#376

VOL. 107 NO. HY5. MAY 1981

JOURNAL OF THE HYDRAULICS DIVISION

PROCEEDINGS OF
THE AMERICAN SOCIETY
OF CIVIL ENGINEERS

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

ISSN 0044-796X

Empirical Investigation of Curve Number Technique[a]

Discussion by Michael Daly,[2] M. ASCE

The writer wishes to thank the author for a most informative presentation. The author speculates that the reason for the poor fit at the Sonoita Creek watershed is that the curve number (CN) technique is inappropriate in the arid west. The writer wishes to concur in this speculation as it has been his experience that the CN technique provides excessive runoff for large rainfall events.

An alternate technique developed by the United States Geological Survey (USGS) has been employed by the writer which has been found to provide very good data (8). This technique uses multiple-regression analysis relating flood peaks of 5-yr, 10-yr, 25-yr, and 50-yr recurrence intervals to selected physical and climatic basin characteristics. The method is based on data for 163 sites where flood records have been obtained for 8 yr or more, and on the maximum known floods at 439 sites. Using this technique, an estimate of the natural-peak flow can be obtained for any desired site within New Mexico by using the basin characteristics at the desired site. Copies of the report detailing this technique are available from the USGS at the address given in Ref. 8. The USGS final report will be available in the summer of 1981. It is being prepared by R. P. Thomas.

Appendix.—Reference

8. Scott, A. G., "Preliminary Flood-Frequency Relations and Summary of Maximum Discharges in New Mexico—A Progress Report," *Open File Report*, U.S. Geological Survey, Water Resources Division, Room 115, Federal Building, Santa Fe, N.M. 87501.

Discussion by Kenneth G. Renard,[3] M. ASCE

The author is to be commended for his effort to present a method for illustrating how runoff frequency relationships can be developed from a frequency relationship for precipitation.

It would be interesting if the author had commented regarding whether the curve numbers he used to develop the information in Figs. 1–5 agreed with values suggested in the *National Engineering Handbook of the Soil Conservation*

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[a] September, 1980, by Allen T. Hjelmfelt, Jr. (Proc. Paper 15693).

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Service (SCS) (3). Similarly, it would be helpful to note which of the antecedent moisture levels was used, as suggested in the handbook. Because the handbook suggests that the curve number changes with varying antecedent moisture, it seems likely that the curve number associated with the author's frequency analysis would change in response to the exceedence probability. Thus, one might expect the curve number for high probability would be lower than it would be for low probability.

That the results of the technique are poor for Sonoita Creek, near Patagonia, Ariz., is certainly not surprising to a hydrologist familiar with the hydrologic and physiographic characteristics controlling the rainfall-runoff process in the region. The spatial distribution of precipitation and the resulting partial area

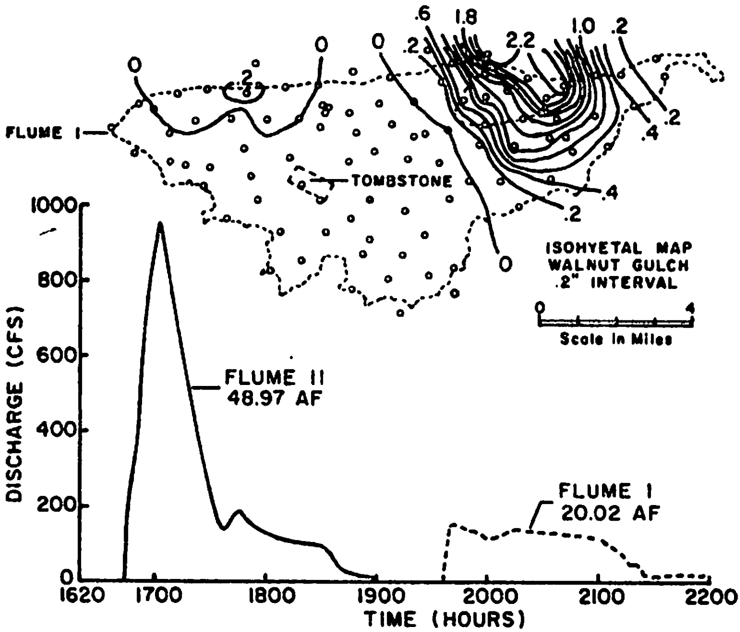

FIG. 6.—Storm near Upper End of Walnut Gulch on July 30, 1966; Each Circle Shows Location of Raingage on 57.7-sq mile area

runoff, along with the reductions in the flow volume (transmission losses) as runoff moves from the source area over the normally dry alluvial streambeds, dominate the hydrologic response of many semiarid watersheds to individual precipitation events.

