

on the 7th. Two and eleven one hundredths inches fell at South Bend on the 13th, more than one-half of which fell within a very few minutes, causing some damage in the business section of the city by the flooding of basements. A storm on the 30th at Plymouth was accompanied by hail. The observer at Plymouth states that no damage resulted from it at Plymouth, but that crops in the eastern half of Marshall County were injured to some extent. The observers at Knox and South Bend recorded 13 thunderstorms at their respective stations.

A PHENOMENALLY HEAVY RAIN AT ALTON, ILL.

By MONTROSE W. HAYES, District Forecaster, St. Louis, Mo.

During the summer half-year local thunderstorms accompanied by rainfall of several inches occur frequently enough to cause no more than passing comment, and doubtless there is no locality to the east of the Rockies that has not a record of a rain of 4 or 5 inches in less than 24 hours, which is popularly referred to as a "cloud-burst." While 24-hour rains of 4, 5, or even 6 inches probably have fallen once or twice in many sections of the central part of the country in the last 30 or 40 years, when the fall gets much above 6 inches it should have a place in the list of very unusual phenomena.

At Alton, Ill., there was a rain during the night of July 13-14 that was, it is believed, unprecedented in the meteorological history of the middle Mississippi Valley.

July 13 was seasonably hot; at 7 p. m. there was an atmospheric depression over eastern New Mexico and southeastern Colorado, and a deeper depression extended from northern Nevada into North Dakota, with its center over eastern Montana and western North Dakota. There was an area of high pressure along the entire Atlantic coast, but the difference between the pressure extremes was only 0.62 inch. The weather was generally fair in all the territory to the east of the Rockies.

About 8 p. m. of the 13th occasional flashes of lightning were observed just above the horizon, in all directions. The display became more brilliant gradually, and shortly after 9 p. m. the whole sky was illumined by almost incessant sheetlike flashes. This continued, but with an increasing intensity, until about 12.50 a. m., when loud peals of thunder were heard and torrential rain began. Peculiarly, there was very little loud thunder during the first half of the night, although there were flashes, one following the other with an almost imperceptible intermission at all points of the compass. The flashes up to 12.50 a. m., or the approximate time of the first loud thunder, were mostly sheet lightning. As nearly as could be ascertained, light rain began about 11 p. m.; the heavy rain fell from 12.50 a. m. to 4 a. m.; more than 9.22 inches fell in the entire storm. There is no rain gage in Alton; the nearest is in East Alton, five miles from the part of Alton in which it is thought the precipitation was the heaviest; this gage caught 5.60 inches. In Alton several empty buckets and jars that had been left in places favorable for the measurement of rainfall were filled; after applying the formulae to ascertain the value of the contents of these vessels in inches and hundredths of rainfall, it was found that the deepest contained 9.22 inches. An empty washtub left in a yard overnight caught 9.50 inches, but was not filled. Unfortunately, the exact dimensions of this tub were not known and a reduction of the 9.50 inches could not be made.

The following evidences of the amount of rainfall were obtained from reliable sources by Mr. L. D. Yager, of Alton:

1. At the home of Reinhold Gossrau, 430 East Ninth Street, being about six blocks east of Ninth and Belle Streets, where the great damage was done, three buckets, to wit, a candy bucket, and two ordinary iron buckets, were in the yard, free from drippings or other outside influence. Saturday night they were empty; Sunday morning they were full.

2. At the home of Hon. John J. Brenholt, corporation counsel of the city of Alton, there were five concrete pillars set for the outside of a porch. They were a foot square, with 2-inch solid concrete on the outer edges, leaving a space 8 inches hollow in the center. In these columns there were found to be 7 inches of water after the great rainfall.

3. At the home of Joseph Curdie, 1607 Henry Street, an ordinary iron bucket left in the yard, and being out in the open, was found filled in the morning.

4. At the home of Mrs. Elizabeth Harris, 920 Burns Street, a tub left in the yard was found to be full Sunday morning; also, an iron bucket that had been placed on the cistern box on Saturday evening, in an empty condition, was found filled on Sunday morning.

5. At the boat dock of W. D. Fluent there were about 12 skiffs, all of which were overflowed within an hour after the heavy rain began. The heavy downpour began about 10 minutes to 1 o'clock on Sunday morning. Taking into account the flare of the skiffs and the curvature from stem to stern, it would be reasonable to assume that the actual depth was about 40 per cent of the depth measured. The skiffs average about 14 inches deep, making approximately 5.6 inches of rain in the first hour. Mr. Charles Norman, who was in charge of the dock, estimates the rainfall between 8 and 10 inches from 12.50 to 3.30 Sunday morning.

