

# Record Heavy Rains in August 2007: Cause, Magnitude, and Impacts

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## ABSTRACT

August 2007 experienced record-setting rains in northern Illinois as the result of a persistent weather pattern. Northeastern Illinois received 11.61 inches, the highest August rainfall since 1895. Northwestern Illinois received 7.83 inches, the fifth highest since 1895. At least 35 sites received 10 inches or more of rainfall. These particular sites experienced either their wettest or second wettest August on record. The site with the most August rainfall was Genoa, Illinois, with 16.56 inches. Record rainfall, high winds, and high river levels over a densely populated area of the state combined to produce at least \$353 million in losses in August. Most of the losses stemmed from the August 23-24 storm event. Insured losses from that one event were \$213 million from personal property, commercial, and crop losses. The utility, transportation, and government sectors experienced additional losses of \$115 million.

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## INTRODUCTION

Heavy rainfall events have been a challenge in rapidly urbanizing northern Illinois in recent years. Heavy rainfall events can come as either large, singular events, or as a series of closely timed smaller events. Once the ground becomes saturated early in the sequence, the subsequent events can cause considerable damage, as a larger fraction of the rain becomes runoff. Impervious land surfaces such as roofs, parking lots, and roads increase the risk of flooding in these densely populated areas of the state. Damages can be considerable and include flooded homes and businesses, and disruptions of the transportation network.

Past studies have shown a pattern of wetter conditions in recent decades. Huff and Changnon (1987) found an apparent climate trend operating on the frequency distribution of heavy rainstorms in Illinois from 1901-1980. Angel and Huff (1997) observed this trend throughout the Midwest as well. Changnon and Westcott (2002) examined heavy rains from a dense raingage network in operation in the Chicago area since 1989 and found an increased frequency of heavy rainstorms. Angel et al. (1997) documented the heavy rainfall event of July 17-18, 1996, that fell over three states (Illinois, Indiana, and Wisconsin) and resulted in a new state record rainfall of 16.94 inches in 24 hours at Aurora, Illinois.

The trend towards more and heavier rainfall events brings special challenges to urban areas such as northeastern Illinois. Changnon (1996) outlined several impacts that heavy rains and flooding cause in urban areas. Typical impacts include the flooding of street and rail viaducts, and basements of businesses and residences. In addition, heavy rains can slow or stop traffic flow while floodwaters can disrupt bus and rail service. In addition, conditions causing heavy rainstorms are related to significant thunderstorm activity. As a result, high winds and lightning cause further damage during these episodes. As will be shown here, the heavy rains of August 2007 produced exactly these impacts.

## DATA AND METHODOLOGY

In this study, impacts from the storms and heavy rainfall were obtained from the media, federal, state, and local agencies, and the insurance industry. Climate data used in this study were obtained from the Midwestern Regional Climate Center (MRCC; <http://mrcc.sws.uiuc.edu/>). Daily temperature data originated at the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) cooperative observer network (COOP) for sites across Illinois and the upper Midwest. The NOAA National Climatic Data Center (NCDC) provided climate division monthly precipitation that began in 1895.

A second source of daily precipitation records is the newly formed Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS; <http://www.cocorahs.org/>). This group of volunteers with standard equipment (4-inch rain gage) and comprehensive training provided additional observations in northern Illinois. As a result, their observations are comparable to those taken by the NWS network.

Climate divisions are sub-regions of the state with similar climate characteristics. The two northern climate divisions are relevant to this study. The northwestern climate division covers JoDaviess, Stephenson, Winnebago, Carroll, Ogle, Whiteside, Lee, Rock Island, Mercer, Henry, Bureau, and Putnam Counties. The northeastern climate division covers Boone, McHenry, Lake, DeKalb, Kane, Cook, DuPage, LaSalle, Kendall, Grundy, and Will Counties.

## RESULTS

### Synoptic Discussion

According to the MRCC's Climate Watch (MRCC, 2007), the dominant weather feature in August 2007 was the location of the jet stream over the north-central Midwest and western Great Lakes region throughout much of the month. A quasi-stationary front in the Midwest, associated with the jet stream, served as a significant trigger for heavy rain and severe weather as it oscillated north and south through northern Illinois and southern Wisconsin.

