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WEATHER NOTE

Unusually Heavy 24-Hour Rainfall at Workman Creek 1, Arizona

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ABSTRACT—On Sept. 5, 1970, 10.99 in. of rain fell in 1 observational day at the National Weather Service cooperative station known as Workman Creek 1, Ariz. A 30-yr series of observations is analyzed to estimate the return period of this unusually large rainfall amount. It is concluded that the return period for this event is well in excess of 500 yr.

In the 24-hr period between 2200 MST on Sept. 4 and 2200 MST on Sept. 5, 1970, 11.40 in. of rain fell at the official National Weather Service cooperative station known as Workman Creek 1, Ariz. The station is located in the Sierra Ancha Mountains at an elevation of 6,970 ft. This rainfall amount was nearly double the previous Arizona record of 6.00 in. in an observational day at Crown King on Dec. 19, 1967. The record prior to that was 5.95 in. in a 24-hr period at Pinal Ranch on Jan. 9, 1905.

The meteorological aspects of the storm producing this rainfall have been well covered by Zimmerman et al. (1971), Hales (1972), and the U.S. Department of Commerce (1970). The gage at Workman Creek 1 is a Friez 12-in. dual-traverse weighing rain gage,[1] and the Arizona Network Specialist visited the site and ran a field check on the gage on Sept. 22, 1970. The results of his check were used in arriving at the final figure of 11.40 in. in 24 hr.

Since the new record is so excessively above anything observed in previous years in Arizona, it seems important to get some idea of the return period of such an event. Records at this station began in 1939, but a complete year of record was not available until 1941. Data available in Phoenix, Ariz., do not make it possible to use the series composed of the greatest amounts received in 24 hr. Instead, the series is composed of the greatest amounts received in an observational day, beginning and ending at midnight. Inspection of the original rain gage trace for the storm in question revealed that the amount received from midnight to midnight on Sept. 5, 1970, was 10.99 in., and it is this figure that is used in the present analysis. The entire series of numbers to be analyzed consists of the greatest precipitation (in.) received in an observational day during each year for the period of record, 1941–70 inclusive. These values are shown in table 1.

TABLE 1.—*Greatest precipitation (in.) received in an observational day (beginning and ending at midnight) at Workman Creek 1, Ariz., during each year for the period of record, 1941–70 inclusive*

Year	Amount
1941	2. 15
1942	2. 84
1943	3. 70
1944	2. 31
1945	3. 93
1946	3. 70
1947	1. 91
1948	3. 15
1949	2. 29
1950	1. 85
1951	3. 92
1952	2. 70
1953	1. 50
1954	5. 27
1955	2. 11
1956	2. 44
1957	3. 41
1958	2. 80
1959	3. 69
1960	2. 30
1961	1. 64
1962	2. 01
1963	3. 22
1964	1. 78
1965	5. 17
1966	4. 77
1967	1. 87
1968	1. 85
1969	2. 42
1970	10. 99

Although a number of extreme-value distribution functions are available for analyzing such data, the one chosen here is the Fisher-Tippett Type 1 distribution, fitted to the data by a method developed initially by Leiblein (Thom 1966) using a table of weights computed by Mann (1967). The cumulative distribution function, $F(x)$, is defined as

$$F(x)=e^{-e^{-(x-\alpha)/\beta}}$$

where $F(x)$ is the probability that a rainfall amount x

[1] Mention of a commercial product does not constitute an endorsement.

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will not be reached in any one year, and α and β are distribution parameters. The return period, R (yr), is defined as

$$R=\frac{1}{1-F(x)}.$$

Since Mann's weights have been calculated for a value of N no greater than 25, the sample of 30 values treated here was broken into two parts of size 25 and 5, respectively. Weighted estimates of $\alpha \approx a^*$ and $\beta \approx b^*$ were then computed for two cases. In case 1, only the series composed of the years 1941–69 was used to estimate the parameters and the return period of the 1970 value (10.99 in.). For case 2, the entire series of years 1941–70 was used in estimating the parameters and the return period. The estimated parameters and the return period for the two cases are as follows:

Case 1	*Case 2*
$a^*=2.353$	$a^*=2.447$
$b^*=0.763$	$b^*=0.972$
$R>82{,}000$ yr	$R>6{,}500$ yr.

A Kolmogorov-Smirnov maximum deviation test (Bradley 1968) for goodness-of-fit was run on both cases and the fit of the Fisher-Tippett Type 1 distribution to the data series was found to be acceptable with at least a 5-percent confidence limit for both case 1 and case 2. Nevertheless, due to the extreme nature of this event, the return periods computed above must be considered only as approximations. We are probably justified in saying only that the return period of the 10.99-in. value is well in excess of 500 yr.

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