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PRECIPITATION IN ILLINOIS 1860 - 1970

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ABSTRACT.—Precipitation records of 110 years in Illinois were analyzed and discussed in relation to tornadoes, hail, sleet, snow, wet cycles, droughts, thunderstorms, industry, agriculture, topography, and pollution.

Ever since man appeared on this planet, water has meant "life" for him. He soon learned that the plants he ate, the animals he hunted, and the sanitation he needed depended upon precipitation.

It was not unusual for the American Indian to have his medicine man vainly attempt to regulate this unchained goddess through ceremonial dances and sacrifices. He would beat on drums to imitate thunder, throw firebrands in the air to simulate lightning, and blow mouthfuls of water into the air like rain or mist as an example for the heavens to do the same.

"Praying for rain" is an idea firmly rooted in our culture and language. Men prayed to the dead and then to the gods for rain. Some men still do so, just as some still stage rain dances that are combined magico-religious rites. The rain god was an important figure and Jupiter-Pluvius reigned among the supreme.

Today our major cities are facing a greater water crisis than ever before. The high standard of living we are accustomed to and our ever-increasing population are making demands on our water supplies never before anticipated. To modern man, water not only means "life," it means his very survival.

EARLY MEASUREMENTS IN ILLINOIS

The first rain measurements were taken about the time the first bowls

or vessels were left exposed to the elements, intentionally or otherwise. Mention is made of rain measurements in India as early as 400 B.C., and the Masenah, a collection of religious writings of the first century, tells of recorded measures of rainfall in Palestine during the first century of our era. These are the first quantitative observations of precipitation now in existence.

Early precipitation measurements in Illinois were crude and unreliable in many parts of the state, especially in the small rural towns where the interested person was selected for the tedious job of daily weather recording. Reliable and dependable recorders were rare and had little responsibility for accuracy and dependability.

Gradually, as small farm communities grew into organized communities, the U.S. government post office became the local weather station. Reliability and accuracy improved under government control and regulations, so that by the mid-19th century dependable weather readings were being compiled. The number of first-order stations were increasing throughout the state, with even more second-order stations in more isolated regions.

The need was not great. Much of the state was rural and its needs were limited to the farmers' needs for crop growth and harvest conditions, and — of primary concern — the last and first-frost expectancy. Droughts and floods were of natural interest since either could mean the difference between success and failure, even life and death, for an entire community.

Communities began to realize the importance of weather stations, since weather data over a period of years was helpful in weather forecasting. Growing season days for corn and other crops was of importance to rural Illinois, for only through past weather records were they able to forecast probable frost expectancies. A record of hail and sleet storms would give the farmer a better chance to prepare himself financially against such losses — thus the "Illinois Weather and Crop Bulletin" prepared jointly by the Illinois and U.S. Departments of Agriculture with the assistance of the ESSA Weather Bureau, which is published today to fill these very needs.

Records of precipitation for Chicago before 1867 were scant except for Hazen, who in his published "Climate of Chicago 1893" estimated precipitation for the city as far back as 1843, with figures obtained by interpolation. But in 1867 a series of observations were begun under the direction of the Smithsonian Institution and continued until establishment in 1870 of the local Weather Bureau Office, which then became custodian of official records.

G. J. Symon devoted a large part of his life to measuring rain and helped establish many precedents that are still practiced. He organized a large group of voluntary observers in England to furnish rainfall observations for the British Isles. He also was instrumental in instigating carefully controlled experiments on the construction, exposure, form, and operation of rain gages. The storm gage was constructed in 1868 and the float gage was revised in 1870.

The Thomas overflow gage was developed in 1904 for the sole purpose of obtaining excessive rainfalls. Several other gages were developed for maximum catch — the 1914 Beard Gimbal hung rotating gage and the 1945 Moore rotating max-

imum catch gage. The Stewart 3-inch gage, 1940, and the standard 18-inch rain gage have been the standard gages used by the U.S. Weather Bureau. Other inventors, like Frank W. Larson, Thomas J. Johnson, and the inventor of the German standard Hellmann rain gage, contributed to the development of our modern-day gages.

By 1918-27 the U.S. Weather Bureau Climatological network consisted of approximately 90 gages, and this had increased to 110 by 1937. More rapid increases in gage density followed and by 1942 there were 160 gages throughout Illinois. There were 250 by 1948 and 280 by 1957. Our present network of first order substation observers and the use of radar for precipitation measurement have given man an unexcelled opportunity to better understand his climatological environment.

The need for adequate instruments to calibrate radar for precipitation measurements pointed out the primitiveness of present-day rain gage. Thus, future rain gages may well be radar instruments since radar measures rainfall more accurately than a fairly dense climatological network of one rain gage per 200 square miles.

Basically the use of rain gages falls into three categories: nonrecording gages for climatological use, self-recording and totalizers for hydrology, and the calibration-type rain gage that accurately portrays rates of rainfall and accounts for cloud physics and radar studies.

NONRECORDING GAGE

The standard gage used for years around determination of precipitation on a climatological basis by various countries to measure rain and snow was considered of secondary importance.

The height of the rim above the funnel varies from 1 to 3 inches. Angle of inclination of the funnel

with vertical walls is also variable, ranging from 45° for New Zealand to 20° for Croatia. The rim should be designed to (1) provide a sharply defined orifice of substantial metal that will not be easily bent; (2) provide a rim high enough to prevent splashing out of the gage; (3) provide a steep enough funnel to bring the water smartly into the receiver and reduce splashout; (4) provide a minimum wetting surface; and (5) have a hole small enough to retard evaporation but not be easily clogged. Shielding of standard gages against wind losses has not generally been accepted because of additional costs.