The first series of rain events was during the period of August 5-7, initiated by a frontal boundary slowly moving through northern Illinois and by the arrival of a weak low-pressure system by August 7. Especially heavy rains fell during the afternoon and evening of August 6 and into the morning hours of August 7. Hardest hit were Stephenson, Boone, Winnebago, and McHenry Counties (Figure 1). Two CoCoRaHS reporters in Freeport

received 7.00 and 6.70 inches of rain while five CoCoRaHS reporters near Rockford received between 6.13 and 6.84 inches of rain. Rockford Airport received 5.15 inches of rain between 9 pm Central Daylight Time (CDT) on August 6 through 8 am CDT on August 7, a span of 11 hours. According to Huff and Angel (1992), this translates into a 35-year storm for that duration.

After a two-week period of relatively quiet conditions, heavy rains returned to Illinois during the period of August 19-21 as a frontal boundary stalled over northeastern Illinois. During this event, COOP observers at Genoa and Elgin received 6.13 and 5.80 inches, respectively. A CoCoRaHS observer near Harvard reported 7.04 inches. Other locations in northeastern Illinois reported amounts of 2 to 5 inches.

The last significant period of heavy rainfall occurred on August 23-24 (Figure 2) as the frontal boundary again stalled over the state. Particularly heavy rains during this period fell in Marsailles (7.00 inches), Peotone (6.45 inches), and DeKalb (6.36 inches), based on reports by COOP observers. By this time, the soils in many parts of northern Illinois were saturated already so the additional rains brought considerable flooding.

#### Rainfall Totals for the Month

Rainfall across the northwestern climate division averaged 7.83 inches, 3.46 inches above normal and the sixth wettest August since records began in 1895. Rainfall across the northeastern climate division averaged 11.61 inches, 7.40 inches above normal and the wettest August on record.

Monthly rainfall amounts at individual sites were even more impressive (Figure 3). In northwestern Illinois, six COOP sites had monthly totals of 10 inches or more. In all six sites, they were either the wettest or the second wettest August on record. The site with the largest rainfall total was Rockford with 13.98 inches, their wettest August on record. In northeastern Illinois, 29 sites had monthly totals of 10 inches or more and were either the wettest or the second wettest August in their period of record. The wettest was Genoa with 16.56 inches. Six sites had periods of record of 100 years or more. Of these, four had their wettest August on record – truly impressive given their length of record (Table 1).

The heavy rains reported above were not confined to Illinois. As seen in Figure 3, heavy rainfall amounts were reported across the upper Midwest from this series of events. Amounts were largest in northeastern Iowa, southeastern Minnesota, and southern Wisconsin. Seventy-seven sites in Iowa had rainfall totals of 10 inches or more with the highest total of 19.43 inches at Rathbun Dam. Thirty-one sites in Minnesota had rainfall totals of 10 inches or more with the highest total of 23.86 inches at Hokah. Seventy-two sites in Wisconsin had rainfall totals of 10 inches or more with the highest total of 21.74 inches at Viroqua. The heavy rains in Wisconsin were especially significant for Illinois because the Rock, Kishwaukee, Fox, and Des Plaines watersheds extend into southern Wisconsin.

#### Extreme Events

Several of the rain events in August could be categorized as being extreme events, defined here as having an expected return period of two years or longer for storm durations up to 10 days as determined from values in Huff and Angel (1992). They did not

make calculations for durations longer than 10 days. An examination of 1-, 2-, 3-, 5-, and 10-day precipitation totals from 73 COOP sites in northern Illinois revealed that 60 sites (82 percent) experienced extreme events during the wet August. From those sites, 23 had an extreme 1-day event, 44 had an extreme 2-day event, 47 had an extreme 3-day event, 58 had an extreme 5-day event, and 54 had an extreme 10-day event. Of the 226 cases, 77 only met the 2-year event threshold, 41 met the 5-year event, 61 met the 10-year event, 26 met the 25-year event, 17 met the 50-year event, and 4 met the 100-year event.

