused on gathering local data from sites with measurements prior to the drought of record in the mid-1950's to present day. The purpose of this data compilation is to facilitate investigations of precipitation, streamflow, and spring discharge trends in Central Texas because these trends directly influence the available water budget.

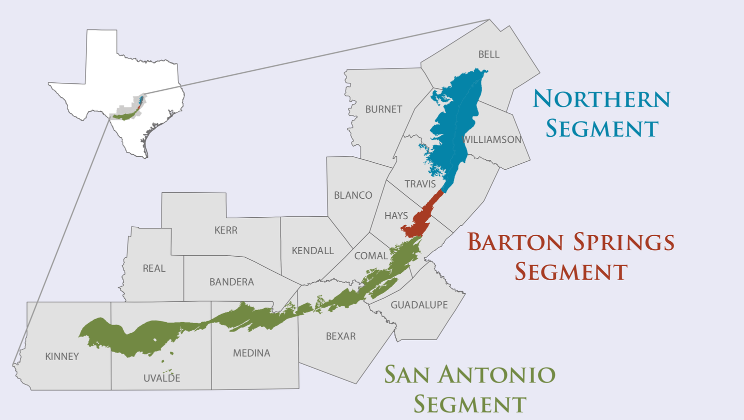


Figure 1. The three segments of the Edwards Aquifer in Central Texas, USA.

Study Area

Data were compiled for weather, streamflow, and springflow stations within a 75-mile radius of Barton Springs—the lowest point of discharge for the Barton Springs segment of the Edwards Aquifer (Figure 2). Weather stations evenly distributed around Barton Springs were selected. Streamflow measurements from sites in the Edwards Plateau were selected. Springflow measurements from springs located along the Edwards Plateau and Blackland Prairie interface were also included.

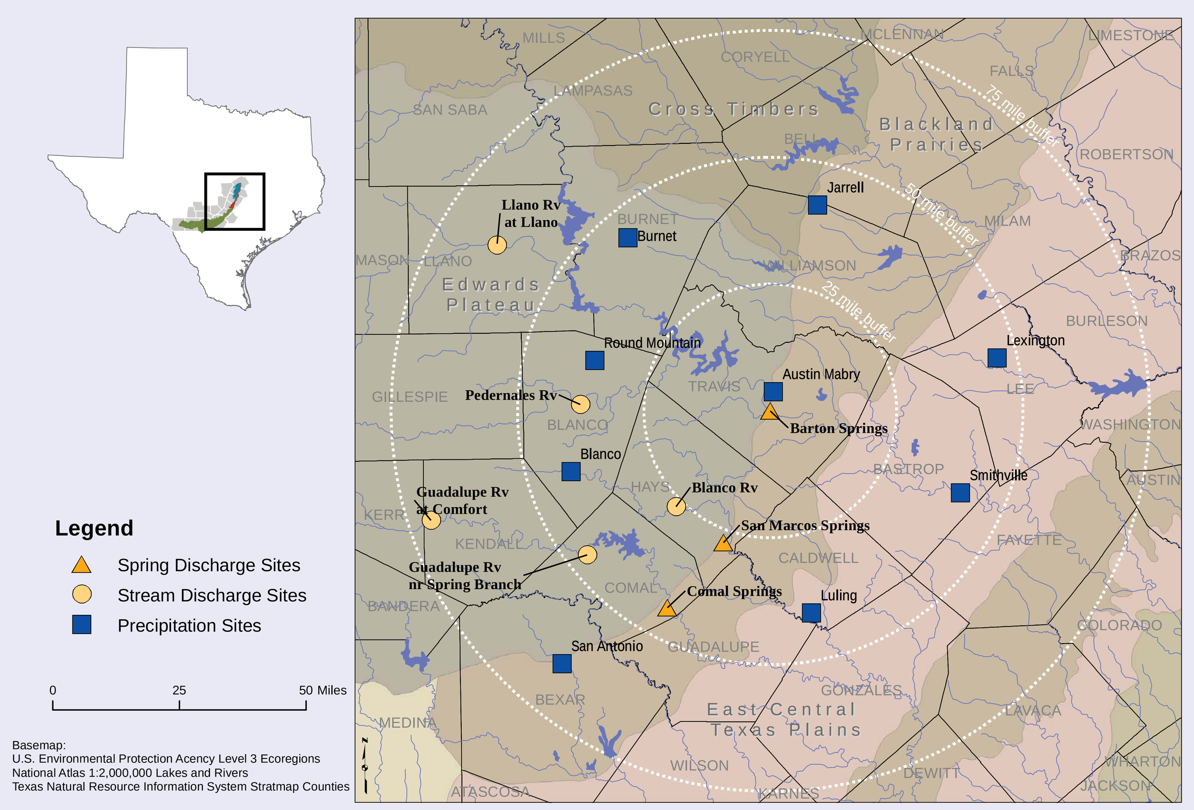


Figure 2. Location of weather, streamflow, and springflow sites in relation to Barton Springs. White dotted circles represent 25, 50, and 75 distances from Barton Springs.

