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Hydrologic Conditions in Arizona During 1999–2004: A Historical Perspective

Introduction

Arizona's climate is prone to extreme changes that range from persistent droughts to frequent local and regional flooding. These changes are evident in hydrologic data collected. Streamflow records indicate that a drought in Arizona during 1999–2004 was the worst drought since the early 1940s and possibly earlier. Droughts result from a decrease in the number of already infrequent storms that bring moisture to Arizona. The drought conditions in the Southwestern United States over the last several years, and especially in Arizona, have resulted in several large summer fires, a decrease in potable water for some smaller communities, and depleted water available for surface water as well as ground-water recharge. An unusually wet December 2004 and January 2005 in Arizona has interrupted the multiyear drought. Dry conditions, however, still prevail in parts of Arizona. It is difficult to conclude, therefore, whether the drought is over or if it will persist.

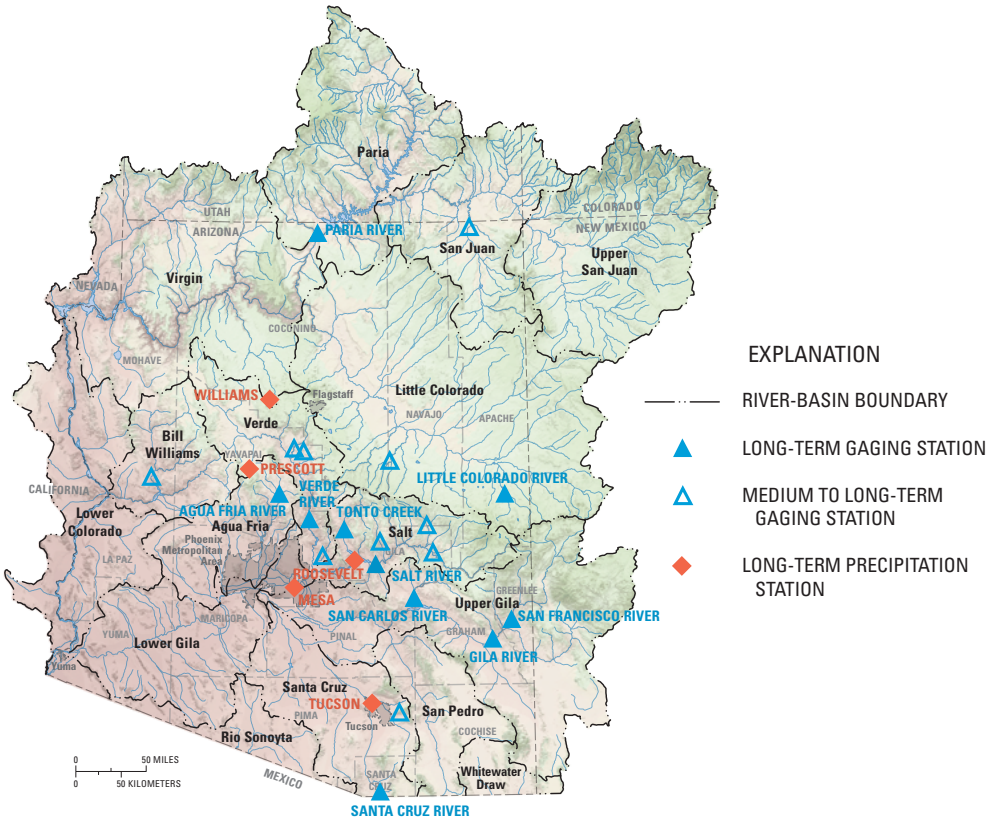


Figure 1. Locations of 10 long-term streamflow-gaging stations, 10 medium- to long-term gaging stations, and 5 long-term precipitation stations.