Holding of precipitation after it has been caught is a principal cause of loss through evaporation. In warm climates, placing the gage into the ground or shade or painting the outside white will keep it cooler and reduce evaporation loss.

Measurement of rainfall can be done in three ways:

1. Weighing the catch — This method involves emptying the contents of the gage into a container of a known weight, then weighing and converting to inches of rain by a suitable table.
2. Use of a graduated measuring glass — This method is most commonly used in foreign countries with a bottle as a receiver and its contents transferred to an accurately graduated measuring glass.
3. Use of a measuring stick — This is the American method and is simple and direct. A graduated stick is used to measure the depth of water in a receiver. The graduations on the stick are calibrated to read in inches of rainfall.

PURPOSE AND SCOPE OF STUDY

The purpose of this study is to gain a better understanding of Illi-

nois precipitation. It is pertinent to observe the past, as well as present and future trends. Has man's activities changed precipitation? If so, how and why is it changing? By investigating the precipitation (rainfall, snowfall, hail, and sleet) for Illinois, one is able to understand weather phenomena such as droughts, wet cycles, tornadoes, thunderstorms, hail and sleet storms. Distribution of precipitation throughout the state was interpreted in relation to industrial and agricultural needs, as were the reasons why precipitation is greater in one geographic location than in another.

STORMS

The seasons of maximum cloudiness and storminess are during winter and spring. During the summer, the storm systems tend to be weaker and stay farther north, leaving Illinois with sunshine and intermediate thunderstorm activity of short duration. The fall months are associated with variable warm, dry periods, ending quickly with the return of storminess in November.

Precipitation during fall, winter, and spring falls uniformly over large areas, while summer showers are brief and erratic, affecting relatively small areas with uneven distribution. These summer thunderstorms often tend to be heavy, with hail and destructive winds, causing local flooding followed by runoff and soil erosion plus tornadoes and lightning.

THUNDERSTORMS

The average annual distribution of thunderstorms in Illinois has a maximum of 50 to 60 days in western and southern Illinois with lowest frequencies of less than 40 days in northeastern Illinois. Table 1 is a summary with the mean annual number of days of thunderstorm activity reported in state divisions. Thunderstorms produce between 38

percent and 45 percent of the average annual precipitation for Illinois with diurnal distribution occurrences in the winter months between 6 A.M. and 2 P.M. In spring (March-May) diurnal distribution is at a minimum from 10 A.M. to 12 P.M. The summer (June-August) thunderstorm minimum also is in the 10 A.M. to 12 P.M. period while the maximum is between 2 A.M. and 4 A.M. In the fall (September-November) midday minimums occur at all locations with maximum occurrence in the 8 P.M. to 10 P.M. period as well as the midnight to 2 A.M. hours. Thus the annual diurnal thunderstorm distribution minimum occurs in the 10 A.M. to 12 P.M. period and double maximum in the nocturnal hours. In northern and central Illinois the first maximum ends at 10 P.M. while in southern Illinois it ends at 8 P.M. The second maximum throughout

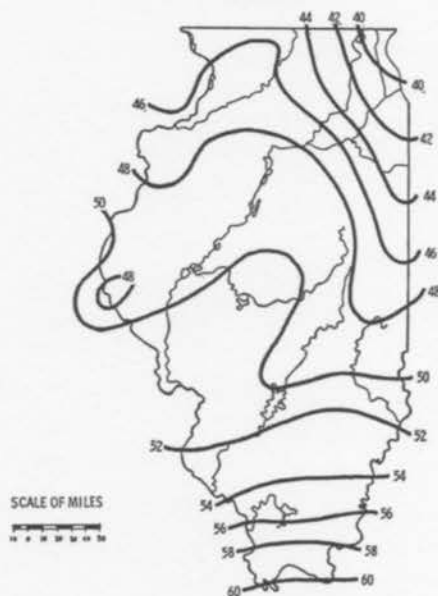
the state occurs between midnight and 4 A.M.

The average seasonal and monthly frequencies of days and hours with thunderstorms reveal that June and July are the peak months throughout Illinois with the longest durations in April-July and the shortest in the winter. During the 1950-1970 period the average long-term thunderstorm averages indicated that this period was below normal for thunderstorm frequencies. Figure 1 shows the annual thunderstorm frequency for the state of Illinois. You can see how the frequency of thunderstorms increases through the Shawnee Hills section and drops off rapidly to the north. The high frequency in the Rock River Hills sector drops off rapidly to the east to the minimum of 40 in the northeast corner of the state.

TABLE 1.—Illinois Climatic Summary.