Methods and Data

Total monthly precipitation data were obtained from nine National Climatic Data Center (NCDC) weather stations (Table 1, Figure 4). To provide the most complete monthly precipitation totals dataset, data gaps within the nine primary sites were identified.

- Data were analyzed and the missing records were augmented using the corresponding record from the closest available secondary site, preferably within the same isohyet boundary (Figure 3).
- When two secondary sites were equidistant from the primary site and had overlapping periods of records, the two monthly totals were averaged.
- In total, 123 monthly averages were added using the secondary sites that were closest and within the isolines.

Daily discharge data for three springflow sites and five streamflow sites were obtained from the U.S. Geological Survey National Water Information System (Table 2, Figure 5).

Data were downloaded, standardized and loaded into an MS Access database. Data-gap analysis and resolution and period-of-record queries were performed, then final data were exported to MS Excel. Yearly averages, deviation from average, and running totals were calculated within MS Excel. Precipitation and discharge statistics were graphed and best fit trend lines were calculated using Grapher.

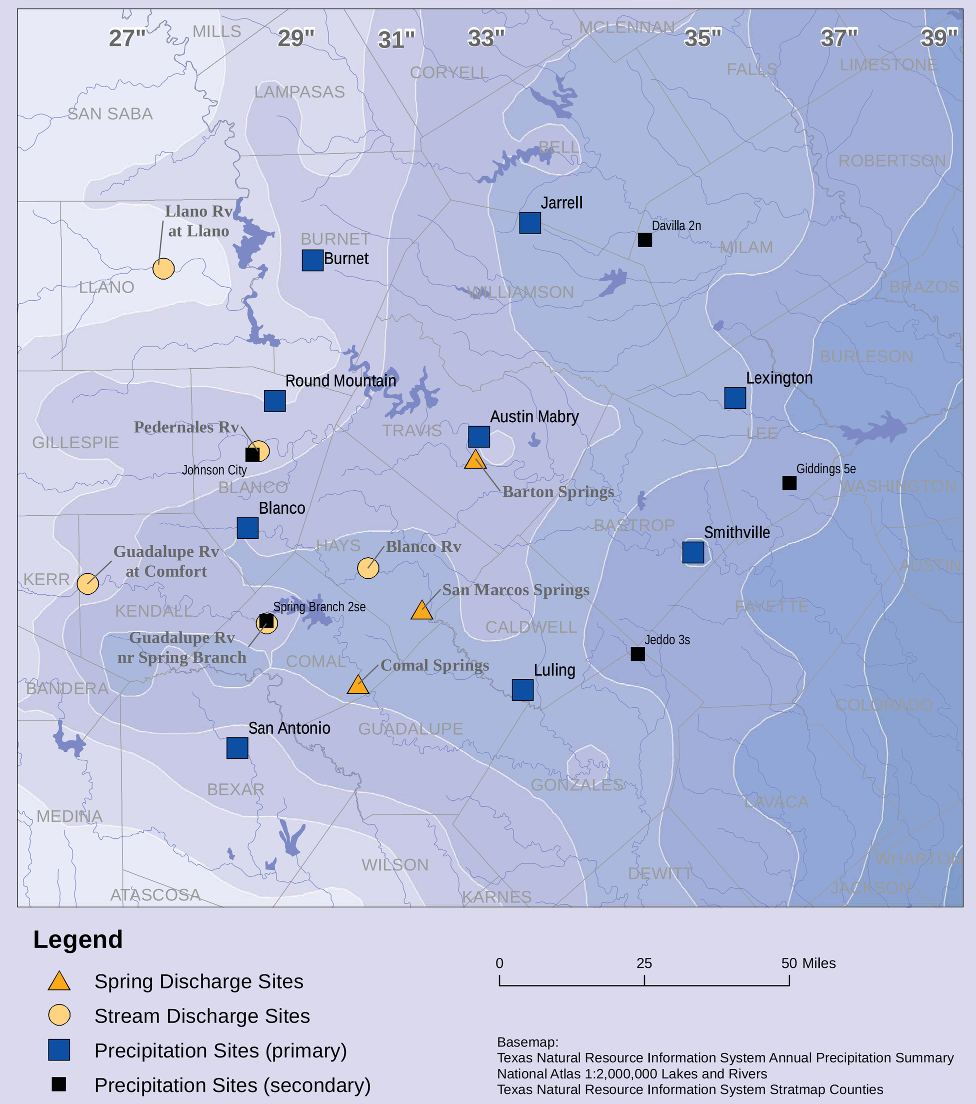


Figure 3. Map of Primary and Secondary Precipitation Sites and Streamflow Sites.

