

OBSERVATIONS OF PRECIPITATION VARIABILITY

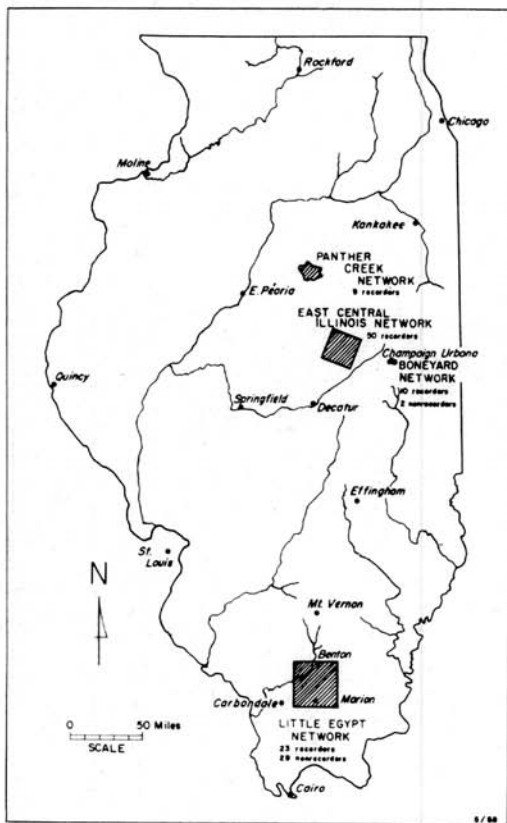
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INTRODUCTION

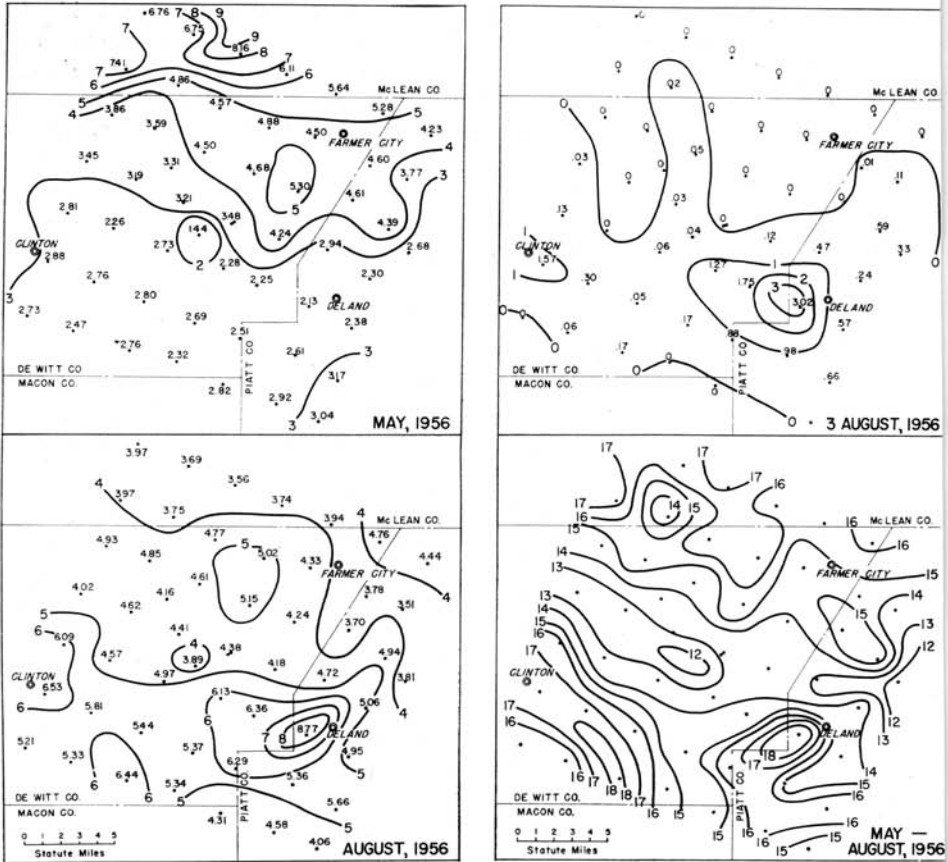
Since 1949, the Illinois State Water Survey has been studying the areal and temporal variability of precipitation as determined from four dense networks of rain gages. Great variability in warm-season

storm-rainfall was readily evident early in the study. After data for several years had been compiled, large differences in monthly and seasonal amounts between stations also became apparent. Since 1956,



