

Summary of Precipitation at Saguaro National Park (2000-2010)



Arizona Star photo, Rincon Creek, 2005

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Summary

This report reports on the amount of precipitation recorded at four locations in Saguaro National Park: the Tucson Mountain District (TMD) Visitor Center, Rincon Mountain District (RMD) Visitor Center, Rincon Creek (on the southern boundary of RMD) and Manning Cabin, at 8,000 feet elevation in RMD. The data have been analyzed for four categories of interest (annual, monsoon, winter, and average monthly) for each location so that readers can easily compare them.

There is little past information on precipitation at Saguaro National Park. Although precipitation data have probably been gathered throughout the history of the park, to our knowledge they have not been collected or analyzed in any consistent or systematic way. The only known published dataset is in *Ecology of the Saguaro II* (1983) by Steenbergh and Lowe, saguaro researchers who summarized monsoon and annual data in desert areas of the two districts for the period 1968-1976. However, there may be valid data available that we do not yet know about.

Average annual rainfall at the four stations during 2000-2010 was 11.70 inches for the RMD Visitor Center, 11.23 inches for the TMD Visitor Center, 9.93 inches for Rincon Creek, and 20.8 inches for Manning Camp. As expected, the annual rainfall at Manning Camp, at 8,000 feet elevation in the Rincon Mountains, is much greater than at the RMD Visitor Center. However, precipitation recorded at the two visitor centers over the 10-year period is almost identical. This is surprising because it is generally assumed that RMD receives more rain than TMD due to the lower elevation of TMD. During 1968-1976, Steenbergh and Lowe recorded 12.30 inches at RMD and 10.27 inches at TMD, with much of that being higher monsoon precipitation in the RMD. That the two district averages are similar may simply reflect specific rainfall patterns during the past decade. It is noteworthy, however, that the published data from the TMD station (http://www.wrh.noaa.gov/twc/climate/seaz_rainfall_normals.php) for the period from 1985 (presumably) through 2000 is 12.53 inches!

Our hope is that this report will provide baseline data for precipitation at the park that can be added to and improved in future years.

Data sources and rain gages

Errors can creep into precipitation data in a number of ways: rain gages can fail for a period of time, the data may be incorrectly recorded, and mistakes can be made in summarizing the data. We have tried to be thorough in this report and avoid errors, but we are certain that some inaccuracies remain. For this report, precipitation for a given year is split into two periods. The monsoon precipitation total includes any rain measured between June and November. Winter rains include any rain measured from December to May. Note that the December month of any year indicates the start of the winter rains for the next year. Figures 1-2 give the locations and elevations of the weather stations used in this report.

RMD visitor center gage: Rainfall data from RMD have been consistently collected from records kept at the Visitor Center since January, 2000 (Figure 3). Prior to that, the park collected

Tucson Mountain District

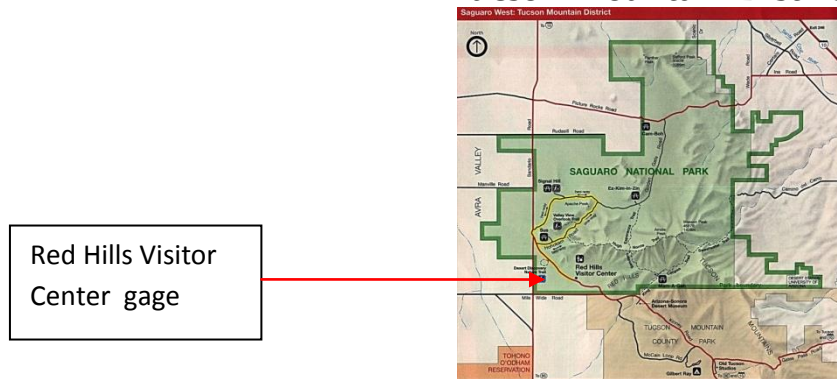


Figure 1. The TMD is located to the west of Tucson. The rain gage is located at the Red Hills Visitor Center on Kinney Road, on the west side of the district at an elevation of approximately 2,500 feet.

Rincon Mountain District



Three rain gages located in RMD are reported in this document: The visitor center (approximately 3,000 feet elevation), Manning Camp (approximately 8,000 feet), and Rincon Creek (approximately 3,100 feet).