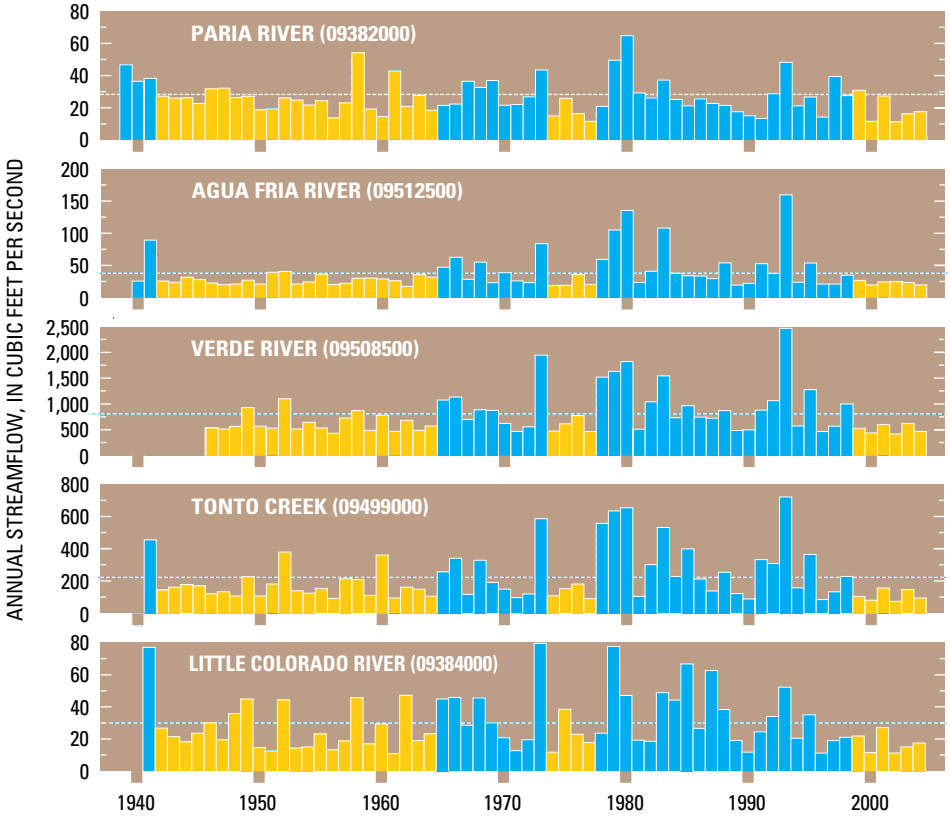
Historical and Current Hydrologic Conditions

Although the spatial and temporal extent of droughts is somewhat difficult to determine, three severe droughts during the 20th century were recognized in a 1989 U.S. Geological Survey National Water Summary (Paulson and others, 1991). The periods of significant statewide droughts, as indicated by records from several streamflow-gaging stations, were recognized as 1932–36, 1942–64, and 1974–77 (figs. 1 and 2; table 1).

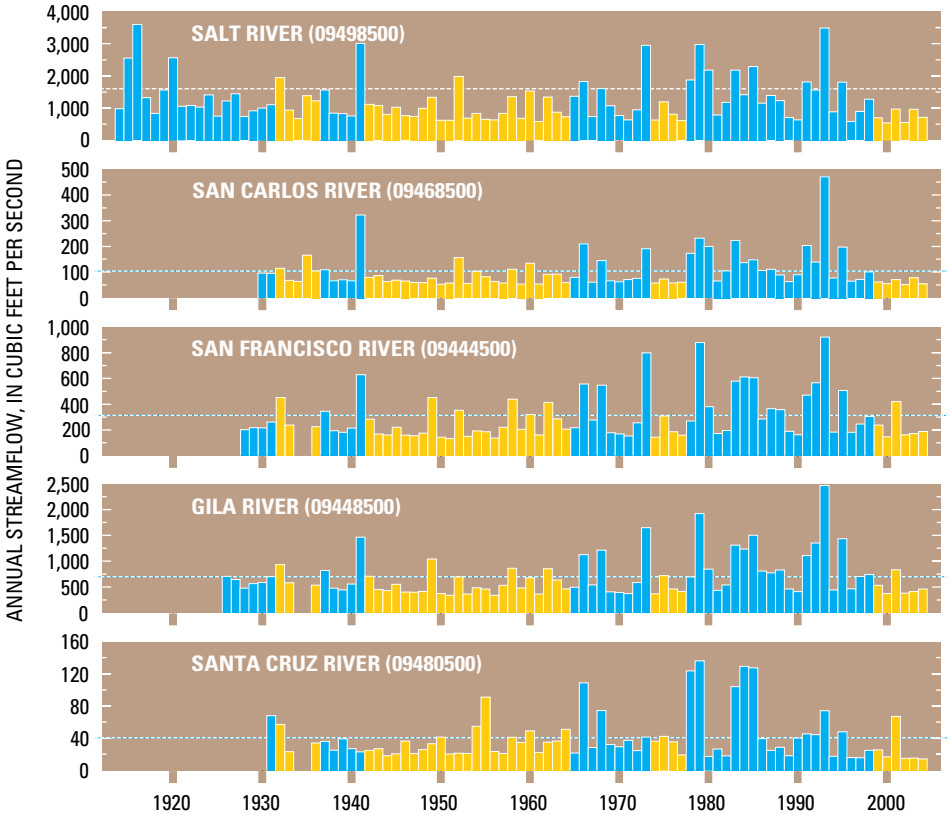
This document utilizes long-term data from streamflow-gaging stations to compare the severity of the current drought to those indicated by Paulson and others (1991; fig. 2).

