

Bixby 20 houses were reported to have been demolished, and a number of oil tanks were damaged or blown away. This wind was not of tornadic character, but simply a straight blow with a front of 8 to 10 miles or more.

The heaviest rainfall, amounting in popular language to a cloudburst, fell in Tulsa, where 5.80 inches was recorded. At Broken Arrow 1.05 inches was recorded. These amounts are somewhat deficient on account of the high wind that accompanied the heaviest downpour. Hailstones 1 inch in diameter fell in Broken Arrow; in Tulsa one hailstone was found to measure 8 by 6½ inches in circumference, and another weighed 4½ ounces. The heaviest fall of hail occurred between Broken Arrow and Tulsa, shown by the dotted area on the map (fig. 2).

#### TORNADO AT FERGUS FALLS, MINN., JUNE 22, 1919.

On the afternoon of Sunday, June 22, 1919, at 4:45 p. m., the town of Fergus Falls was struck by a tornado which, almost in a twinkling, razed 228 houses, killed 57 people, and injured many more.

From descriptions given by persons who saw the tornado as it approached the city it appears that it was accompanied by all the phenomena which characterize such storms—a black, funnel-shaped, “twisting” cloud, or several of them, a heavy downpour of rain, and a terrific roar. Mrs. Elsie Rathbun, who watched the storm from the Great Northern Railway Station, is quoted in the Minneapolis Tribune as saying that “the storm approached rapidly, with black clouds pushing up from the west toward the city. Just before it struck Fergus Falls there was a humming like a dozen factories all full of buzzsaws running at once, and then when the storm arrived there was a pandemonium of noise.” Richard Krynen, according to the same paper, also watched the storm from the Great Northern station. He is quoted:

For a considerable time before the tornado struck there was a rumbling sound, and then it started to rain and rained hard. We thought the rain was going to stop, but hailstones the size of marbles began to fall.<sup>1</sup>

Quoting from the Minneapolis Journal of June 23, 1919:

The first storm, they say, struck the town from the northwest, and tore through the Lake Alice district. This was the one that wrecked the Grand Hotel. The second storm, which brought driving rain, approached from the southwest. A third, it is claimed, swept over the eastern portion of the town from the southeast, but did less damage.

Fergus Falls, with a population of 12,000, is situated in northwestern Minnesota. The town is divided into two sections, north and south of the Red River. It was the north portion that was demolished. See figures 1 and 2.

Telegraphing over hay-bale wire from Fergus Falls two days after the tornado occurred, Carlton W. Miles, of the Minneapolis Journal, said:

“Half the town looks like a vast acreage of kindling; the other half, save for trees split at the roots, is unharmed.”

But while it is true that only half the town was demolished, the line of wreckage could be clearly traced for a distance of 10 miles to the east, and a bank check was picked up 60 miles away. The property loss was \$3,500,000, of which \$500,000 was in automobiles, many of which were caught by flying débris. In one instance the force of the wind split a huge tree, threw

Here the hailstones said to have been the size of hens' eggs fell in large quantity. Over a wide area in this section the hail caused almost a total loss of what had promised to be an abundant crop of wheat and oats. Corn was torn to shreds, gardens obliterated, and fruit, particularly peaches, of which there were a number of commercial orchards, was nearly all knocked from the trees, while even the bark was seriously injured by the hail.

The flood in Tulsa resulting from the excessive rain caused property damage amounting to thousands of dollars. Houses were moved from their foundations (fig. 3), and garages and automobiles were washed away by a torrent several feet deep that raged through the lower sections of the city.

an automobile into the intersection, and then closed up the opening, holding the machine like a vise.

The following are some of the remarkable freaks of the tornado as recorded in the Minneapolis Journal of June 23, 24, and 25, 1919:

*Wind force.*—A trunk with clothing was carried from the residence of E. T. Barnard into the attic of a house two blocks away. The trunk was found uninjured.

A slender weed was driven 6 inches into a heavy plank.

Clover leaves were driven into the plaster in many residences on the north side of the river.