STATE WATER SURVEY RAINGAGE NETWORKS

Figure 1.



three of the rain-gage networks have been operated continuously to record cold-season and annual precipitation in addition to the warm-season data. The fourth rain-gage network has been operated continuously since 1949. Analysis of these data has also revealed considerable areal variability in cold-season and annual precipitation.

Three of the networks are located in central Illinois and the fourth network is located in southern Illinois (Fig. 1). The Boneyard network in Champaign-Urbana consists of 10 recording and two non-recording rain gages in an area of about 15 square miles. The East Central Illinois network, located about 25 miles west of Champaign-Urbana, includes 50 recording rain gages arranged in an approximately homogeneous pattern over an area of 400 square miles. The Panther Creek network is located near El Paso, Illinois, about 70 miles northwest of Champaign-Urbana, and consists of nine recording rain gages in an area of 95 square miles on the Panther Creek watershed. Centered around West Frankfort, the Little Egypt network in southern Illinois consists of 22 recording and 28 non-recording rain gages spaced over an area of 540 square miles. All of the recording rain gages are serviced weekly by Survey personnel.

STORM, MONTHLY, AND SEASONAL PRECIPITATION

The great variability in storm, monthly, and seasonal precipitation that can occur during the warmer half of the year on the East Central

Illinois network is shown in Figure 2. On August 3, 1956, rainfall varied from three inches to zero within a distance of five miles. The monthly totals for May and August 1956 indicate a maximum difference of nearly 600 percent between points within the network during May and more than 200 percent in August. During the 1956 growing season, May-August, gages near Deland in the southeast corner of the network indicated 50 percent more rainfall than gages near the center of the network.

Figure 3 illustrates the variability in precipitation during the cold season on the East Central Illinois network. These isohyetal maps were prepared from the records of 25 rainfall stations instead of the 50 normally in operation. Precipitation during the extremely damaging ice-storm of January 20-21, 1959, varied from a low of 0.72 inch to a high of 1.80 inches. The melted-water content resulting from the heavy, wet snowfall of March 9-10, 1959, is shown in the upper right portion of the figure. The lowest amount was 0.09 inch while the highest amount was 0.62 inch, and the snowfall varied from about one inch to over six inches. The precipitation pattern during February 1959 shows a maximum difference of 1.17 inches in a distance of eight miles. For the period November 1958 through February 1959, seasonal values varied considerably with distance. A maximum range from 8.56 to 12.23 inches, or a seasonal difference of 3.67 inches, was recorded in a distance of nine miles.