Climatology in Arizona

Precipitation in Arizona is biseasonal, having both winter and summer regimes (Hereford and others, 2002). The moisture comes from three major sources: (1) Pacific winter frontal storms that can produce significant snowpack in northern Arizona as well as flooding in the central and southern parts of Arizona, (2) subtropical Pacific moisture (dissipating hurricanes or tropical storms) that is generally warmer and can produce regional flooding of large magnitude, and (3) convective storms that occur throughout the State during the summer months. The location and intensity of convective storms are difficult to predict as the storms can form quickly and produce large amounts of precipitation in localized areas. They also generally result in flooding in smaller basins and urban areas, but are not significant for



STREAMFLOW-GAGING STATIONS IN NORTHERN AND CENTRAL ARIZONA, 1939–2004—Drought periods shown in gold; horizontal line indicates long-term average. Record for the Paria River begins in 1923; data for 1923–38 not shown.



STREAMFLOW-GAGING STATIONS IN CENTRAL AND SOUTHERN ARIZONA, 1914–2004—Drought periods shown in gold; horizontal line indicates long-term average. Record for the Salt River begins in 1913; data for 1913 not shown. Gaps in plots after 1914 indicate data are not available.

Figure 2. Annual mean streamflow at 10 long-term streamflow-gaging stations in Arizona.

production of higher flows in main-stem river systems (Paulson and others, 1991).

Additional Information on Hydrologic Conditions in Arizona, 1999–2004

Precipitation data acquired by the National Weather Service can serve as an indicator of drought and flood conditions. Data acquired at five long-term precipitation stations in different parts of Arizona indicate that precipitation during the last 6 years was below the long-term average (fig. 3).

Streamflow in water years (WY) 1999–2004 was compared to historical streamflow data for 20 streamflow-gaging stations in Arizona for this report (table 2 and fig. 1). Included in the 20 stations are 10 long-term stations, as well as an additional 10 medium- to long-term stations (fig. 1). These 20 stations are considered index stations because they have medium to long periods of record and are little affected by flow diversions. The data for the period 1999–2004 for these 20 stations, when compared to historical data, indicate WY 2000 and WY 2002 were two of the driest years during the period of record. Annual discharge for almost all sites for individual years from 1999 to 2004 was well below long-term average conditions, indicating statewide drought conditions since the beginning of WY 1999 (October 1998). Annual discharge exceeded the long-term average only 6 times at the 20 sites from WY 1999 through WY 2004 (table 2). Annual discharge for the 20 sites over this same period of time was less than 10 percent of the average annual discharge 17 times and less than 50 percent 83 times. The drought of 1999–2004 is considered the most severe drought in Arizona since the early 1940s and possibly earlier (table 1). The average streamflow during three drought periods—1942–64, 1974–77, and 1999–2004—was compared to average streamflow for the 10 long-term index stations. Streamflow at the stations was 45 percent of the long-term flow during 1999–2004, 53 percent during 1974–77, and 68 percent during 1942–64 (fig. 2). Data for 1932–36 were insufficient for comparisons with data for 1999–2004.

Table 1. Chronology of major and other memorable floods and droughts in Arizona, 1862–2005

[Modified from Paulson and others, 1991]