A case illustrating the extraordinary nature of the heavy rains can be found in the daily precipitation records for Genoa, DeKalb County, Illinois (Figure 4). Genoa received 16.56 inches in August, making it the wettest station in Illinois for the month. Within that period, Genoa experienced three outstanding events: a 3.75-inch total on August 7 that qualified as a 1-day, 5-year storm; a 6.11-inch total on August 19-20 that qualified as a 2-day, 30-year storm; and a 4.20-inch total on August 23-24 that qualified as a 2-day, 5-year storm.

## **IMPACTS**

The series of days with moderate to very heavy rains from August 5-24 resulted in much runoff, and flooding developed on several rivers in northeastern Illinois, especially after the heavy rains on August 23-24. These August rains all came from a series of thunderstorms, and at times the storms produced high winds and hail. The principal conditions causing the month's major impacts in the region on August 23-24 were heavy rains (>4 inches) and high winds. Winds in excess of 70 mph were reported in various parts of the Chicago metropolitan area during this last event.

The major sectors with impacts from the heavy rains, flooding, and high winds of August 2007 included:

- Property—houses, buildings, and vehicles
- Agriculture—growing crops
- Transportation—airlines, railroads, and vehicles
- Government—costs to prepare for flooding and to respond to damages
- Environment—major damage to thousands of trees, and release of polluted waters into Lake Michigan
- Power—widespread power outages and multiple days before repair
- Health and well-being—the storms resulted in two deaths—one from electrocution in a flooded basement and another person hit by a falling tree. Several hundred people had to be evacuated from flooded area in suburban communities along the Des Plaines and Fox Rivers.

### Property Losses

Several Illinois suburbs along the Fox and Des Plaines Rivers had serious flooding during August 23-28, and many places fought the floods with massive sandbagging efforts. Communities with major flood-related problems included Prospect Heights, Mc Henry, Gurnee, Des Plaines, and Riverside. The levels of the Des Plaines River reached near record levels at locations from the Wisconsin border south to west of Chicago. The Kishwaukee River also flooded and set all-time record high levels in the DeKalb area,

closing most bridges, destroying a golf course, and leading to the closure of Northern Illinois University. More than 600 persons in De Kalb and Sycamore had to be evacuated. Flooding on the Fox River extended south from Fox Lake past Geneva and to Morris where damages occurred. The Du Page River also had flooding which created damages in Bollingbrook and Plainfield. Most of the area's rivers drain into the Illinois River and it experienced levels well above flood stage on August 25 and as far south as Havana on August 31. The Mississippi River exceeded flood stages in late August at Quincy and Grafton, a result of the heavy rains in northwestern Illinois and southern Wisconsin.

The high winds, particularly on August 23, caused thousands of trees and branches to fall. Many fell on homes and vehicles, causing serious damages. Severe wind damages were reported in Schaumburg and Wilmette.

The property insurance industry assesses major loss events and if the losses to personal and commercial property (including vehicles) exceed \$25 million, an event is called a catastrophe. Two such catastrophes occurred in Illinois and adjacent states during August 2007. On August 8-9, Illinois had \$25 million in property losses in the Rockford area, with \$5 million in Missouri and \$62 million in Ohio. Then on August 23-24, Illinois experienced \$200 million in insured property losses. Two other catastrophes occurred in Minnesota and Wisconsin during August 2007. Storms on August 10 created property losses of \$160 million in those two states, and then storms on August 13 caused losses totaling \$220 million.

The types and amounts of loss on August 23-24 in Illinois and Michigan are shown in Table 2. This reveals that losses to personal property were the major damages with \$150 million in Illinois. High winds of over 50 mph in this storm occurred in most of the suburbs north of Chicago. Commercial business losses ranked second and vehicle losses ranked third in Illinois. The total losses for Michigan were \$75 million and much of this was due to tornado damages. Besides the \$200 million in insured property losses, additional losses occurred in the agriculture, utility, transportation, and government sectors. These losses are shown in Table 3 and described below.