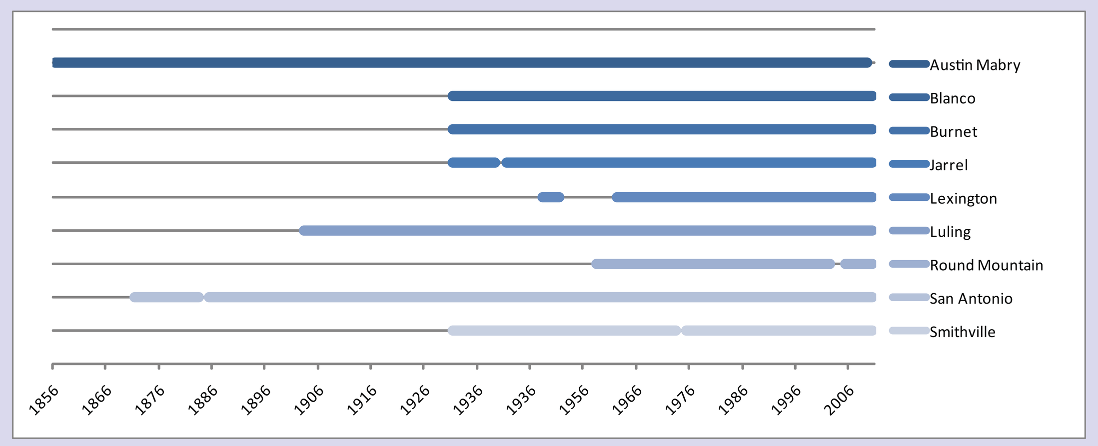


Figure 4. Precipitation Data Range Chart (augmented by secondary data).

NCDC Site ID	Station Name	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Altitude (feet)	Date Range	Years of monthly precipitation
410428	Austin Mabry	30.3182	-97.7607	647.00	1856 2008	121
410832	Blanco	30.1000	-98.4333	1379.92	1933 2009	62
411250	Burnet	30.7667	-98.2333	1285.10	1932 2010	60
414556	Jarrell	30.8500	-97.6000	850.07	1931 2010	57
415193	Lexington	30.4000	-97.0167	464.90	1949 2008	39
415429	Luling	29.6833	-97.6500	399.93	1903 2009	98
417787	Round Mountain	30.4167	-98.3500	1350.07	1958 2009	24
417945	San Antonio	29.5504	-98.4720	847.00	1872 2009	118
418415	Smithville	30.0167	-97.1500	339.89	1931 2009	65

Table 1. Inventory of National Climate Data Center (NCDC) Precipitation Sites.

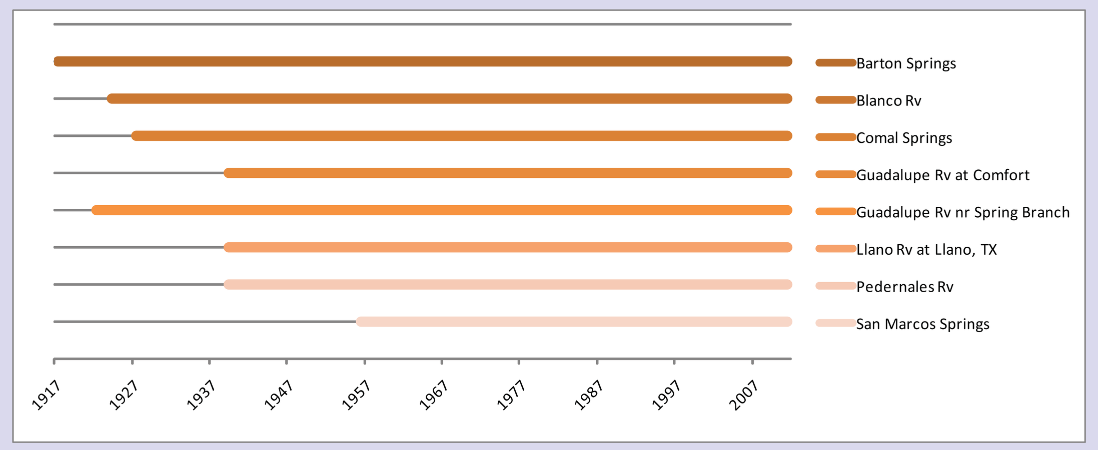


Figure 5. Streamflow and Springflow Data Range Chart.