Figure 3. The rain gage at the RMD Visitor Center, located on the path to the Administration Building. This gage has been checked daily by Visitor Center staff and volunteers since January 2000.

hard copies of data generated by Pima County at the RMD helibase. There may be data available from previous years, but because this tipping gage frequently failed during thunderstorms, park staff did not consider the data to be reliable. Therefore, a manual rain gage (Figure 3) was installed at the Visitor Center in late 1999. Additional data (monthly totals) from the 1990s were collected by a park volunteer who lived near Broadway and Freeman and are kept in a spreadsheet on the park's server (p:/resources/weather/RMD_Rainfall_1990s.xls).

Since January 2000, the Visitor Center rain data have been diligently recorded and entered into an Excel spreadsheet on the park server (p:/resources/weather/RMD_Rain Stats.xls), first by RMD interpretive ranger Jeff Kartheiser, and more recently by WNPA employee Jay Loughlin. Since August 24, 2008, these data have also been recorded on the National Oceanic and Atmospheric Administration (NOAA) website (<http://wxcoder.org>). The park receives a report each month called "Climatological Data, Arizona", published by the National Climate Data Center. Currently these data are restricted, and we are seeking information on how the public can access it. This station is cooperative #027398, and there additional information is available at <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?WWDI~StnSrch>.

TMD visitor center gage: Rainfall data at TMD has been collected at the Visitor Center since at least January, 1986. This station is an official NOAA weather station called Tucson 17 NW (cooperation #0287957). Most of the data are available on-line at <http://www.wrcc.dri.edu/summary/climsmaz.html>, and a summary can be found at http://www.wrh.noaa.gov/twc/climate/seaz_rainfall_normals.php. For a number of years these data have been collected by Visitor Center staff and entered into a database at the park (p:/resources/weather data/TMD_weather database/weather.mdb) by volunteer Louise Conrad.



Figure 4. Weather station south of the TMD Visitor Center.

Manning Camp gage: Rainfall data at Manning Camp (Figure 5) are collected at a Remote Automated Weather Station (RAWS), one of nearly 2,200 interagency RAWS stations strategically located throughout the US that provide weather data to assist land management agencies, especially for wildland fire. The RAWS network is operated by National Interagency Fire Center, NOAA, and others. More information is at <http://raws.fam.nwcg.gov>. Data from the Manning Camp RAWS are available at <http://www.raws.dri.edu/cgi-bin/rawMAIN.pl?azARIN>. For our analysis in this report, we used the summary data under the category of “Monthly Summary Time Series,” which seemed to be the most complete summary; note that there are some contradictions between these data and the “Monthly Summary” data.

There is a second weather station at Manning Camp, and these data are also available on-line. This station is operated by the Pima County Flood Control District, and is an ALERT (National Weather Service Automated Local Evaluation in Real Time) station that provides real-time rain and other weather data to assist in flood control downstream. These data are not reported here but available at <http://159.233.69.3/perl/pima.pl>, which is an excellent and very user-friendly website for viewing current weather conditions at Manning and throughout Pima County.

Rincon Creek gage: There is a second Pima County ALERT station at Rincon Creek (<http://159.233.69.3/perl/pima.pl>). This gage (Figure 6) is located at the U.S. Geological Survey stream gage # 9485000 in Rincon Creek on the south boundary of Saguaro National Park, approximately two miles southwest of Madrona Ranger Station and one mile east of Hope Camp.



Figure 5. RAWS station located near Manning Cabin, a historic cabin and park back-country ranger station located at approximately 8,000 feet elevation in the Rincon Mountain District.

Data from this stream gage are managed by Pima County. Real-time stream gage data, dating back to the 1950s, are also available for this site from Pima County and the U.S. Geological Survey (<http://waterdata.usgs.gov/nwis>). This gage was destroyed in the major flood of July 31, 2006 and not replaced until August 2007.



Figure 6. USGS/Pima County rain and stream gage along Rincon Creek, approximately 1 mile east of Hope Camp on RMD's southern boundary. View from the south, with Sentinel Butte in background.

Other weather stations and precipitation data for Saguaro National Park: We are aware of several other potential sources of rainfall data for the park that are not included in this report.