#### Agriculture

The rains were of some benefit to the corn and soybean crops of northern Illinois. However, some farmers reported that the rains and high winds caused soybeans to fall over and become entangled (i.e., lodging). The high winds also did considerable damage to corn crops including broken roots and stalks. One insurance firm had 900 claims related to the wind-damaged crops of August 23-24. Losses were estimated at \$13 million.

#### Transportation

The storms on August 23-24 caused a shutdown of O'Hare Airport at 3 pm on August 23 and many flights were cancelled and delayed. From 3 pm to 9 pm on August 23 Chicago had 342 flights cancelled. Thousands of travelers had to spend the night at O'Hare, but by noon on the 24<sup>th</sup> operations were back to normal. Thirteen flights to Chicago were diverted to Milwaukee. Chicago's Midway Airport also had many flights cancelled, and 26 incoming flights were diverted to other regional airports.

Flooding along the Mississippi River in northwestern Illinois caused rail lines adjacent to the river to be closed for 1 to 3 days. The Burlington Northern Sante Fe railroad main line from Chicago to Minneapolis had a washout just north of Galena, Illinois. Its trains had to be diverted to other rail lines for several days. Flooding of streets in several Chicago suburbs on August 23-25 stopped vehicular traffic. The high winds on August 23 led to massive power outages and this led to no power for crossing lights on railroads, and signals at hundreds of junctions were inoperable, causing major delays and numerous accidents. Losses and costs to transportation systems were \$33 million.

#### Government

The flooding and high wind damages impacted local city governments in many ways, and led to expensive repairs. Some communities along the Fox and Des Plaines Rivers were involved in sandbagging endeavors. On August 23, the National Weather Service issued a tornado warning for areas just west of Chicago, leading to many warnings, and sirens were sounded in Aurora, Montgomery, and Sugar Grove. Concern was raised later because the city of Chicago did not issue alerts from the tornado warning.

The state government reviewed the sizable damages, and Illinois' Governor declared Cook, Du Page, De Kalb, Kane, Lake, and Mc Henry counties as disaster areas, making them available for state and federal assistance. Furthermore, the Federal Emergency Management Agency (FEMA) made available grant money for future flood mitigation efforts. The total amount available was 15 percent of the amount paid out by FEMA for flood damages.

The flooding and local damages led to school closures on August 24 in several Chicago suburbs. Costs for repairs experienced by local and state government agencies amounted to \$19 million.

#### Environment

The high winds on August 23 caused thousands of trees to be blown down. Chicago had 3,000 trees down and Wilmette had 150. Other communities with massive tree damages included Evanston, Villa Park, Lombard, Lisle, Winnetka, and Elmhurst.

The heavy rains on August 23-24 created sizable runoff in Chicago. The Deep Tunnel system, designed to hold 1.8 billion gallons of floodwaters had filled by 7 pm on August 23. These floodwaters included untreated sewer waters. The Chicago Metropolitan Water Reclamation District had to open the locks at Wilmette and let the overflow of untreated water into Lake Michigan. This was the first time in five years such an action was necessary. A total of 224 million gallons of polluted water were released into the lake between 7 pm and 6 am on August 24. Local water experts testified that Chicago's drinking water, which is taken from cribs located farther out into the lake, was not polluted by these released floodwaters. However, swimmers were warned about using the beaches from Chicago to Waukegan in succeeding days.

#### Electrical Power

The storms of August 23 with widespread high winds blew down many power poles, and the thousands of downed trees and limbs also brought thousands of power lines down, creating a serious loss of power in parts of Chicago and many suburbs. Outages affected

650,000 consumers including 57,000 in Chicago. On August 25, 245,000 consumers were still without power with extensive outages existing in Glenview, Wilmette, and Des Plaines. Commonwealth Edison officials labeled this event as “one of the worst storms ever.” Thousands of homes and businesses were without power, street intersection control lights were out, and railroad-crossing signals were inoperable. By August 25, Commonwealth Edison had 800 crews, each with 2 or 3 men, working on 16-hour shifts to restore power. This included 200 workers imported from other power companies in Illinois. Most power had been restored by August 29, five days after the storm. The costs to repair the power systems were estimated as \$63 million.