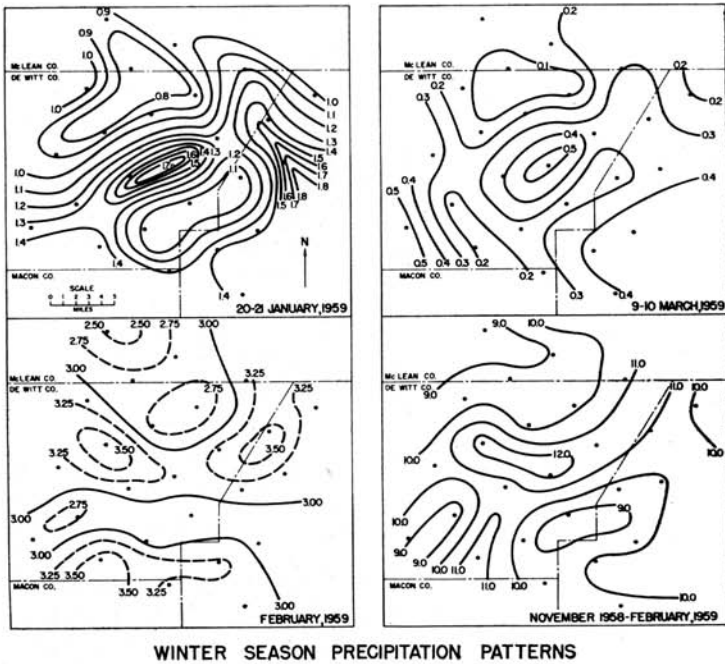


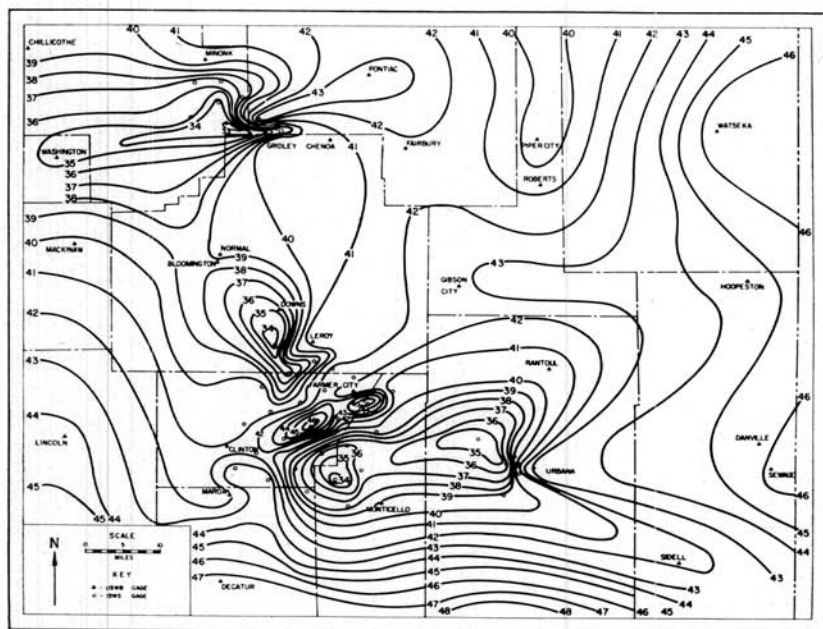
Figure 3.

ANNUAL PRECIPITATION

Since 1956, annual operation of the dense rain-gage networks has provided data on the variability of annual precipitation. Table 1 shows the mean annual precipitation on each network, highest and lowest station amounts, percent of the mean, difference and distance between the highest and lowest amounts, and the maximum point-to-point difference in inches per mile. A maximum difference of eight inches per mile was observed on the small Boneyard network in 1958, while the three larger networks had maximum differences ranging from two to five inches per mile during 1956-58.

Annual Precipitation Variability

Figure 4 shows the annual precipitation pattern for central Illinois in 1957, based on data from the three dense networks and on data from the 28 U. S. Weather Bureau climatological stations. Considerably greater detail is evident in the regions of the dense networks. Precipitation ranged from 43 inches to 35 inches in the Champaign-Urbana area, and from 46 inches to 34 inches in the area encompassed by the 50 gages in the East Central Illinois network located west of Champaign-Urbana. In the Panther Creek network, values ranged from 43 inches to 34 inches.



1957 PRECIPITATION AS BASED ON U.S. WEATHER BUREAU AND ILLINOIS STATE WATER SURVEY DATA

Figure 4.

The precipitation pattern for 1957, based solely on data from the Weather Bureau climatological stations, is shown in Figure 5. Steep gradients of precipitation evident in Figure 4 are eliminated, although there is still considerable variability. Long-term records indicate that the average annual precipitation in this region ranges from 34 inches in the north to 37 inches in the south (Fig. 6).