The National Park Service Inventory and Monitoring program has a real-time rain gage at Madrona Ranger Station. Data from this station are available on-line (<https://www.hobolink.com/p/141ec69629c789a0207b026c20915eb1>). The station has been in operation since prior to 2006, but because this record is not as continuous as the other stations, we have not included it here. This gage was originally part of a network of weather stations operated by SODN during the 2000s, and at one time included stations at Happy Valley, Rincon Peak, Manning Meadow, Grass Shack, and between Grass Shack and Madrona. The very large amount of data from these stations is still being analyzed (A. Hubbard, personal communication).

The Pima County Department of Environmental Quality operates a weather station at the RMD helibase. We are not aware if any precipitation data are collected at this site, but this is the location of a weather station prior to the establishment of the rain gage at the Visitor Center in 2000. Other weather stations with useful precipitation records near to Saguaro National Park include ALERT sites at Picture Rocks and the Arizona-Sonora Desert Museum near TMD, the RAWS station at Sabino Canyon (called "Saguaro", although it is not in the park), and a number of other ALERT sites located throughout northern Pima County.

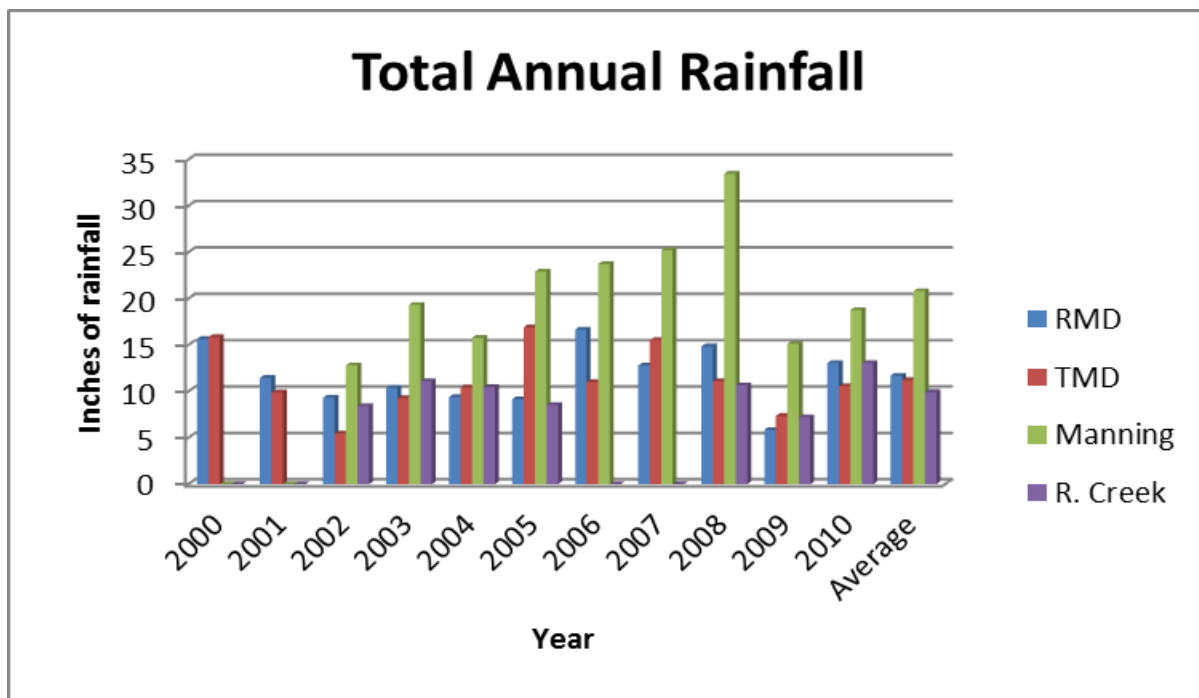


Figure 7. Total annual precipitation for four locations - Note: Data were not collected at Manning for 2000 and 2001, or at Rincon during 2000-2002 and most of 2006-2007.