USGS Site ID	Station Name	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Altitude (feet)	Date Range	Years of daily discharge
08155500	Barton Springs at Austin, TX	30.2635	-97.7714	462.34	1917 to 2010	94
08168710	Comal Springs at New Braunfels, TX	29.7061	-98.1225	582.80	1933 to 2010	78
08170000	San Marcos Springs at San Marcos, TX	29.8891	-97.9342	557.67	1957 to 2010	54
08171000	Blanco River at Wimberley, TX	29.9944	-98.0889	797.23	1929 to 2010	82
08167000	Guadalupe River at Comfort, TX	29.9652	-98.8972	1371.43	1940 to 2010	71
08167500	Guadalupe River near Spring Branch, TX	29.8605	-98.3836	948.10	1923 to 2010	88
08151500	Llano River at Llano, TX	30.7513	-98.6698	970.01	1940 to 2010	71
08153500	Pedernales River near Johnson City, TX	30.2919	-98.3995	1096.70	1940 to 2010	71

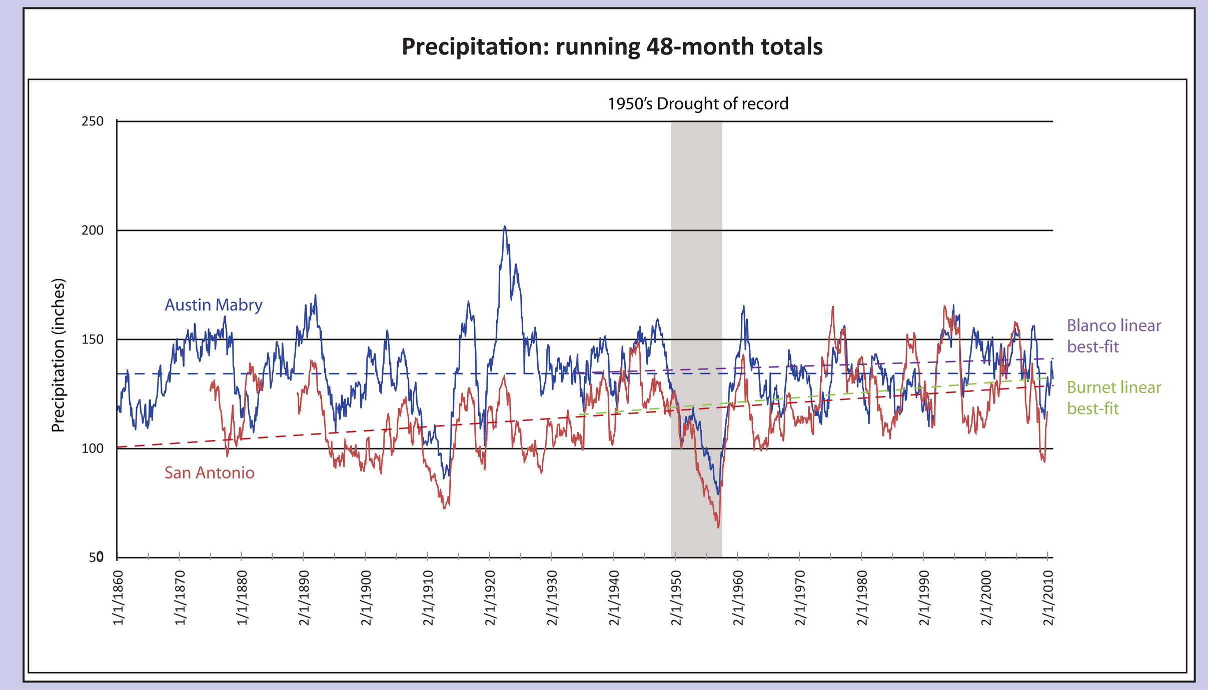
Table 2. Inventory of Streamflow and Springflow Sites.

Results and Observations

Rainfall

Despite climatic models that show Texas as "generally drying" with regard to precipitation over time, our review of Central Texas data shows a general increase in precipitation over the past 50 years, which agrees with previous state-wide assessments (Nielson-Gammon, 2008).

- Most precipitation stations in Central Texas (Burnet, Blanco etc.) show increasing precipitation trends over the last 50 years.
- The two longest periods of record (150 yrs) show a flat (Austin), or increasing (San Antonio) precipitation trend.