The Great Northern “Oriental Limited,” west-bound, was traveling between 30 and 40 miles an hour when the twister struck the baggage car behind the tender when about 6 miles east of Fergus Falls, throwing 7 of the 11 coaches from the rails. The baggage car was torn out of the train and set down about 30 feet from the rails at right angles to them. The suction also tore out the track under this car.

*Suction (explosive expansion of air as low pressure of tornado passed).*—In homes where there were stained-glass windows, the colored portion is intact although the regular window glass is broken.

In many homes all the clothing stored in closets disappeared in the storm.

In one flock of 30 chickens all their feathers were stripped off, and the chickens were found in the hen-house sitting up stiffly at attention. All of them were dead.

Agnes Palm, the little daughter of August Palm, was sitting on her father's lap in their home on the east side of Lake Alice. The father, mother, and sister were killed, but little Agnes escaped injury, although her shoes were torn from her and she was set down a short distance away.

*Localization of damage.*—Three houses stand alone on Cleveland Avenue north. The top story of each is sliced off as clean as if with a cleaving knife.

In the Knoff residence a cut-glass vase was carried from its resting place on a buffet over a pile of dishes, around a corner into the living room and was found unbroken on the floor.

The Levorsen house on Lakeside drive was so badly damaged that it was deemed unsafe to enter it. \* \* \* All the furniture was in splinters except the buffet, which was moved 2 feet from the wall with not a dish broken.

In one house every stick of furniture was destroyed with the exception of the piano and a talking machine, which were not even scratched.—H. Lyman.

<sup>1</sup> The *Literary Digest*, New York, July 26, 1919, pp. 38 and 40, has a detailed account of this storm and the damage wrought.



FIG. 1.—View of tornado damage in Fergus Falls, Minn. Note the trees stripped of bark, probably by the explosive action of the air in the bark, as the low pressure of the tornado passed. (Courtesy, *Minneapolis Journal*.)



FIG. 2.—Tornado destruction along Red River in Fergus Falls, Minn.

DISCUSSION.

The weather map showing the conditions two hours after the tornado occurred (fig. 3) fails to indicate any large cyclone or low-pressure system such as is usually associated with the occurrence of tornadoes. In this case, there was a small low with generally moderate winds. The weather in front of the center was cloudy and cool, while that in the rear was warm, hot in the southwest quadrant. Intermediate clouds at Minneapolis (Ci. Cu., SE.) and Duluth (A. St., S.) moving from the south indicated, perhaps, an unusual depth to the cyclonic circulation. Since violent convection is necessary to the production of tornadoes and such severe thunderstorms as were experienced through central and southern Minnesota in the afternoon and night of the 22d, it seems reasonable to suppose that the cool southerly and easterly winds of the front half of the cyclone overran, in part at least, some of the warm winds in the rear half, thereby producing steep vertical temperature gradient. Or the hot winds of the southwest quadrant may have under-run the cool winds of the southeast. One is led to wonder whether the movement of the thunderstorms toward the region with cool weather instead of away from it as is usual had anything to do with their extreme severity.—  
C. F. Brooks.