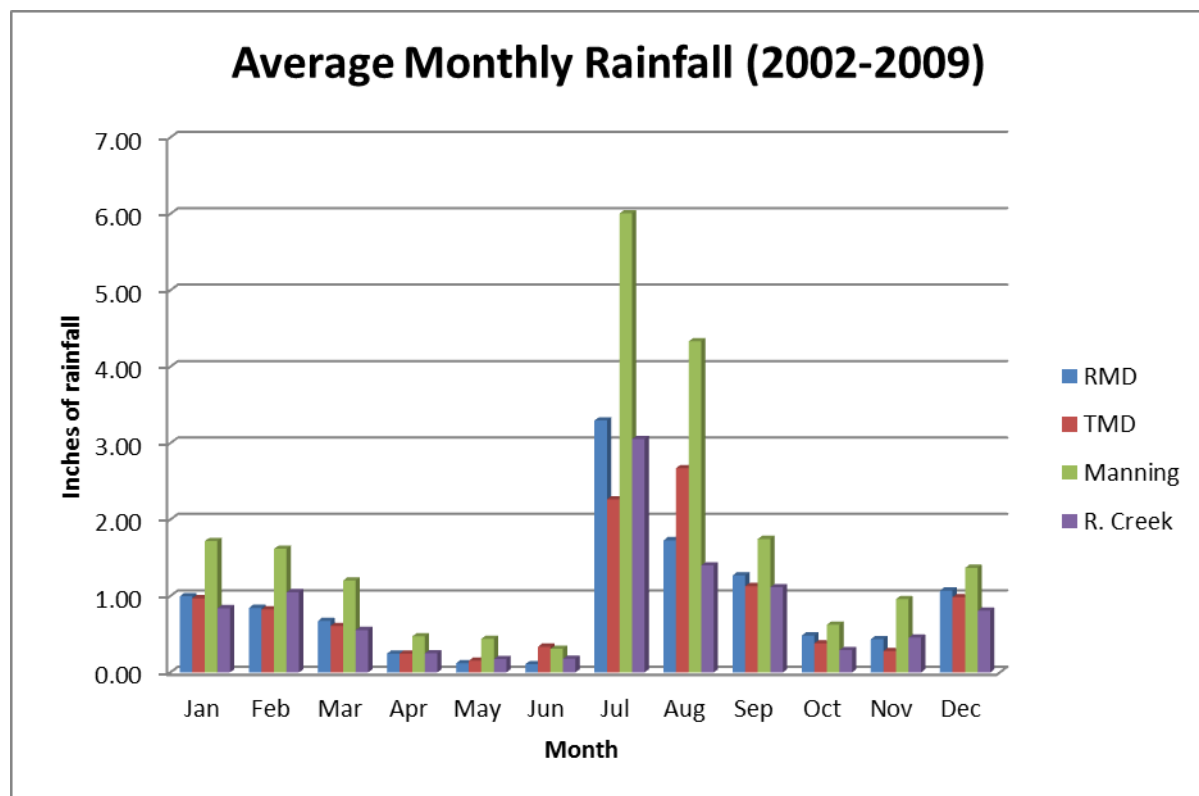


Figure 8. Average monthly precipitation for four locations: 2002 – 2009.