To illustrate these phenomena, two runoff events on the Walnut Gulch Experimental watershed near Tombstone, Ariz. are used. The watershed is a 57.7-sq mile (150-km^2) tributary of the San Pedro River about 75 mile from Sonoita Creek. Mean annual precipitation is about 14 in. (350 mm), which is slightly less than that at Sonoita Creek. The hydrologic phenomena, however, are very similar in both watersheds.

Fig. 6 represents a precipitation event concentrated in the upper portion of the watershed. Precipitation was not recorded for this event at the raingage in Tombstone. Much of the runoff was lost by transmission losses in the channel before reaching the watershed outlet at Flume 1. Such an event shows a typical air-mass thunderstorm's limited areal extent. Runoff measured at the outlet of a small 3.18-sq mile (8.24-km^2) subwatershed of Walnut Gulch was appreciable. By the time this flow had traversed nearly 11.4 mile (18.3 km) of normally dry streambed, the flow was significantly less.

Fig. 7 shows what can happen if the storm is located nearer the watershed outlet. For this storm, the opportunity for transmission losses to reduce the

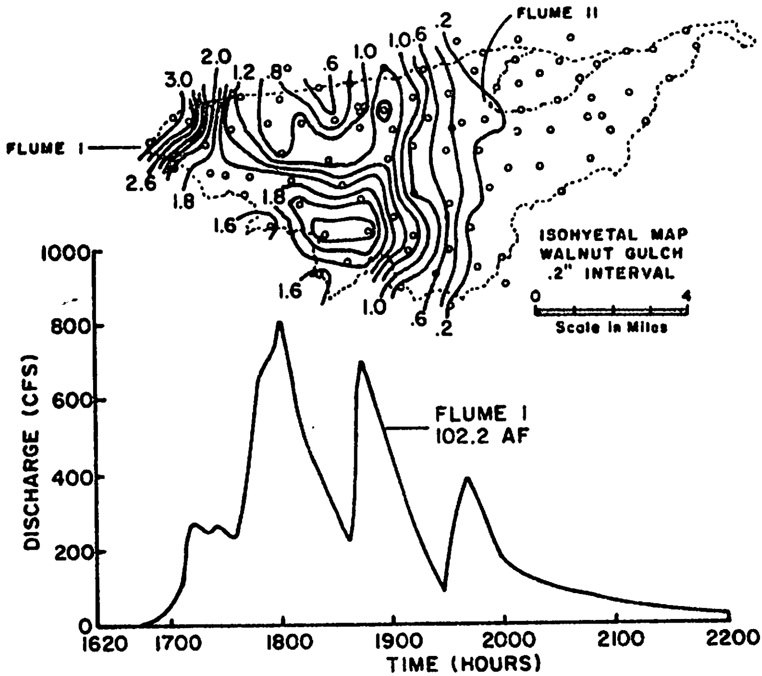

FIG. 7.—Storm of August 25, 1968 Was Concentrated in Lower Portion of Watershed; Multipeaked Hydrograph Resulted from Runoff in Various Tributaries and from Longer Duration Hyetograph with Several Periods of Precipitation Excess

streamflow are much less, and in fact, runoff from different tributaries results in a multipeaked hydrograph. If the storm timing was such that all peaks arrived at the same time, the flood peak would have been significantly larger.

In summary, it should be apparent that no single precipitation gage will provide an adequate representation of the input to the watershed for a single runoff event. Thus, the frequency relationship between individual precipitation events and corresponding runoff is nonexistent in ephemeral streams in southwestern United States. Given that the raingages at Tombstone were used for these two events, it would not have recorded the storm shown in Fig. 6, and would have seriously underestimated the precipitation producing the runoff in Fig. 7.