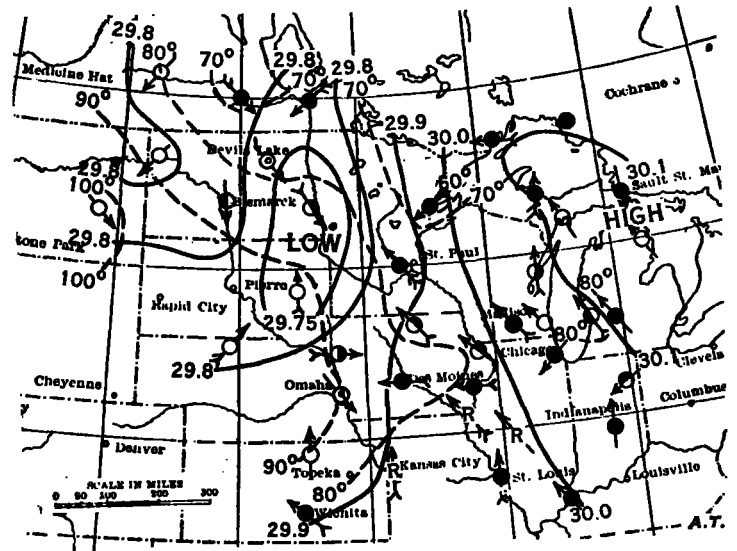


FIG. 3.—Weather map, 6 p. m. (90th meridian time), June 22, 1919. Dot shows location of Forcus Falls. Barbs on arrows show wind velocities in Beaufort unitsem. (Courtesy, Minneapolis Journal.)

HAILSTORMS IN SOUTH CAROLINA, JUNE 8 AND 9, 1919.

By RICHARD H. SULLIVAN, Meteorologist.

[Printed: Weather Bureau, Columbia, S. C., July 5, 1919.]

FIG. 1.—Hailstorms in South Carolina, June 8-9, 1919.

On the basis of newspaper reports of hailstorms published on June 9 and 10, 1919, inquiries were sent to postmasters and others in the affected areas.

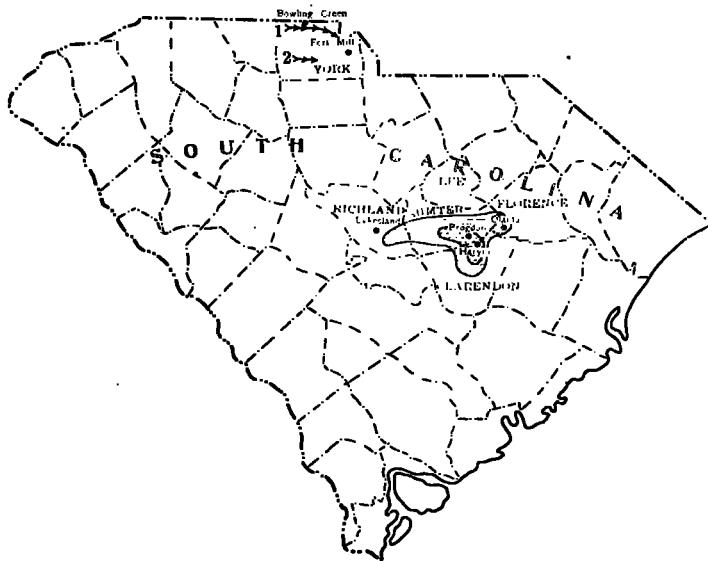


FIG. 1.—Hailstorms in South Carolina, June 8 and 9, 1919.

The most destructive storm was in southern Sumter and northern Clarendon counties, where the damage to growing crops approximated \$262,000 in a region 5 by 20 miles on the county line, in the neighborhood of

Brogdon and Harvin. The general hail area extended from near Lykesland, in eastern Richland County, to near Olanta, in western Florence County, and from central Sumter County to central Clarendon County in greatest breadth, or approximately 25 by 50 miles. The hailstones ranged in size from pebbles or small marbles to hen eggs, the storm culminating between Brogdon and Harvin, where growing crops were damaged probably 30 per cent, and in isolated instances probably 100 per cent. As in most cases of hail damage, magnified by large heads in the newspapers, the area of total hail damage is comparatively small, and crops frequently recover to full fruitage in large areas after the storm, as in the case of the great hailstorm in the northern part of this State in July, 1914, which was the most widespread and destructive of record in this State.

In York County, the path of the hailstorm of the afternoon of the 8th was 1.5 to 12 miles in extent, beginning at a point west of Bowling Green and running eastward and thence southeastward toward Fort Mill. The hailstones were mostly small, according to the postmaster at Bowling Green. The total damage was estimated at \$50,000 to \$65,000.

The second storm in York County during the afternoon of June 9 was only 0.5 to 3.0 miles in extent, in a path about 3 miles south of the town of York. The hailstones ranged from peas in size to 1 inch in diameter. The damage approximated \$35,000.

Figure 1 shows the location and extent of these storms.