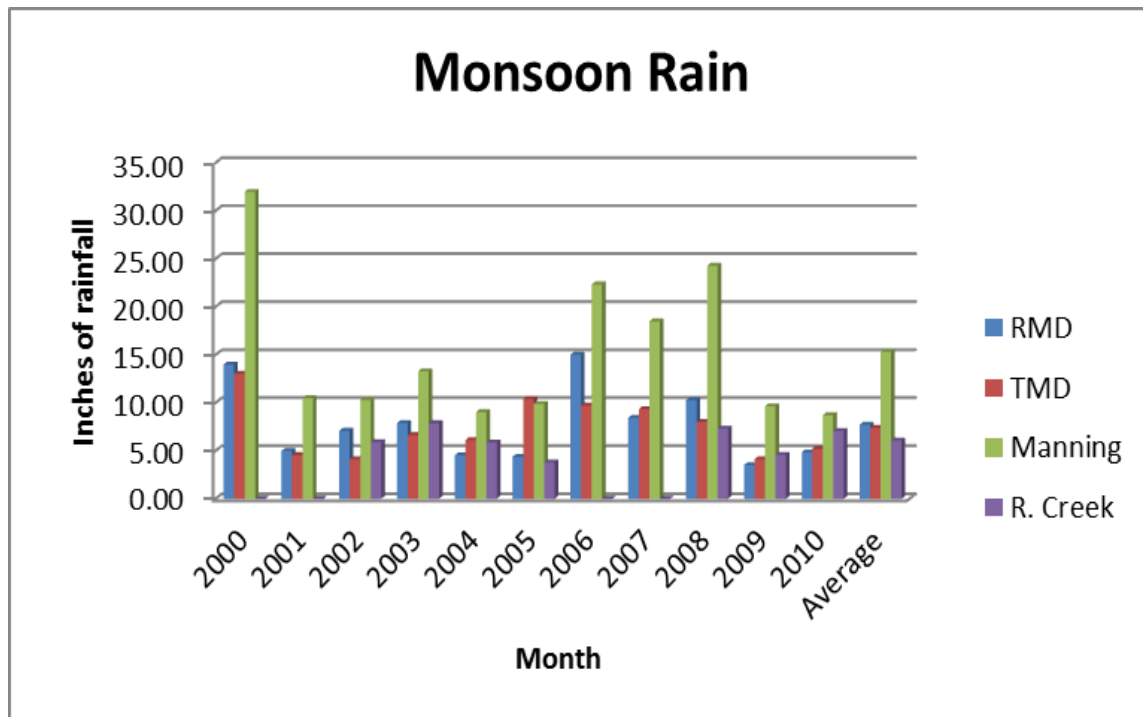


Figure 9. Total summer precipitation for four locations - Note: Data not collected at Manning for 2000 and 2001, or for Rincon for 2000-2002 or 2006-2007. Summer season is defined as June-November.

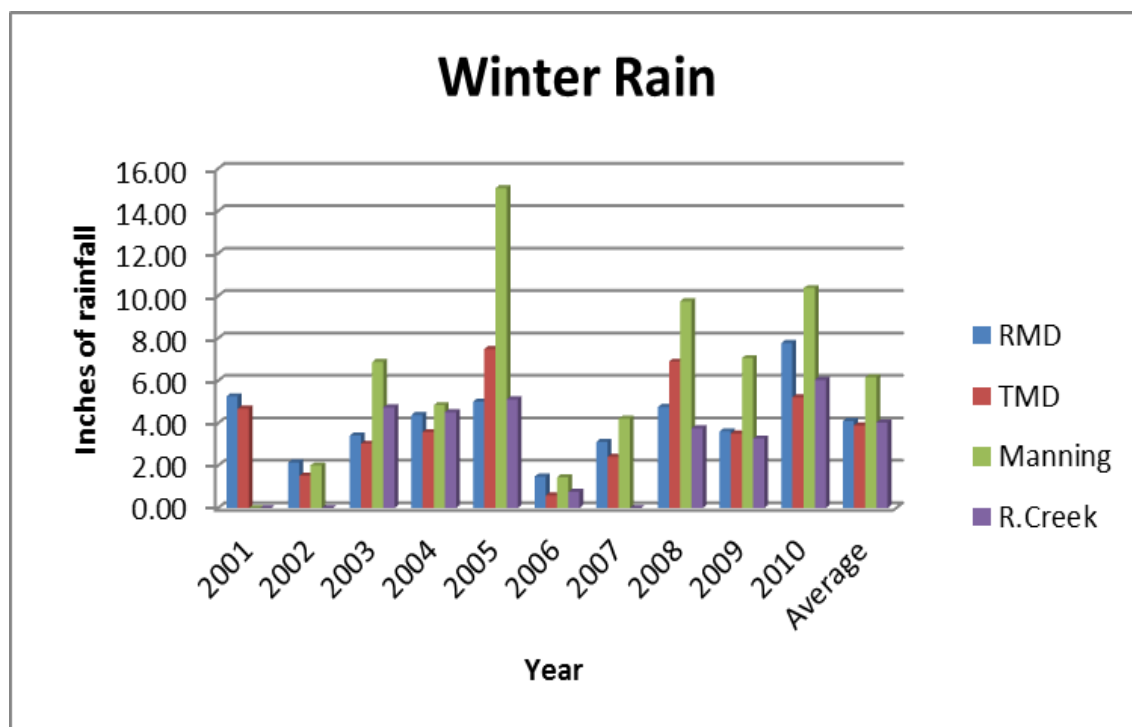


Figure 10. Total annual winter precipitation for four locations - Note: Data were not collected at Manning for 2001 or for Rincon for 2000-2002, or 2006-2007. Winter season is defined as December-May.