PRECIPITATION IN INCHES	YRS.	NW	NE	W	C	E	WSW	ESE	SW	SE
Mean Annual	30	34.25	33.27	35.85	35.04	35.57	36.26	39.94	43.26	43.27
Maximum Annual and Year	38	46.38	41.49	46.85	45.56	43.93	47.39	55.46	60.45	66.83
		1965	1965	1965	1965	1965	1945	1957	1945	1950
Minimum Annual and Year	38	26.47	23.93	25.28	25.58	24.12	24.94	28.19	28.00	29.19
		1963	1956	1953	1963	1693	1953	1953	1953	1936
Max. Monthly Average Month & Year	38	10.05	11.55	11.92	10.72	10.08	10.88	11.86	12.96	14.04
		9/61	9/61	10/41	9/61	5/43	5/43	5/43	8/46	1/50
										10/64
Min. Monthly Average Month & Year	38	.05	.15	.15	.09	.17	.11	.11	.21	.11
		10/64	10/64	10/64	10/64	2/47	2/47	2/47	10/64	2/47
Mean Precipitation Season October - April	30	15.22	15.75	16.43	17.20	17.64	18.18	21.17	23.93	24.60
Mean Annual Number of Days with 10" or More	38	66	66	67	67	67	67	71	70	71
Mean Annual Number of Days With Thunderstorms	25	45	40	50	48	44	50	47	52	49
Mean Annual Snowfall	30	29.4	28.6	23.4	22.1	21.6	16.5	15.6	11.6	11.1

FIG. 1 ANNUAL THUNDERSTORM FREQUENCY



SLEET

Central Illinois has the highest sleet frequency with a six to seven-day occurrence per year, whereas points in northern and southern Illinois average five or six days of sleet. Regional variations exist in the diurnal distribution of sleet. In southern Illinois sleet is most common in the afternoon and relatively uncommon

in the morning. In the state's central areas, sleet is most common in the late afternoon, early evening, and early morning. In the northern part of the state, the mid-morning is the most frequent period for sleet and the late afternoon the least frequent. Table 2 illustrates the number of occurrences of sleet per 2-hour periods for the northwestern, central, and southeastern sectors of the state. Comparisons can be made during January, February, and March and the hours of termination.

HAIL STORMS

Of all weather phenomena, only hail has a short-duration, never more than 20 minutes and an average of only 7 minutes. In an average year, the number of hail days at any one station in Illinois varies from one to four. Hail is most frequent in the Springfield Plain area. Other regions with relatively high average frequencies are the Shawnee Hills of southern Illinois, the Rock River Hill country, and the Wisconsin Driftless Section in the northwestern part of the state. Areas experiencing the lowest number of hail days in an average year include a portion of the Galesburg Plain west of the Illinois River Valley and most of eastern Illinois.

The number of hail days varies

TABLE 2.—Number of occurrences of sleet per two-hour periods.

ENDING HOURS (CST)	JANUARY			FEBRUARY			MARCH			TOTALS		
	NW	C	SE	NW	C	SE	NW	C	SE	NW	C	SE
0200	3	6	5	3	0	0	0	1	2	10	8	11
0400	1	6	2	3	1	1	1	1	0	8	10	3
0600	2	4	3	3	3	1	0	4	0	7	14	4
0800	6	2	0	10	1	0	0	4	1	17	8	1
1000	5	3	4	7	2	2	1	1	3	15	9	9
1200	1	2	6	2	2	2	4	4	1	9	11	7
1400	1	2	8	0	2	0	4	1	0	8	7	13
1600	1	1	6	1	3	1	3	0	3	6	6	14
1800	3	4	4	1	3	1	1	4	1	7	15	12
2000	2	0	3	0	7	2	3	4	0	7	13	7
2200	2	2	2	4	5	4	5	2	2	11	10	12
2400	2	7	4	4	1	0	4	1	2	10	10	10
TOTAL	29	39	47	38	30	14	26	27	15	115	121	103

considerably from year to year and decade to decade, with as many as fourteen days of hail in a single year at one station and no hail days over much of the state. Usually, though, about 90 percent of the state experiences at least one day of hail in an average year. Eighty percent of hail days occur between March and August, and mostly in the spring, from March through May. The minimum

is reached in winter, with a gradual decrease through summer and fall.

TORNADOES

Tornadoes are the most violent of all storms, but their narrow, short, and random paths lessen their danger. In the early 1950's the Weather Bureau's efforts in making the public aware of tornadoes and their typical forms for rapid reporting and re-

TABLE 3.—A half century of tornadoes.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1956-65 (10 yrs.)	0	10	28	52	41	37	14	19	29	3	8	21	262
Tornado Days	0	4	12	28	21	25	8	16	11	3	2	2	132
Deaths	0	6	1	11	0	1	0	0	2	1	2	15	39
1916-55 (40 yrs.)	4	0	46	32	46	21	10	12	8	8	12	8	207
Tornado Days	3	0	22	19	28	19	10	9	6	4	5	4	129
Deaths	2	0	7	14	33	140	7	1	0	22	1	0	922
1965 Tornadoes	0	1	0	9	3	1	0	2	4	0	8	0	28
Tornado Days	0	1	0	3	1	1	0	2	2	0	2	0	12
Deaths	0	0	0	6	0	0	0	0	0	0	2	0	8
1964 Tornadoes	0	0	3	4	0	0	0	0	0	0	0	0	7
Tornado Days	0	0	2	2	0	0	0	0	0	0	0	0	4
Deaths	0	0	0	0	0	0	0	0	0	0	0	0	0
1963 Tornadoes	0	0	1	8	0	2	0	0	1	0	0	0	12
Tornado Days	0	0	1	4	0	2	0	0	1	0	0	0	8
Deaths	0	0	0	2	0	0	0	0	0	0	0	0	2
1962 Tornadoes	0	0	1	1	5	2	1	0	0	0	0	0	10
Tornado Days	0	0	1	1	4	2	1	0	0	0	0	0	9
Deaths	0	0	0	0	0	0	0	0	0	0	0	0	0
1961 Tornadoes	0	0	9	2	3	3	6	2	9	0	0	0	34
Tornado Days	0	0	2	2	1	3	2	2	4	0	0	0	16
Deaths	0	0	1	0	0	0	0	0	1	0	0	0	2
1960 Tornadoes	0	3	2	7	11	14	1	1	0	0	0	0	39
Tornado Days	0	1	1	4	4	8	2*	1	0	0	0	0	21
Deaths	0	0	0	0	0	0	0	0	0	0	0	0	0
1959 Tornadoes	0	3	5	1	5	1	3	3	14	2	0	0	37
Tornado Days	0	1	3	1	4	1	2	3	3	2	0	0	20
Deaths	0	0	0	0	0	0	0	0	1	0	0	0	1
1958 Tornadoes	0	0	0	4	6	7	3	5	0	1	0	0	26
Tornado Days	0	0	0	1	2	4	2	3	0	1	0	0	13
Deaths	0	0	0	1	0	0	0	0	0	1	0	0	2
1957 Tornadoes	0	0	5	4	6	5	0	0	0	0	0	21	41
Tornado Days	0	0	1	4	3	2	0	0	0	0	0	2	12
Deaths	0	0	0	0	0	1	0	0	0	0	0	15	16
1956 Tornadoes	0	3	2	12	2	2	6	1	0	0	0	0	26
Tornado Days	0	1	1	6	2	2	5	1	0	0	0	0	18
Deaths	0	6	0	2	0	0	0	0	0	0	0	0	8