6. William Bradish, of 728 Langdon Street, states he is a member of the firm of Webb & Bradish, having a boathouse at the foot of State Street. They had 14 skiffs in the water, and when he came down early Sunday morning all the skiffs were filled with water. The 40 per cent estimate ought to apply here.

7. At the Equitable Powder Co.'s plant a rain gage had been established on account of a lawsuit involving rainfall. This plant is 5 miles east of the main point of destruction in Alton, and it is generally conceded that the rainfall at the powder plant was not so heavy as in Alton proper. On account of the flood no reading of the gage could be made until 2 p. m., Monday, July 15. The gauge then showed 5.6 inches, and it was estimated by Theodore Masel, the mechanic of the company, and Richard Stout, secretary, that the evaporation amounted to enough to have made the rainfall at the end of the storm to be about 6.5 inches. The gage used is practically the same as used by the United States Weather Bureau, having an 8-inch opening at the top.

8. At the store of Mr. Baum, in West Alton, Mo., about 4 miles southwest of the main point of destruction in Alton, there were two milk jars left in the yard on Saturday evening and in an empty condition. The jars are about 10 inches deep and the sides are straight up and down. These jars were found filled with water on Sunday morning.

9. L. D. Yager, compiler of this report, watched the storm from 12.50 a. m., Sunday until 3.30 a. m., same day. At first wind and clouds were from the east; at about 2 a. m. the wind and clouds were from the south, and at about 3 o'clock the wind and clouds were from the west, indicating that the storm hovered over the city and really crossed three times.

The damage done by water (there was practically no damage by lightning) was greatly augmented by the topography of Alton, which is an unusually hilly place. Belle Street, the scene of the greatest havoc, lies between two precipitous hills, and its extremity farthest from the river is steep.

At Twelfth and Belle Streets the water was over the curbstones at 1.15 a. m. After this the rate of rise is problematical, but mud lines on houses in Belle Street, below the steep portion of the thoroughfare, show that at some time there was a torrent 7 feet deep. In the principal business portion of the city the water was 2 to 3 feet deep and much damage was done to goods. Basements were filled with water and a heavy deposit of mud was left.

A 7-foot masonry sewer in Belle Street gave way in several places under the hydrostatic pressure and the street was washed out to a depth of 20 feet. This sewer gave way under the Alton Gas Works and a portion of the plant was wrecked. Small houses were washed away and in numerous houses several inches of mud was left on the first floor. Four persons were drowned by being caught in low-ceiled rooms. In some of the other streets paving bricks and macadam were washed out and the street bed eroded several feet.

The entire damage is conservatively estimated at \$250,000.

The storm was severest at Alton, but was very heavy along the river, particularly on the east side, from slightly above Alton to a short distance below St. Louis. In St. Louis rain fell from 2.32 a. m. to 4.52 a. m.; the total amount was 3.16 inches, of which 2.95 inches fell in one hour. This is the heaviest rainfall for one hour ever recorded in St. Louis. The nearest approach to it was in 1873, when 2.93 inches fell in one hour on June 9.

The weather chart prepared on observations made at 7 a. m., July 14, showed gradually increasing pressure from a depression over the Rocky Mountain slope (with its center near Winnipeg, Manitoba) to a wave of high pressure over the Atlantic seaboard; in the 24 hours just ended there had been no rain in the Mississippi Valley except over the limited territory covered by the storm just described.

SEVERE THUNDER STORM AT MINNEAPOLIS, MINN., JULY 12, 1912.

By MARTIN R. HOVDE, Assistant Observer.

Late in the afternoon of July 12, 1912, an unusually severe thunderstorm passed over Minneapolis. Excepting the tornadic disturbance of August, 1904, the storm was the most terrific the city had ever experienced. The morning weather map revealed an area of low pressure extending from the Canadian Province of Manitoba southward to Mexico with its center over eastern South Dakota and Nebraska. It foreboded unsettled weather and showers for eastern Minnesota. The day opened with light to fresh southeasterly and southerly winds, and occasional showers. By midday the temperature began to rise rapidly and the sky became generally clear. The barometer was falling slowly. Shortly before 4 p. m. the sky clouded rapidly in the west and southwest, and the thunderstorm and darkness approached. At 4.35 p. m. the rain began to fall at an excessive rate coincident with the sudden, outrushing squall. At 4.36 p. m. the extreme wind velocity was 90 miles an hour and for a five-minute period, 80 miles. Backing winds indicated a passage to the south of station. After a short interval (about 20 minutes) excessive rain set in again, 0.7 inch being recorded in 15 minutes. Before the hour had passed another storm was passing, winds now veering to southwest. An extreme velocity of 60 miles an hour was recorded at 6.07 p. m. The suddenness and severity of the winds may be inferred when one considers that the total wind movement for the hour of 4 to 5 and 6 to 7 p. m. were but 23 and 6 miles, respectively.