APPENDIX A

Total Yearly Rainfalls

Year	RMD	TMD	Manning	R. Creek
2000	15.66	15.86	-	-
2001	11.46	9.91	-	-
2002	9.33	5.465	12.82	8.42
2003	10.39	9.28	19.33	11.11
2004	9.4	10.44	15.78	10.47
2005	9.17	16.91	22.92	8.54
2006	16.66	11.02	23.74	-
2007	12.8	15.54	25.23	-
2008	14.87	11.12	33.48	10.66
2009	5.86	7.36	15.14	7.22
2010	13.07	10.58	18.78	13.06
Average	11.70	11.23	20.80	9.93

Table 1. Data for Figure 7

Average Monthly Rainfall

Month	RMD	TMD	Manning	R. Creek
Jan	1.00	0.97	1.72	0.84
Feb	0.84	0.83	1.62	1.05
Mar	0.68	0.61	1.20	0.56
Apr	0.25	0.25	0.47	0.25
May	0.12	0.15	0.44	0.18
Jun	0.11	0.34	0.31	0.18
Jul	3.30	2.27	6.01	3.06
Aug	1.73	2.67	4.33	1.40
Sep	1.27	1.13	1.75	1.12
Oct	0.48	0.38	0.63	0.29
Nov	0.44	0.28	0.96	0.46
Dec	1.07	0.99	1.37	0.81

Table 2. Average monthly rainfall 2002-2009

Monsoon Rainfall

Year	RMD	TMD	Manning	R. Creek
2000	13.99	13.01	31.96	-
2001	4.98	4.55	10.48	-
2002	7.08	4.13	10.27	5.91
2003	7.89	6.62	13.26	7.87
2004	4.54	6.10	9.02	5.87
2005	4.37	10.38	9.88	3.78
2006	15.02	9.70	22.33	-
2007	8.43	9.33	18.47	-
2008	10.27	8.02	24.27	7.3
2009	3.50	4.12	9.63	4.58
2010	4.83	5.2	8.7	7.06
Average	7.72	7.38	15.30	6.05

Table 3. Monsoon data for Figure 9

Winter Rain

Year	RMD	TMD	Manning	R.Creek
2001	5.27	4.69	0	-
2002	2.15	1.52	2.01	-
2003	3.42	3.03	6.89	4.75
2004	4.39	3.58	4.85	4.52
2005	5.01	7.50	15.08	5.12
2006	1.49	0.60	1.45	0.76
2007	3.12	2.41	4.21	-
2008	4.77	6.90	9.75	3.76
2009	3.62	3.51	7.07	3.28
2010	7.78	5.22	10.37	6.04
Average	4.10	3.90	6.17	4.03

Table 4. Winter rain data for Figure 10

APPENDIX B

Although not presented in graph form (due to so many values), the following tables contain the monthly rain totals for each of the three rain gages. All measurements are in inches of rainfall.

Rincon Mountain District

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Jan	0.20	2.05	0.61	0.23	0.98	1.61	0.00	1.02	0.68	0.59	3.25
Feb	0.21	0.59	0.02	1.15	0.81	1.50	0.02	0.12	1.58	0.25	2.15
Mar	1.26	0.96	0.31	0.60	1.47	0.42	0.78	0.86	0.11	0.20	1.33
April	0.00	1.41	0.00	0.08	0.70	0.50	0.00	0.27	0.06	0.22	0.40
May	0.00	0.26	0.00	0.05	0.04	0.12	0.04	0.05	0.29	0.48	0.03
Jun	2.01	0.06	0.00	0.02	0.03	0.00	0.36	0.10	0.41	0.06	0.00
July	0.64	2.25	2.11	2.82	1.68	1.26	7.46	4.25	5.35	2.12	2.62
Aug	3.09	2.28	2.42	0.94	0.39	2.69	3.09	1.08	2.54	0.71	1.71
Sep	0.13	0.08	2.05	1.95	1.00	0.08	2.99	1.76	1.19	0.23	0.18
Oct	6.47	0.22	0.20	0.97	0.66	0.34	1.12	0.59	0.12	0.03	0.32
Nov	1.65	0.09	0.30	1.19	0.78	0.00	0.00	0.65	0.66	0.35	0.00
Dec	0.00	1.21	1.31	0.39	0.86	0.65	0.80	2.05	1.88	0.62	1.08
Total	15.66	11.46	9.33	10.39	9.40	9.17	16.66	12.80	14.87	5.86	13.07