The average annual precipitation pattern in Illinois (Fig. 6) shows relatively large differences in rainfall within distances of 30 miles or less in many areas of Illinois. Research is currently underway to determine the causes of these average differences and the extreme variabil-

ity that occurs in a single year. When annual precipitation data are used in hydrologic studies, such as determining the potential water resources of an area, one must select data that are representative of the area being studied.

Annual Small-Scale Variability

Variations within short distances, as exhibited in the patterns of precipitation for 1957, might be considered as having a minor effect on the average annual precipitation pattern. However, the 10-year average distribution of precipitation in the Boneyard network (Fig. 7) indicates otherwise (Changnon, 1959). Average values vary from 30 to 35 inches within this network of 15 square miles. The heavier precipita-

TABLE 1.—Annual Rainfall Statistics from Dense Rain Gage Networks.

Network	Year	Area per Gage	Mean Rainfall	Highest Amount	% above Mean	Lowest Amount	% below Mean	Difference in Highest and Lowest Amounts	Difference Between Highest and Lowest Amounts	Maximum Point-to-Point Difference
		(sq. mi.)	(inches)	(inches)		(inches)		(inches)	(inches)	(inches per mile)
East Central.....	1958	16.0*	34.20	41.15	20	30.95	10	10.20	5.5	2.26
East Central.....	1957	14.9*	39.95	46.67	17	33.60	16	13.07	7.5	2.94
Boneyard.....	1958	1.25	34.41	39.80	16	30.01	13	9.79	3.0	8.28
Boneyard.....	1957	1.50	39.11	43.52	11	35.01	22	8.51	4.5	7.20
Little Egypt.....	1958	10.8	45.05	54.38	21	39.40	13	14.98	22.0	3.26
Panther Creek.....	1958	10.6	29.11	38.06	31	24.05	17	14.01	8.5	4.12
Panther Creek.....	1957	10.6	35.82	43.26	21	32.83	8	10.43	4.0	4.82
Panther Creek.....	1956	10.6	19.33	25.19	30	14.92	23	10.27	4.0	2.33

* Cold Season Density.