*Single Tornado continued past midnight.

liable recognition has resulted in more sightings. Approaching storms may bring harmless but ominous-looking clouds which a frightened populace will mistakenly report as a tornado.

Tornadoes are most frequently associated with thunderstorms, which can move along a path of a hundred miles or more. Nine U.S. tornadoes during the last fifty years covered paths of 200 miles or more. Three of these touched Illinois. The Mattoon-Charleston tornado of May 26, 1917, had the longest officially reported path — 293 miles. The killer Tri-State tornado of March 18, 1925, had a 219-mile path, mostly in the Murphysboro and West Frankfort area. On April 17, 1922, a less fatal tornado traversed 210 miles in Illinois, Indiana, and Ohio. Most tornado paths have an average range of about 15 miles.

Illinois tornadoes can hit any hour of the day or night, but 75 percent of them have occurred between noon and midnight, about 65 percent between 2 and 8 P.M. and nearly 50 percent between 3 and 7 P.M. Less than 50 percent occurred between 6 A.M. and noon.

Most tornadoes occur during the months of March, April, May, and June, with April and May the peak months. But no months can claim total immunity. Table 3 shows a half century of tornadoes from 1916 through 1965, when they occurred, and the number of deaths.

The mathematical probability that a specific location will be struck by a tornado in any one year is small, but statistics seem meaningless when one considers an 1888 tornado that killed 18 people in Mt. Vernon. Then on December 18, 1957, two tornadoes just 35 minutes apart again struck

TABLE 4.—Counties with the fewest number of tornadoes.

<i>One Since 1916</i>	
Scott	4-24-61
Harden	6-10-59
<i>Two Tornadoes</i>	
Bond	12-2-50, 2-5-60
Calhoun	4-19-27, 5-31-58
Menard	3-26-48, 3-12-54
<i>Three Tornadoes</i>	
Pope	5-12-18, 3-2-40, 4-30-40
Johnson	3-2-40, one death, 4-30-40, 12-18-57
Williamson	3-18-25, seven deaths, 5-9-27, 12-18-57
Jo Davies	5-16-56, 7-9-66, 6-11-67
Stephenson	6-22-44, 10-8-58, 4-17-57
Kendall	5-26-17, 8-15-58, 9-26-59
Cumberland	2-9-60, 3-6-61, 6-13-63
Schuyler	5-9-27, one death, 3-30-38, 3-14-57
Case	12-3-55, 6-10-57, 6-23-60
Henderson	4-18-63, 4-22-63, 1-24-67
Tutnam	8-29-28, 11-26-65, 4-21-67

COUNTIES WITH THE GREATEST NUMBER OF TORNADOES

Madison	16 tornadoes, 22 deaths
Randolph	17 tornadoes, 1 death
St. Clair	16 tornadoes, 16 deaths
Vermillion	17 tornadoes, 7 deaths
Macoupin	18 tornadoes, 5 deaths
<i>Highest Number</i>	
Champaign	21 tornadoes, 7 deaths
Cook	21 tornadoes, 55 deaths

Mt. Vernon. Every county in the state has experienced at least one tornado in the past fifty years, but the northwest and southeast portions of the state were most immune. The highest frequency of tornadoes occurs in an area approximately 50 miles from St. Louis and extends northeast to the northern suburbs of Chicago, with a southern line extending northeast to Danville.

In recent years Illinois' northern counties have had the greatest number of tornadoes while the southern half of the state has had the least.

The highest tornado death toll in Illinois was recorded on March 18, 1925, when 606 persons were killed in the Murphysboro and West Frankfort area between 1 and 4 P.M. On May 26, 1917, 106 persons were killed in the Mattoon-Charleston area at 3:26 P.M. On June 4, 1877, 16 lives were lost in a tornado which hit Mt. Carmel at 4:30 P.M. And on May 18, 1898, the Carroll-Ogle area recorded 16 deaths due to tornadoes.