Flood or drought	Date	Area affected	Remarks
Flood	Jan. 19–23, 1862	Gila and Colorado Rivers	Severe at Yuma. Wet year in Verde and Bright Angel Basins, but not in upper Salt River Basin
Flood	Feb. 18–26, 1891	Central Highlands	Phoenix and Yuma flooded. In Clifton, 18 deaths, $1 million in damage
Flood	Nov. 27–30, 1905	San Francisco to Verde Rivers	Several severe to moderate floods, particularly at Phoenix and along the lower Gila River
Flood	Jan. 19–22, 1916	Central Highlands	Intense rain on melting snow produced large flows in central Arizona; 4 deaths, $300,000 in damage
Flood	Aug. 21, 1921	Phoenix (Cave Creek)	Six inches of rain in 2 days flooded 4,000 acres and the State capital building; $240,000 in damage
Flood	Sept. 27–29, 1926	San Pedro River and Mexico	Tropical storm. Peak flow 2–3 times any other in 70 years; $450,000 in damage
Drought	1932–36	Statewide	Effects differed among basins
Flood	Mar. 14–15, 1941	Central Arizona	One of several storms that caused general runoff and filled reservoirs
Drought	1942–64	Statewide	Severe long-term drought interrupted by several wet periods
Flood	Sept. 26–28, 1962	Brawley and Santa Rosa Washes	1 death; $3 million in damage, mostly to agriculture near Casa Grande
Flood	Dec. 22 1965 to Jan. 2, 1966	Verde, Salt, and Gila Rivers and Rillito Creek	First large flow through Phoenix since reservoirs were built on Verde River (1939); $10 million in damage
Flood	Dec. 5–7, 1966	Grand Canyon to southwestern Utah	Mudflows and channel erosion damaged Indian ruins that had been undisturbed for 800 years
Flood	Sept. 5–7, 1970	Tonto Creek to Hassayampa River	Labor Day weekend floods in recreation areas. Reservoirs stored most runoff; 23 deaths, $8 million in damage
Flood	Oct. 17–21, 1972	Upper Gila River	Tropical storm; 8 deaths, $10 million in damage
Drought	1974–77	Statewide	Most severe in eastern Arizona
Flood	July 17, 1974	Safford (Holyoke Wash)	Thunderstorm produced flow of 1,740 cubic feet per second from 0.85-square-mile drainage basin
Flood	Oct. 1977 to Feb. 1980	Central and southeastern Arizona	Seven regional floods. Phoenix declared a disaster area three times; 18 deaths, $310 million in damage
Flood	July 26, 1981	Tucson (Tanque Verde Falls)	Flash flood at recreation area on Sunday; 8 deaths. Two larger peak discharges in the same week were not noticed
Flood	June 20 to Aug. 7,1983	Colorado River	Upper basin rain and snowmelt. First reservoir spill since Hoover Dam was built (1935); $80 million in damage
Flood	Oct. 1–3, 1983	Santa Cruz to San Francisco Rivers	Record floods on 18 streams; two peak discharges doubled 65-year-old records; 8 deaths, $226 million in damage
Flood	Winter 1993	Statewide	Resulted from extremely intense El Niño; breach of Gillespie Dam on Gila River
Drought	1999–present (2005)	Statewide	Extensive and abundant fires (Rodeo-Chedeski fire, for example) and decreased water supplies statewide

Although streamflows generally were low in Arizona during 1999–2004, floods during the winter of 2005 were substantial—to the point of filling reservoirs in central Arizona. The climate of Arizona, however, naturally tends to extremes—large floods and severe drought conditions are common. Determining whether this was an interruption to a longer drought, or the beginning of wetter years in Arizona, therefore, is difficult. Data acquired at 20 medium- to long-term streamflow-gaging stations, however, indicate the period 1999–2004 was the driest since the early 1940s and possibly earlier.

—Jeff V. Phillips and Blakemore E. Thomas

(Figure 3 and table 2 on next page)

References

Hereford, R., Webb, R.H., and Graham, S., 2002, Precipitation history of the Colorado Plateau region: U.S. Geological Survey Fact Sheet 119–02, 4 p.

Paulson, R.W., Chase, E.B., Roberts, R.S., Moody, D.W., 1991, National Water Summary 1988–89, Hydrologic events and floods and droughts: U.S. Geological Survey Water-Supply Paper 2375, p. 181–188.