### **SUMMARY**

A quasi-stationary front set up in northern Illinois in August 2007 produced record-setting heavy rains, flooding, and severe weather across the region. The major events occurred on August 5-7, 19-21, and 23-24. Rainfall amounts of 5 inches or more were common during these events. Many of these were classified as extreme events as they exceeded the amounts expected once every two years for storm durations of 1 to 10 days. As a result, northeastern Illinois experienced its wettest August since 1895 with a total of 11.61 inches. Northwestern Illinois experienced its sixth wettest August since 1895 with a total of 7.83 inches. Amounts at individual stations were even higher. Some 35 sites received rainfall of 10 inches or more while Genoa reported the largest total for the state, 16.56 inches.

These heavy rain events produced significant impacts. In particular, the August 23-24 storm in northeastern Illinois was of major proportions. Heavy rains fell, and floods and winds were at record or near record levels. The storms occurred in the state’s most heavily populated areas with a high density of high valued property. Several sectors of the economy were negatively impacted, including insured losses in personal and commercial property, and crop losses of \$213 million with additional losses of another \$115 million in transportation, government, and utilities. Combined with the \$25 million from the August 5-7 event, the total losses to Illinois in August were at least \$353 million.

The events in August 2007 fit the documented pattern of more frequent and heavier rainfall in recent decades in Illinois. The combined impact of record rainfall, high winds, and high river levels over a densely populated area produced sizeable financial impacts that underscore society’s continued vulnerability to such events. Their impacts should be considered in future planning and mitigation efforts.

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Table 1. Rainfall totals for August 2007 for the northwest and northeast climate divisions. A \*\* denotes those stations with over 100 years of data that set their all-time August record.

Name	Rainfall	Name	Rainfall
<b>Northwest Illinois</b>		Ottawa 5SW**	14.27
Rockford Airport	13.98	Marengo**	14.19
Roscoe 2SE	12.24	Barrington 3SW	13.84
Freeport Waste Wtr Pl	12.11	Woodstock 5NW	12.96
Shirland	11.62	Chicago Botanical Garden	12.76
Steward 3S	10.53	McHenry Wg Stratton L&D	12.71
Rochelle	10.23	Morris 1NW	12.59
Apple River Canyon St Pk	9.30	Mundelein 4WSW	12.48
Hennepin Water Trmt	8.92	Crystal Lake 4NW	12.12
Prophetstown	8.83	De Kalb	12.02
Oregon 3SW	8.29	Newark 2SSE	11.90
Geneseo	8.08	Streamwood	11.79
Aledo	7.96	Peru	11.66
Amboy	7.92	Harvard	11.55
Illinois City Dam 16	7.80	Antioch**	11.42
Kewanee 1E	7.66	Yorkville 3SW	11.17
Dixon 1NW	7.35	Mendota 2SE	10.91
Moline Wso Ap	7.34	Plano	10.86
Polo 5NW	7.32	Joliet Brandon Rd Dam	10.75
Rock Falls 3NE	7.25	Earlville 3S	10.65
Elizabeth	7.20	St Charles 7NW	10.49
Stockton 3NNE	7.16	Channahon Dresden Island	10.35
Galva	6.98	Monee Reservoir	10.10
Lanark	6.81	Spring Grove	10.06
Paw Paw 2NW	6.52	Romeoville Wfo	9.76
Rock Island L&D 15	6.10	Chicago OHare Ap	9.70
Galena	6.04	Little Red School House	9.68
Morrison	6.01	Plainfield 3ne	9.38
Woodhull	5.79	Aurora	9.20
Mount Carroll	5.52	Elburn	9.06
Fulton L&D #13	3.45	Chicago Midway Ap 3SW	8.76
<b>Northeast Illinois</b>		La Grange	8.72
Genoa 2SW	16.56	Shabbona 3S	8.30
Peotone	16.06	Glen Ellyn 4S	8.28
Elgin**	15.69	Oak Brook 2W	8.13
Belvidere	15.29	Park Forest	6.88
Marseilles Lock	14.46	Lansing	6.77
		Wheaton 3SE	5.56

Table 2. Types of loss and amounts of loss to property in Illinois and Michigan from storms on August 23-24, 2007.