On April 21, 1967, Belvidere experienced a severe tornado killing 24 persons between the hours of 3:50 and 4:25 P.M. On the same day, three lives were lost in between 5:24 and 5:39 P.M. Fifty-nine tornado deaths were reported in 1967, when 17 of the 40 tornadoes occurred in April, eight in January, five in June, three in May and December, and one each in March, July, August, and October (Table 4).

It is important to remember in observing where tornadoes occur the greater the county area, the greater the frequency of tornadoes. In other words, the more square miles there are in a county, the greater the chance of a tornado developing within its borders. Also, the heaviest occurrence of tornadoes is through the south central and north central section of the state, running in a southwest to northeast diagonal, and with Cook, Kane, and Will Counties in

the north; Champaign and Vermilion Counties in the central state and Macoupin, St. Clair, and Randolph Counties in the southwestern section.

DROUGHTS

A record of drought periods of varying durations were obtained from 1906-1955 data. These are recorded as 1908-1909, 1914-1915, 1931-1934, 1940-1941, and 1953-1954. All droughts are classified as to statewide severity and ranked according to severity, with durations of 3, 6, 12, 24, 36, 48, and 60-month periods.

The frequency of droughts for periods of 3 to 60 months in relation to severity is greatest in the southeastern, extreme southern and southwestern regions of the state. Normally, the severity of droughts decreases with the larger dry periods. One of the worst droughts in Illinois history from the standpoint of severity and extent occurred in the 1930's.

The regions of Illinois that are most susceptible to drought are elongated and oriented in a SW-NE axis, with shorter droughts in a NW-SE axis. The NS axis is usually found in droughts of 36 months and longer.

There is always a 50 percent chance of another drought somewhere in Illinois about 30 months after the first one. But the state enjoyed a major drought-free period from 1943 through 1951.

In northern Illinois very low readings were recorded in the years 1956 and 1957. Antioch recorded 22.35", Aurora 22.09", Chicago 21.19", Freeport 27.49", Elgin 22.17", Morris 22.30", Minonk 21.54", LaSalle 18.91", Galena 25.35", Galva 23.13", Joliet 25.74", Kankakee 25.18", Ottawa 22.06", PawPaw 24.93", Pontiac 22.94", Wheaton 23.44", Walnut 24.86", Tiskiliva 19.36", Streator 22.08", and Sycamore 22.08". Read-

ings in 1901 were 17.31" at Mt. Carroll, 19.33" at Alledo, 22.56" at Walnut, 25.52" at LaGrange, 22.21" at Aurora, and 20.11" at Ashton. Other stations experiencing minimums in that same northern region were Galesburg with 18.80", Marengo with 19.70", Galena with 20.44", Sycamore with 21.35", and Winnebago with 24.43".

In central Illinois, not as many low readings were recorded during these years, with Athens recording 25.12", Blomington 26.24", Golden 21.19", Hoopston 27.82", Macomb 26.73", LaHarpe 24.22", Roberts 26.52", Watseka 29.80". All recordings had a ten-year minimum.

A ten-year (1950 to 1960) minimum precipitation was reached in 1953 for southern Illinois with the

following readings, 30.04" Albion, 30.88" Anna, 24.82" Benton, 33.83" Cairo, 23.90" Carlyle, 30.15" Carbondale, 26.00" Centralia, 27" Carmi, 24" Chester, 26.32" Duquoin, 28.18" Edwardsville, 28" Flora, 29.68" Golconda, 25.04" Greenville, 31.62" Harrisburg, 27.57" McLeansboro, 30.80" Shaweetown, 23.32" Sparta, and Waterloo 20.04".

WET PERIODS

Southern Illinois had ten-year average maximum readings of 60.40" at Albion, 63.86" at Anna, 72.98" at Cairo, 57.82" at Carbondale, 53.68" at Carmi, 54.26" at Chester, 61.09" at Fairfield, 60.39" at Flora, 55.84" at McLeansboro, 60.36" at Mt. Carmel, 61.14" at Salem, 67.45" at Shaw-

TABLE 5.—TIME SCALE FOR PEAK PERIOD OF DROUGHTS

Year	3-Month Period		6-Month Period		12-Month Period		24-Month Period		36-Month Period		48-Month Period		60-Month Period	
	Period	Rank	Period	Rank	Period	Rank	Period	Rank	Period	Rank	Period	Rank	Period	Rank
1906	I	3	I	7					I	7				
1910	I	10			I	8	I	9	I		I	6	I	4
1915	I	7	I	11	I	5	I	2	I	1	I	7	I	5
	I	8	I	5			I	6	I	8	I	5		
1920	I	2	I	13	I	9	I		I	8	I	5		
	I	12			I	10	I	7	I	5	I	3	I	3
1925			I	10	I	7	I	8	I		I		I	
1930	I	1	I	7	I	2	I	3	I	3	I	2	I	1
	I	5	I	1	I	1	I	5	I		I		I	
1935	I	16	I	3	I	4			I	6			I	6
	I	4							I					
1940	I	7	I	4	I	6	I		I		I		I	
	I	14			I	11	I	1	I	4	I	4	I	
1945	I	11	I	8										
			I	12										
1950	I	13	I	2	I	3	I		I		I	1	I	2
	I	6					I	4	I	2	I		I	
1955			I		I		I		I		I		I	

TIME SCALE - YEARS

neetown, 54.51" at Sparta, and 50.49" at Waterloo.