The total damage is conservatively estimated at \$25,000, confined principally to erosion of streets, blowing away of awnings, signs, etc., breakage of trees and windows, and flooding of low places and basements. Three lives were lost and a score of people were injured.

In a storm of this nature many curious and interesting experiences happen. A few are given, taken from the local press:

J. H. Rose saw the wind lift Leonard Gripp's garage from its foundation next door and carry the building 50 feet away. The automobile was left on the floor unharmed.

Fire Chief Ringer had to open the auto doors to let the rain water out of the machine while motoring to a fire.

Assistant Fire Chief Hamilton's auto was submerged in the street while responding to an alarm.

A strong gust of wind seized a delivery wagon and rolling the horse and wagon over and over carried the outfit across the street and dumped it down a steep incline into a ditch.

WISCONSIN RIVER FLOOD, JULY, 1912.

By JAMES H. SPENCE, Local Forecaster, Dubuque, Iowa.

The Wisconsin River flood from Rothschild to Merrill on the 23d and 24th of July, 1912, was one of the worst, if not the worst, on record for that section of the country. Conservative estimates place the loss at more than one-half million dollars. Torrential rains fell on the 23d immediately north and northeast of Wausau. At Merrill, Lincoln County, 11.25 inches was recorded. Only an inch fell at Grand Rapids, and 1.16 inches at Rhineland, while Wausau reports 4.50 inches; Prentice, 5.09 inches; Koepenick, 3.20 inches; and Antigo, 6.03 inches.

It was the great rainfall in Lincoln County that caused the flood. The result of the enormous downpour at Merrill is thus described in the Grand Rapids, Wis., Reporter, by Hon. Neal Brown, of Wausau:

A wall of water came down the river, taking out one dam after another. At Brokaw they didn't even have time to open the gates.

Mr. Brown further states in the Reporter that the flood loss is several hundred thousand dollars, and that among the dams carried out were the Wisconsin River Dam at Merrill; the Prairie River Dam of the Merrill Paper Co.; the Brokaw dam; the guard-lock Dam at Wausau; a small dam of the Wausau Street Railroad Co.; a part of the Brooks & Ross Dam at Schofield; while the cofferdam of the Marathon Paper Mills at Rothschild was blown out to relieve the pressure. Four bridges at Wausau and one at Schofield were carried out in whole or in part. Several million feet of logs between Wausau and Merrill were carried downstream, but a large amount was recovered. (See also Mr. Brown's letter at the close of this report.)

In an account of the flood the Wausau Record-Herald of July 24, 1912, says:

The "Old Wisconsin" went on a tear last night and continued the work of devastation to-day. The heavy and constant rainfall of 24 hours resulted in an extraordinary high stage of water last night, and about 10 o'clock the dam at Brokaw gave way, being unable to stand the strain. A telephone alarm was at once sent to this city, but before precautionary measures could be taken the crest of the flood was here. The water rose to an unusual height, said to be greater than for years.

As a matter of fact, the water at Wausau rose to 15.3 feet, or the highest ever known there by nearly 2 feet. It was about 1.8 feet higher than in September, 1881; about 4.1 feet higher than in September, 1900; and 4 feet higher than in October, 1911. The rise was from 3.6 feet at 7 a. m. of the 23d to 15.3 feet at about 10.30 a. m. of the 24th, or 11.7 feet in 27½ hours.

Mr. A. W. Trevill, postmaster at Wausau, reports as follows relative to the flood:

WAUSAU, WIS., July 30, 1912.

Information here given was obtained from the parties sustaining the loss, and is, I think, a fair estimate:

Barker & Stewart Lumber Co.....	\$20,000
J. Mortenson Lumber Co.....	25,000
Wausau Street R. R. Co.....	20,000
A. Kickbusch Grocery Co.....	3,000
The Northern Milling Co.....	1,500
Badger Turpentine Co.....	3,000
B. Heineman Lumber Co.....	5,000
Brokaw Paper Co.....	30,000
Marathon Paper Co.....	30,000
John Manser Saw Mill.....	10,000
Brooks & Ross Lumber Co.....	10,000
City of Wausau.....	35,000
Chicago, Milwaukee & St. Paul R. R.....	20,000
Chicago & Northwestern R. R.....	20,000
Total.....	232,500