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State	Vehicles			Personal Goods			Commercial		
	# claims	Avg	Total*	# claims	Avg	Total*	# claims	Avg	Total*
Illinois	7,000	\$2142	\$15	35,000	\$4285	\$150	6,000	5,883	\$35
Michigan	3,000	\$4916	\$6	12,000	\$4916	\$59	2,000	\$5,000	\$10

\*Losses in millions of dollars

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Table 3. Losses and costs associated with the severe storms on August 23-24, 2007.

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Sector	Losses/costs in millions of dollars
Property	\$200
Agriculture	\$13
Transportation	\$33
Government	\$19
Utilities	\$63
Total	\$328

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Figure 1. Map of 1-day precipitation ending August 7, 2007, at 7:00 a.m. CDT.

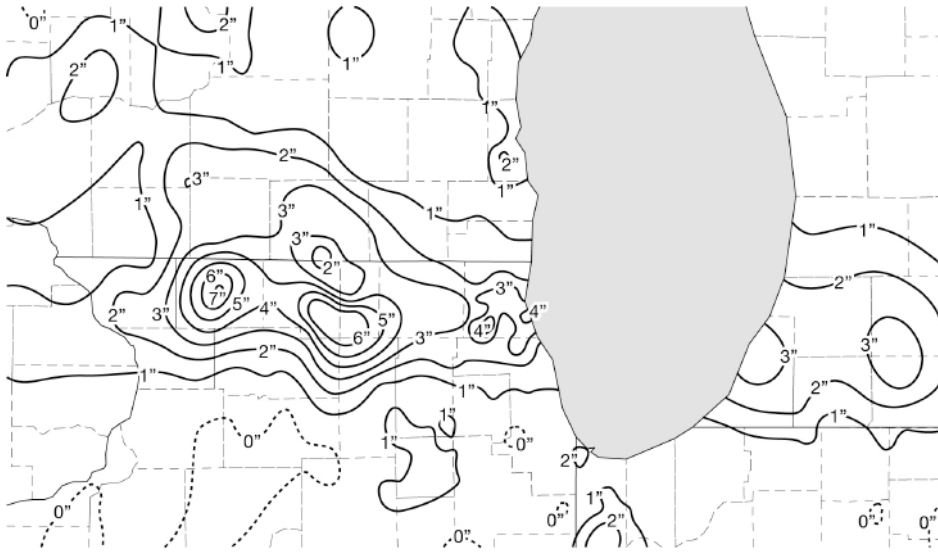


Figure 2. Map of 2-day precipitation ending August 24, 7 a.m. CDT.

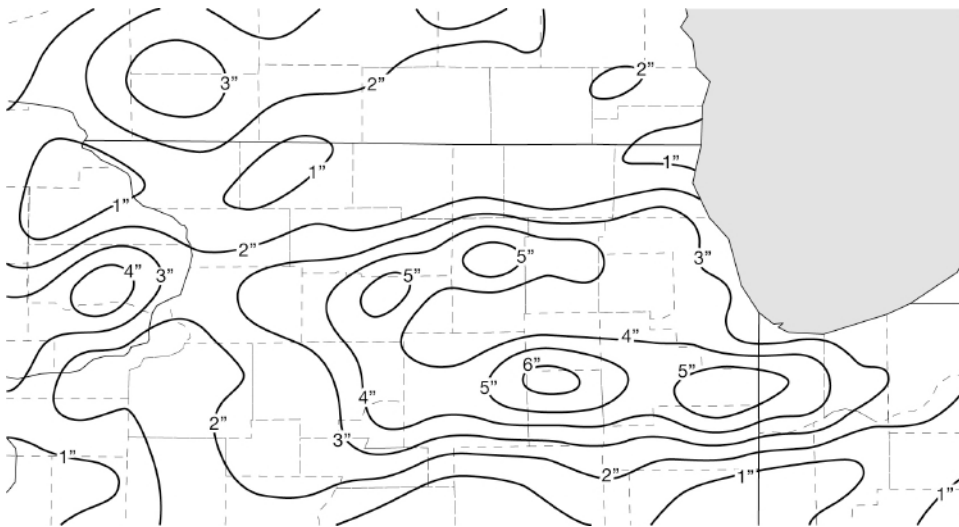


Figure 3. Map of monthly total precipitation for August 2007.