In northern Illinois, 1954 was a wet year with these ten-year maximum precipitation readings: Joliet 44.69", Monmouth 40.31", Antioch 42.71", Aurora 47.03", Chicago 45.71", Elgin 42.41", Streator 39.50", Rochelle 41.02", Tiskilwa 43.78", and Wheaton 45.58".

In 1945, one in every three southern stations recorded maximum precipitation. Only about one to five northern stations experienced minimum precipitation during the same period.

In 1902, northern Illinois experienced one of its wettest years in a century with average maximum annual precipitation totals of 53.37" at Streator, 48.73" at Walnut, 51.68" at Tiskilwa, 48.89" at Dixon, 56.11" at Joliet, 53.09" at Monmouth, 49.97" at LaSalle, 51.54" at Mt. Carmel. The year before, some of these same stations experienced some of their driest years.

In summary, regions of heavy precipitation have corresponding regions of dryness throughout the state. This is also true in reverse, with drought conditions in southern counties and wet conditions in northern counties. A similar situation presents itself with reversals of extreme precipitation from one year to the next.

The reason for these reversals in yearly precipitation and area droughts is difficult to explain, but the condition seems to exist in all phases of weather phenomena. Eventually they do seem to balance off.

Figure 2 geographically shows the ending dates of the driest 24-month periods in 1922-1927. Table 5 illustrates the time scale for peak periods of droughts from 1906-1955 and their rankings in relation to their durations.

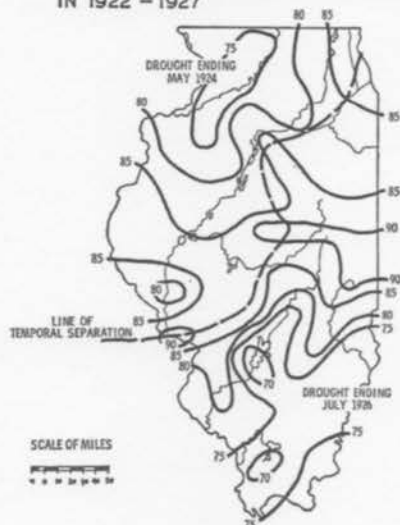
SNOW

The average annual snowfall ranges from 30" in the north to 10" in the

extreme south. Ninety percent of Cairo's seasonal snowfall ranges from 10" to 68" but Cairo has had 48" of snow in one winter and none in another winter. One-third of Cairo's winters have recorded less than 5" of snow. Snow cover in northern Illinois is 50 days annual average, as against only about 15 days in the south. Table 6 illustrates the average monthly and annual snowfall by divisions from 1931-1960. Monthly totals indicate which months receive the maximum snowfall and which receive the minimum.

Heavy snows, 4" to 6" or more, average one or two per year in northern areas and less frequently in the south, while the statewide winter snowfall has averaged approximately 21.5" for the seasons before the turn of the century up to the present. Thirty-seven winters have had that amount or more; 39 have had less. Eleven winters out of 76, which had an average snowfall of more than 30" are considered winters of "heavy snow." Four such winters occurred from 1900-1930. But the average

FIG. 2 ISOPERCENTILE PATTERN & ENDING DATES OF DRIEST 24 MO. PERIODS IN 1922 - 1927



snowfall from 1930-1950 was only 18.2" and no winter produced as much as 29". Our winters seem to follow a consistent pattern with heavy snow one season and light snow the next (Table 7). For example, in the winter of 1910 Illinois had less than 20" of snow. In contrast, the next season's snowfall was totaled over 40". Again, in 1912 we had less than 20" while the next winter recorded approximately 27".

Winters having approximately the same snowfall for two consecutive

seasons have been few during this century. They were the winters of 1914 and 1915, 1920 and 1921, 1936 and 1937, 1950 and 1951. The record for the least snow during the three winter months was established in the months of December 1930, through February 1931, with a state average of only 5.1". The most significant continuous snow shortage extended through three winters, 1920-1923, with an average of less than 12" for the period.

TABLE 6.—Average monthly & annual snowfall by climatological divisions 1931-60.

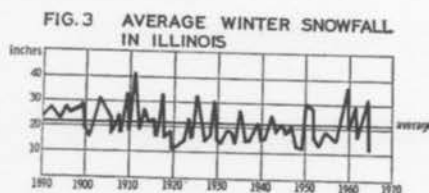
	NW	NE	W	C	E	WSW	ESE	SW	SE	Average Monthly Illinois Snowfall
January	7.6	7.2	6.0	5.2	4.6	3.7	3.2	2.9	2.6	4.8
February	5.7	6.1	4.8	4.8	4.9	3.5	3.3	2.8	3.0	4.3
March	6.2	5.3	5.3	4.6	4.1	3.8	3.7	2.6	2.3	4.2
April	0.7	0.8	0.8	0.5	0.5	0.2	0.2	0.1	0.1	0.4
November	2.1	2.3	1.4	2.0	2.5	1.5	1.5	1.0	0.8	1.7
December	7.1	6.9	5.1	5.0	5.0	3.8	3.7	2.2	2.3	4.6
1931-1960 30 yr. Ave.	29.4	28.6	23.4	22.1	21.6	16.5	15.6	11.6	11.1	20.0
1956-1965 10 yr. Ave.	32.6	33.1	29.0	27.2	25.6	22.0	20.9	14.3	14.6	24.4
1961-1965 5 yr. Ave.	33.4	35.2	29.9	27.5	27.3	23.7	23.8	13.7	15.9	25.4

TABLE 7.—Average monthly snowfall & extremes in inches for winters of 30 inches or more.