Table 5. Monthly rain totals for RMD

Tucson Mountain District

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
January	0.23	1.82	0.18	0.00	1.03	2.03	0.00	0.74	0.55	1.77	2.43
February	0.46	0.50	0.00	0.92	0.59	2.15	0.00	0.10	1.20	0.64	1.83
March	2.06	0.89	0.57	0.68	0.94	1.15	0.59	0.48	0.60	0.12	0.35
April	0.00	1.28	0.00	0.40	0.80	0.44	0.00	0.36	0.00	0.08	0.15
May	0.00	0.10	0.00	0.44	0.00	0.75	0.00	0.00	0.02	0.17	0.00
June	1.81	0.56	0.00	0.00	0.01	0.06	0.86	0.08	1.72	0.30	0.00
July	0.67	1.24	0.38	0.79	1.18	1.58	5.19	4.46	3.22	2.15	1.44
August	3.02	1.90	0.43	2.81	1.63	8.02	1.45	4.27	1.69	0.87	2.89
September	1.80	0.41	2.74	1.73	2.11	0.22	1.74	0.49	0.71	0.40	0.03
October	4.47	0.33	0.06	0.63	0.63	0.50	0.46	0.00	0.00	0.30	0.84
November	1.24	0.11	0.52	0.66	0.54	0.00	0.00	0.03	0.68	0.10	0.00
December	0.10	0.77	0.59	0.22	0.98	0.01	0.73	4.53	0.73	0.46	0.62
Total	15.86	9.91	5.47	9.28	10.44	16.91	11.02	15.54	11.12	7.36	10.58

Table 6. Monthly rain totals for TMD

Manning Cabin

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
January	0	n/a	0.01	0.18	1.73	4.66	0	0.81	3.8	0.9	3.39
February	0	0.31	0.51	2.68	0.89	5.69	0.02	0.83	1.14	0.69	2.11
March	0	0.4	0.61	2.17	1.44	0.9	0.9	1.5	0.4	0.57	2.33
April	0	n/a	0	0.13	0.14	0.79	0.02	0.56	0.09	0.86	1.66
May	0	0.38	0	0.31	0.05	0.53	0.04	0.08	1.34	1.61	0
June	2.29	0.66	0	0	0.12	0.07	0.61	0.2	0.62	1.16	0
July	4.79	5.67	5.53	3.78	0.97	3.88	12.6	5.09	15.01	3.47	3.73
August	10.6	3.08	2.04	3.44	3.41	4.7	5.95	8.11	4.93	3.29	3.12
September	1.42	0.19	1.54	2.53	2.3	1.17	2.24	0.98	2.29	1.45	1.22
October	10.47	0.83	0.55	1.27	1.45	0.06	0.93	0.33	0.19	0.22	0.63
November	2.39	0.05	0.61	2.24	0.77	0	0	3.76	1.23	0.04	0
December	n/a	0.88	1.42	0.6	2.51	0.47	0.43	2.98	2.44	0.88	0.59
Total	n/a	n/a	12.82	19.33	15.78	22.92	23.74	25.23	33.48	15.14	18.78

Table 7. Monthly rain totals for Manning Cabin

Rincon Creek

Month	2002	2003	2004	2005	2006	2007	2008	2009	2010
January	0.48	0.04	0.88	2.2	0	-	0.28	0.64	2.2
February	0.04	1.64	1.08	1.48	0.04	-	1.48	0.68	1.96
March	0.16	0.84	1.32	0.32	0.68	-	0.16	0.16	0.8
April	0	0.08	0.92	0.36	0	-	0	0.12	0.52
May	0	0.32	0	0.36	0	-	0.24	0.48	0
June	0	0	0.04	0.12	0.2	-	0.95	0.12	0
July	1.82	1.19	2.1	1.19	7.46	-	3.76	1.5	5.42
August	1.66	2.81	2.06	1.99	-	0	1.28	0.56	0.84
September	1.51	1.64	1.23	0.28	-	0.68	0.87	2.4	0.32
October	0.52	1.03	0.04	0.2	-	0.08	0	0	0.48
November	0.4	1.2	0.4	0	-	1.2	0.44	0	0
December	1.83	0.32	0.4	0.04	-	1.6	1.2	0.56	0.52
Total	8.42	11.11	10.47	8.54	8.38	3.56	10.66	7.22	13.06

Table 8. Monthly rain totals for Rincon Creek

APPENDIX C

Long-term precipitation record for Tucson (current data from Tucson International Airport)