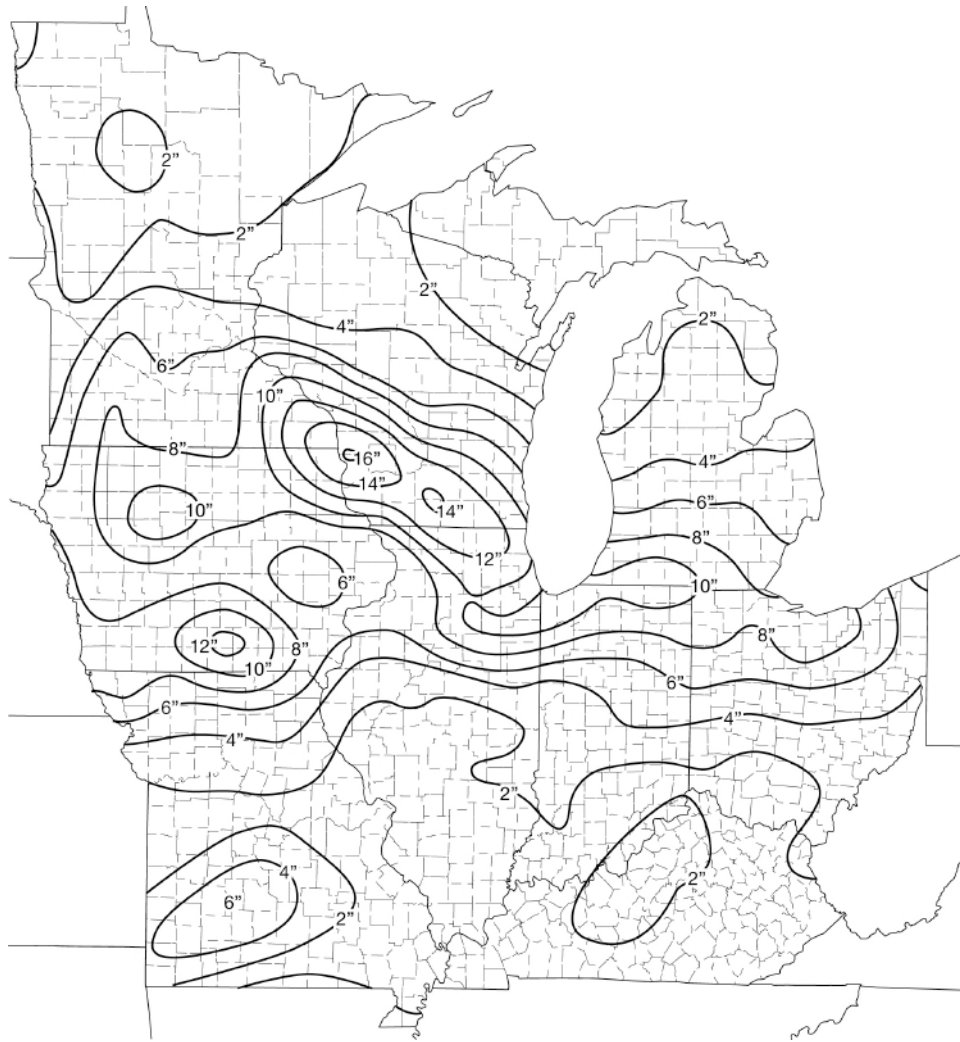


Figure 4. For Genoa, Illinois (DeKalb County) in August 2007, the daily precipitation (bars), accumulated precipitation (line), and the three outstanding rain events of the month (amounts, storm duration, and return period).