WINTER	OCT	NOV	DEC	JAN	FEB	MAR	APR	SEASON
1911-12		2.3	4.0	7.3	12.0	14.8	2.2	42.6
1959-60		3.4	2.9	3.3	12.4	17.3		39.3
1964-65		2.1	5.0	6.7	8.4	11.8		34.0
1917-18	0.8	0.3	9.9	20.8	2.0	0.2		34.0
1909-10		0.3	14.9	5.8	8.4		3.9	33.3
1925-26	2.3	3.2	3.1	5.7	3.3	9.9	5.0	32.5
1961-62		1.2	9.0	10.6	8.5	2.4	0.7	32.4
1903-04		1.3	6.5	11.6	6.0	5.0	1.6	32.0
1950-51		3.1	9.8	5.5	5.0	7.1	1.4	31.9
1929-30	1.9	1.4	9.5	12.1	1.4	5.2		31.5
1951-52		7.9	11.6	3.3	3.3	5.2	0.1	31.4

EXTREME FEBRUARY AVERAGE = 14.7 INCHES IN 1900

The relatively snow-free winter of 1965-1966 was again an example of little one year and heavy the next, with the record snowfall for Chicago in the winter of 1967. Figure 3 shows graphically the great diversity and fluctuations in snowfalls throughout the years that they have been recorded in Illinois. In conclusion, when considering trends and analogies, it is rather difficult to discern any definite trend (Figure 3), although there seem to be slight 20-year cycles of above-average snowfalls from 1900 to 1920 and below-average snowfalls from 1930 to 1950.



POLLUTION EFFECTS ON ILLINOIS PRECIPITATION

It has long been theorized that pollution of the atmosphere, through distribution of smoke, foreign particles, and gases, has contributed to precipitation changes.

There have been several studies in reference to these claims, especially in down wind localities of St. Louis, Champaign-Urbana, Peoria, Decatur, and LaPorte, Indiana. Many of these studies have ended inconclusively; others have indicated definite trends. Falconer and Vonnegut (1948) and Stout (1962) have reported that industrial effects may increase precipitation, and Landeberg (1956) has noted that large urban areas produce 5 to 15 percent increases in precipitation, frequencies of rainy days, and number of thunderstorm days. LaPorte, Indiana has recorded a 30 to 40 percent increase in precipitation and other related conditions since 1925, and the change compares favorably with the produc-

tion curve of the Chicago steel industrial complex 30 miles west.

A ten-year study of precipitation records from gages throughout the Champaign-Urbana area indicate 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. The major industrial complexes throughout the state produce great quantities of heat, moisture, condensation, and freezing nuclei conducive to sizable increases in precipitation.

A careful assessment of all available climatological data indicates that these sizable increases were real, not fictional, as related to micro-climatic conditions; however, the same cannot be said about the general statewide climate. Here there seem little if any consistent changes or trends to warrant any concern. Smoke and haze records indicate little increase until the early 1940's, and even then, the only definite effects have been local, not statewide (Figure 4). Of course, one of the major problems when assessing climatic changes is the percentage of error by the recorder and the short-time duration in official precipitation records.

Today, with the great interest in the effects of pollution on our environment, it is easy to make quick conclusions and assumptions. Atmospheric pollution has always been with us, not through man's involvement but in much greater degree through huge volcanic eruptions. Today we have definite proof that microclimatically man's pollution of his cities does affect the down-wind localities in direct proportion to the amount of pollutants in the air. If man continues to pollute his atmosphere at the same rate, it stands to reason that there will be major worldwide climatic changes that will have

a drastic influence on man's very survival.

Figure 5 geographically indicates some abnormalities in local microclimatic areas of the state, especially noticeable around industrial complexes.

TOPOGRAPHIC EFFECTS
ON PRECIPITATION

Illinois encompasses approximately

56,000 square miles, is centered near 40° north latitude and 89° west longitude, has a humid continental climate, and is located within a major thunderstorm region. The state is relatively flat except for the Shawnee Hills area in the extreme southern sector and the Rock River Hill country in northwestern Illinois.

The mean elevation above sea level

FIG. 4 ANNUAL NUMBER OF DAYS WITH SMOKE-HAZE CONDITIONS 3YR. AVE.