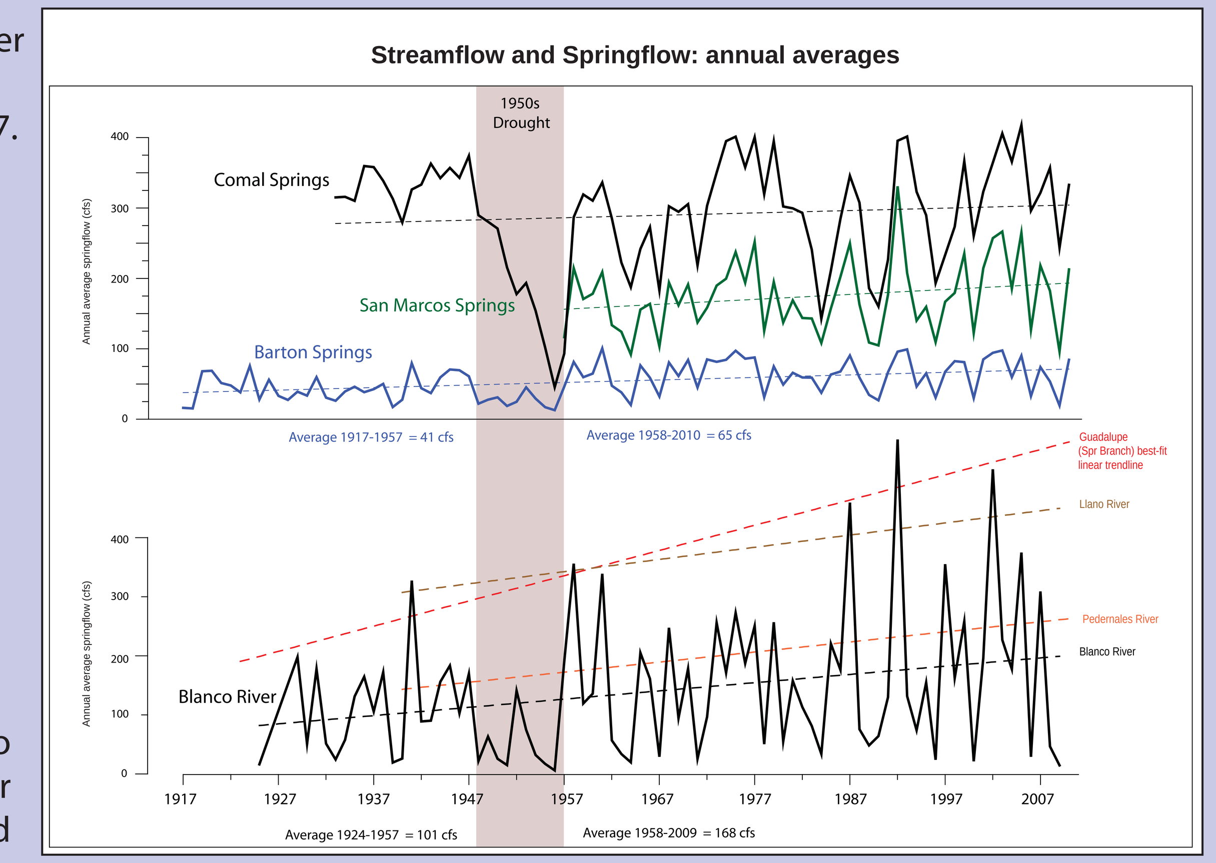


Streamflow

- A significant shift to higher streamflow values occurred after about 1957.
- All long-term streamflow stations (>70 yrs data) reviewed for this study show an increase in streamflow trends.
- Streamflow appears to have greater variability (extremes) over the past 50 years.

Springflow

- A significant shift to higher Edwards Aquifer spring discharge occurred after about 1957.
- This shift coincides with the streamflow shift.
- All three major Edwards Aquifer springs (Barton, San Marcos, and Comal) have an increasing springflow trend.



Conclusions

- Precipitation trends have increased in Central Texas over the past 50 years.
- Streamflow trends are increasing in Central Texas, with an apparent shift at about 1957.
- Increased streamflow has likely produced more recharge and a corresponding increase in Edwards Aquifer springflow.

References

Nielsen-Gammon, J., 2008, What Does the Historic Climate Record in Texas Say About Future Climate Change?, Proceedings from Climate Change Impacts on Texas Water, April 28-30, 2008, Texas State Capitol Extension, Austin, Texas.

Sharp, J.M., 2010, The Impacts of Urbanization on Groundwater Systems and Recharge, AQUAmundi, Am01008: 051 - 056.