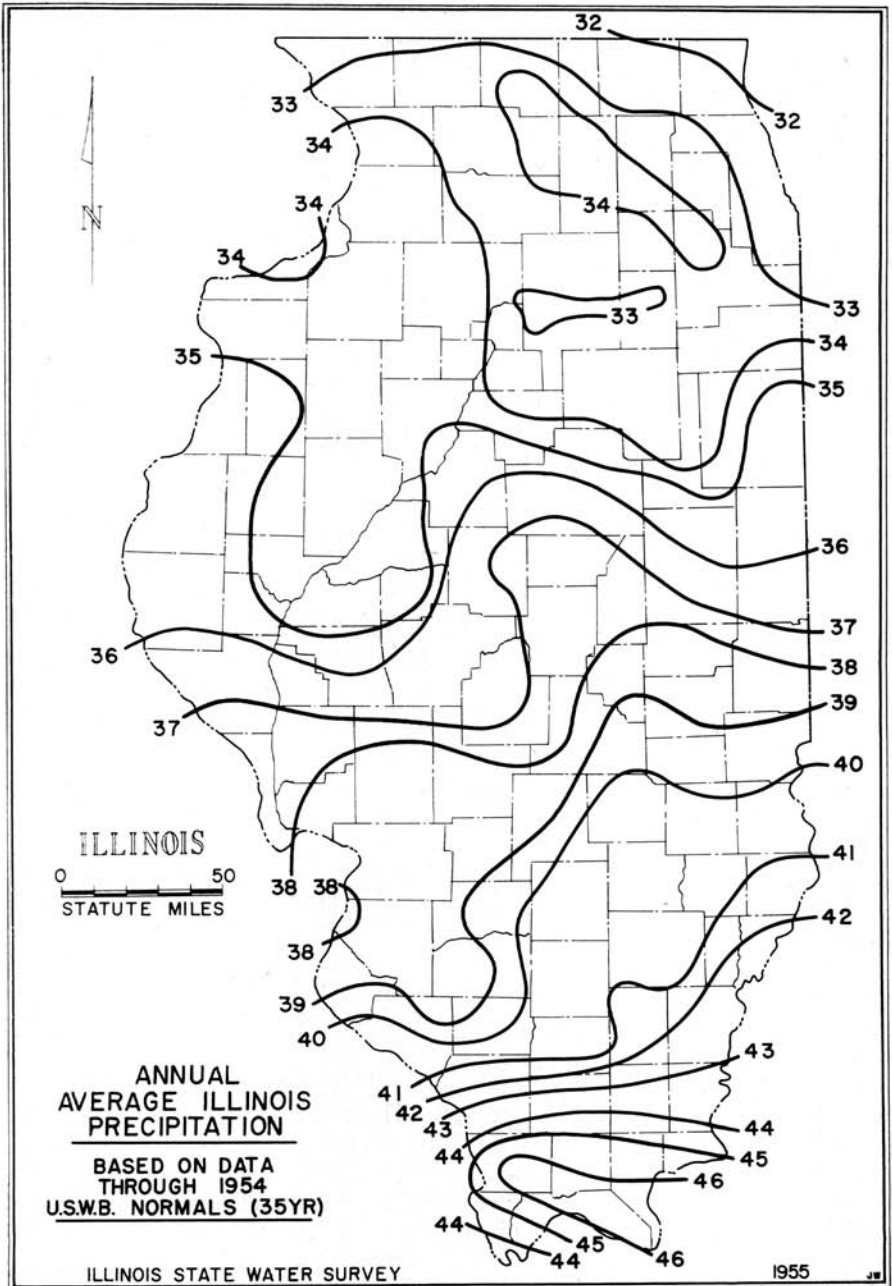


Figure 6.

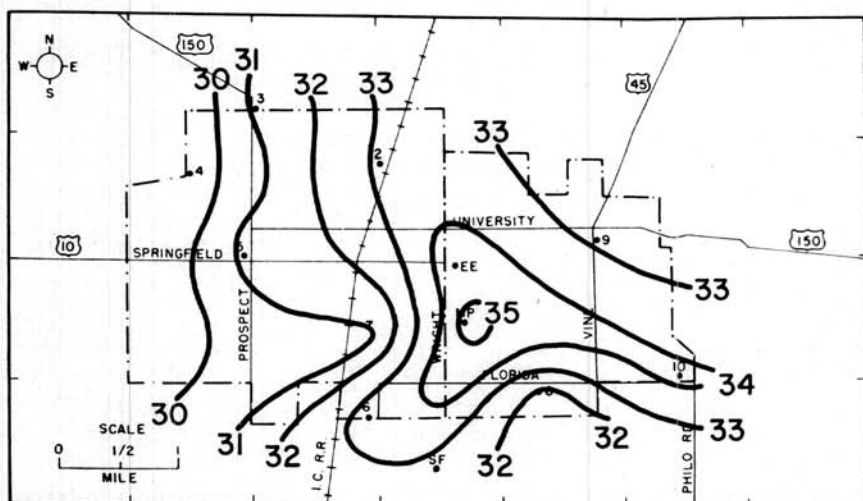


Fig. 7.—Average annual precipitation for Champaign-Urbana, 1949-1957.

A study of 10 years of precipitation records from gages located throughout Champaign-Urbana indicates that the average annual precipitation over the central part of these cities is five inches greater than the precipitation recorded on the western edge of Champaign. Urban effects on the rainfall process are considered responsible for part of this difference.

ACKNOWLEDGMENTS

The author is indebted to Stanley A. Changnon and Douglas M. A.

Jones for the computation of much of the data and to members of the staff of the Illinois State Water Survey who reviewed the manuscript.

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