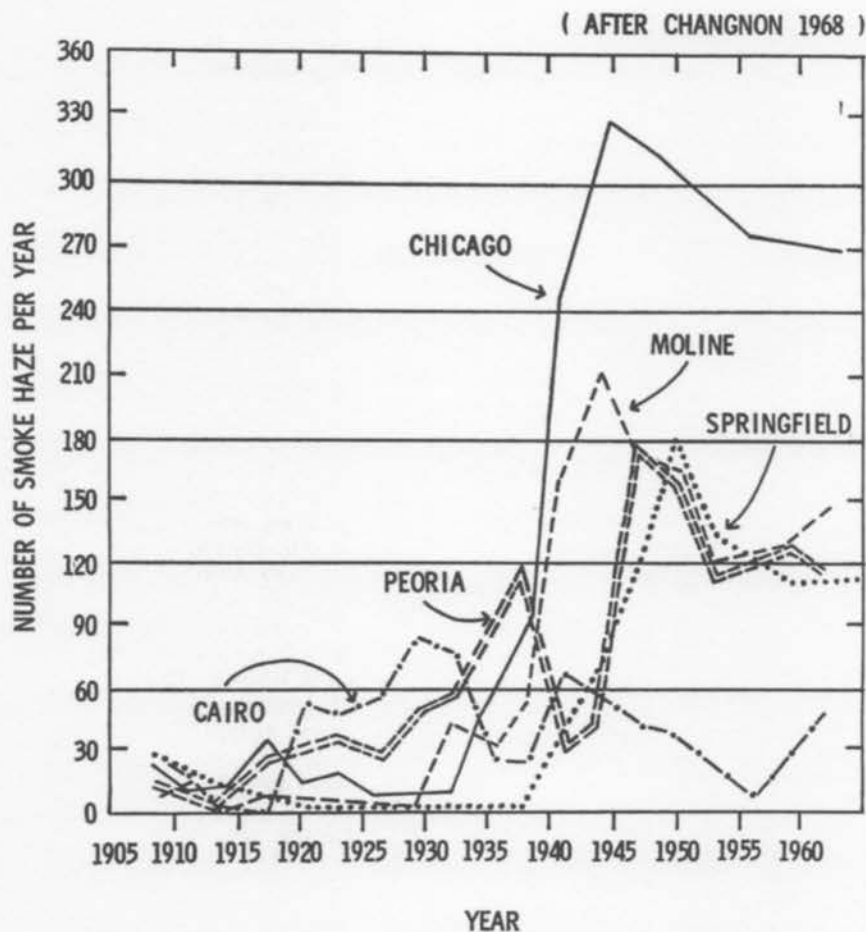


FIG. 5 1860-1930 AVE. MEAN PRECIPITATION



is 60 ft. and elevation varies from a low of 260 ft. in the south to a high of 1240 ft. in the northwest. The annual rainfall varies during the warmer half-year from 20 to 24 inches and in the colder half from 12 to 23 inches. The driest month is February and the wettest month varies from March in the south to June in the north.

The mean annual precipitation ranges from 32.6" in the northern part of the state to 47.5" in the extreme south. This is principally due to latitude difference which control both temperature and precipitation since the Gulf of Mexico with its warm air-mass temperature and high-moisture content is the primary source of precipitation in the central to eastern half of the U.S. The annual precipitation is approximately one and one-half times as great in the extreme south as in the extreme north, but most of the excess in the southern portion falls during winter and early spring.

The mean precipitation map il-

lustrates this fact with the isohyetal lines running basically from west to east in the extreme southern portion of the state and then begins running in a southwest to northeast axis just north of the Shawnee Hills sector. The topography of this region, with its higher elevations and rougher terrain, correlates very closely with greater precipitation in direct response to higher elevations. Precipitation falls off again to normal precipitation for its latitude just north of the Shawnee Hills region with an annual mean precipitation of 44 inches, the same as for the region south of the Shawnee Hills sector.

The 46" annual mean precipitation for the Shawnee Hills sector, plus greater thunderstorm and hail activity for this sector, seems to indicate definite topographical effects through greater turbulence and uplift of unstable air masses as they move north to northeast across the state.

There is a noticeable increase in thunderstorm and hail activity, as well, in the Rock River Hills region in northwestern Illinois. At this latitude the normal precipitation would average 32" to 33" instead of 34" to 35", which seems to be normal for the area. The isohyetal lines do not run in the normal southwest to northeast direction but almost in a north to south direction with the 35" annual mean precipitation running from about Grafton, Illinois, up to Keithsburg, some 115 miles to the north. This is probably due to the nearness of the thunderstorm centers in Missouri and Arkansas to the southwest and west of Illinois. The storm systems and weather fronts also move eastward and northeastward through the state, causing heavier amounts of rainfall from west to lighter amounts in the eastern tracks.

The Galena area receives an annual mean of 33" of precipitation that increases over the Rock Hills area to the west and then drops off

again from Marengo along a line to Gary, Indiana. Thus topography of these regions must be considered when considering the influential factors that might cause abnormal precipitation for specific locations. Figure 6 geographically illustrates these observations.

FIG. 6 MEAN ANNUAL PRECIPITATION (INCHES)



PRECIPITATION AND LAND USE

Land use in relation to precipitation throughout the state is adequate in certain areas and inadequate in others. Most of Illinois industry is well developed and located near Lake Michigan or along the major rivers of the state. Few industries are restricted by the climate, but some are restricted by water supply. Adequate ground water for industrial and municipal uses is limited to a few locations. Large areas in the central and southern portions of Illinois depend on artificial reservoirs which in turn depend greatly upon climatic factors of precipitation, runoff, evap-

oration, evapotranspiration, silting, and erosion.

Precipitation throughout the state is remarkably regular, and it is unusual to have prolonged dry periods during the growing season. Generally speaking, the state is extremely well suited for corn, soybeans, wheat, hay, and oats, with sufficient precipitation for truck farming in northern Illinois and around Chicago and St. Louis. The normal precipitation for July and August is insufficient to meet the demands of a vigorous growing field crop, so sub-soil moisture must be stored during the previous fall and spring for best crop production. The 32" to 48" of precipitation favor a very high standard of agricultural production throughout the state.

On the whole, land use and precipitation are usually quite adequate thanks to Illinois' lack of severe extremes. When they do exist, the extremes balance one another off over the long-term cycles. Variability in the climate on a daily and seasonal basis does promote a vigorous and healthy populace.

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