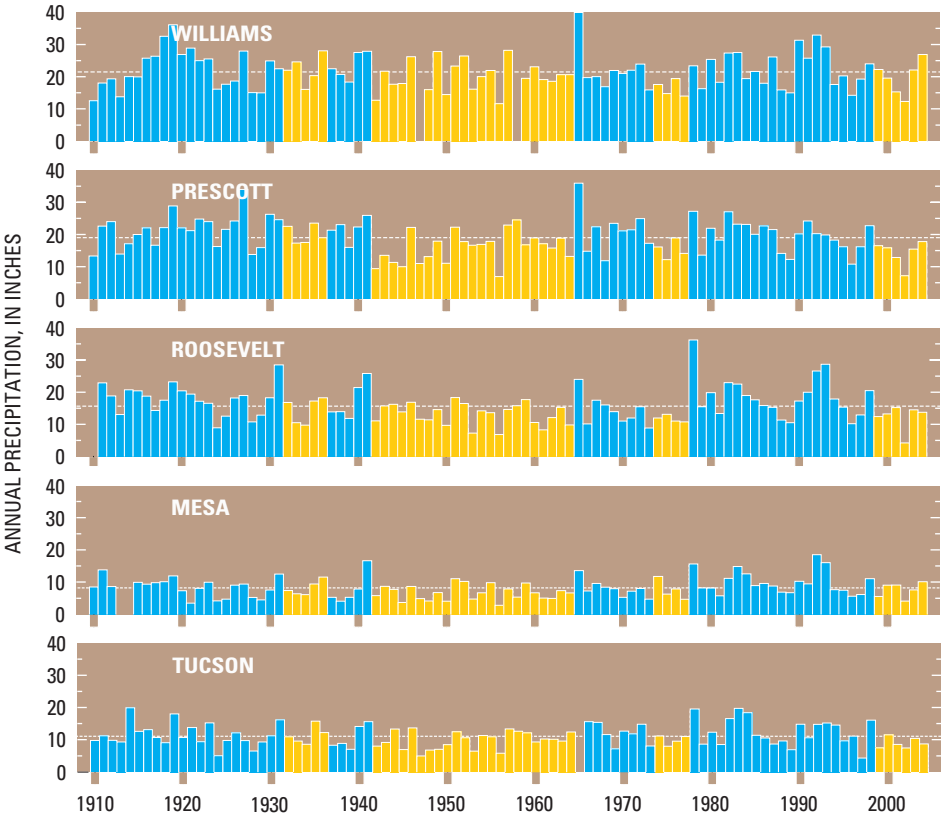


Figure 3. Annual precipitation at five long-term stations in Arizona. Drought periods shown in gold; horizontal line represents long-term average. Gaps in plots after 1910 indicate data are not available.

Current streamflow conditions in Arizona can be obtained from **http://waterdata.usgs.gov/az/nwis/rt**

Historical streamflow conditions can be obtained from **http://waterdata.usgs.gov/az/nwis/sw**

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Table 2. Percentage of average annual discharge for 20 selected streamflow-gaging stations during water years 1999–2004

Site	Number	Site Name	Period of Record	Percentage of average annual mean discharge for indicated water year					
				1999	2000	2001	2002	2003	2004
1	09382000	Paria River at Lees Ferry	1924–2004	109	41	96	39	57	62
2	09512500	Agua Fria River near Mayer	1940–2004	49	17	38	40	34	17
3	09508500	Verde River below Tangle Creek	1946–2004	51	36	65	32	68	40
4	09499000	Tonto Creek above Gun Creek, near Roosevelt	1941–2004	24	8.0	58	3.1	52	17
5	09384000	Little Colorado River above Lyman Lake	1941–2004	65	17	88	15	33	44
6	09498500	Salt River near Roosevelt	1914–2004	40	22	70	23	70	41
7	09468500	San Carlos River near Peridot	1930–2004	29	18	45	11	56	17
8	09444500	San Francisco River at Clifton	1928–2004	67	26	150	33	37	44
9	09448500	Gila River at head of Safford Valley	1921–2004	62	29	130	31	38	49
10	09480500	Santa Cruz River near Nogales	1931–2004	45	12	205	4.0	5.0	1.6
11	09490500	Black River near Fort Apache	1958–2004	31	13	73	15	66	40
12	09496500	Carrizo Creek near Show Low	1952–2004	18	11	28	35	55	26
13	09424450	Big Sandy River near Wikieup	1967–2004	5.0	3.8	61	4.1	13	44
14	09397500	Chevelon Creek below Wildcat Canyon	1948–2004	17	6.7	80	0	48	24
15	09504500	Oak Creek near Cornville	1941–2004	55	41	63	34	83	55
16	09510200	Sycamore Creek near Fort McDowell	1961–2004	5.0	.61	52	.23	36	2.7
17	09505350	Dry Beaver Creek near Rimrock	1961–2004	25	5.0	48	.8	77	20
18	09485000	Rincon Creek near Tucson	1953–2004	25	17	190	4.4	14	45
19	09497980	Cherry Creek near Globe	1966–2004	35	16	53	12	35	16
20	09379200	Chinle Creek near Mexican Water	1965–2004	110	19	49	74	34	43