HAILSTORM OF SEPTEMBER 7, 1930, ACROSS EXTREME SOUTHEASTERN SOUTH DAKOTA AND NORTHWESTERN IOWA

By GERSHOM K. GREENING

[Weather Bureau Office, Sioux City, Iowa]

On Sunday afternoon, September 7, 1930, one of the most destructive hailstorms of record for the middle Missouri Valley cut a swath 60 miles long and 5 miles wide across the extreme northern portion of Union County in South Dakota and extreme southwestern Sioux, central Plymouth, and north central Woodbury Counties in Iowa. (Fig. 3.) Although heavy rains were reported earlier in the day in line of the path of the storm projected to the northwest for 200 miles, the first hail was reported near Beresford, Union County, S. Dak., about noon. It was last observed at 3 p. m. 3 miles to the north of Oto, Woodbury County, Iowa. The path of greatest destruction as viewed by the writer ranged from a mile to a mile and one-half in width straight as "the crow flies" over the 60-mile stretch, although it is not intended to infer that the loss was constantly uniform. In some fields the damage would be as low as a bushel or two to the acre, while in others the corn would be a total loss. Cornfields that would have yielded 30 to 40 bushels to the acre were hammered to a barren waste. Others looked more like they had been "hogged down" for a couple of weeks. Large groves were left destitute of leaves and in the areas worst hit, "it looks just like January." Hailstones ranging in size from peas to walnuts and some say as large as baseballs covered the ground to more than an inch in places after the storm. The county is generally rolling and the hailstones were collected along the dry runs and small creeks that were filled to overflowing. Three or four days after the storm some hail had not entirely melted.

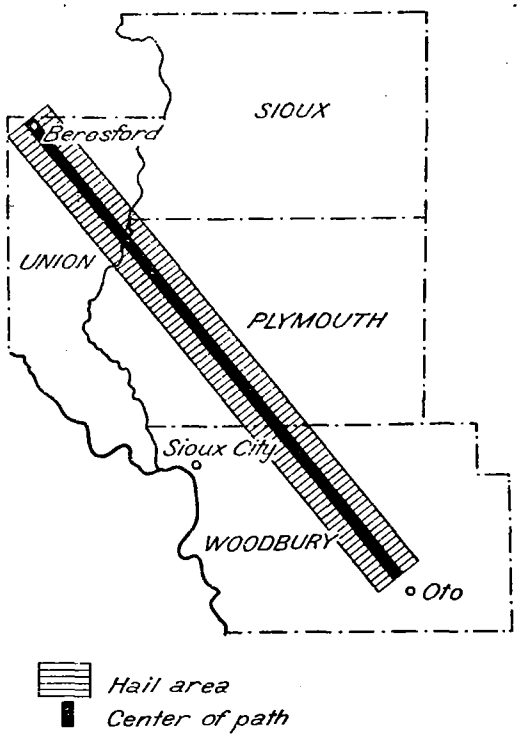

FIGURE 3.—Path of hailstorm, September 7, 1930

Eye witnesses are in agreement that the cloud was a heavy low black rolling formation with that peculiar greenish cast common to hailstorms.

One million dollars would be a conservative estimate of the damage done, most of which was to the corn crop. Poultry suffered heavily. Paint, roof, and window damage to buildings was likewise a big item of loss. Individual farmers reported as many as 200 chickens killed during the storm. The area swept was a heavy producing livestock section and cattle and horses exposed to the hail were literally covered with "bumps" for several days. Livestock must by instinct protect itself, as with the hailstones in the center of the path unusually large, no animals were found to have been blinded, although some small pigs were killed and there was also some loss to livestock from high water in connection with the storm. Telephone poles, fence posts, and farm buildings in numerous places were badly pelted by the stones as shown by the marks on the north and west exposures.

Twenty years ago hail insurance was little thought of in northwestern Iowa. To-day, it is carried on a large percentage of the farms and in many instances is required to protect the mortgage, rather than being due to the desire of the landowner or tenant to protect his own interests. Whether the hail insurance was taken as a result of foresight or compulsion, nevertheless quite a little of the loss will be retrieved from that source.

SOME 1929 FIRE-WEATHER COMPARISONS[1]

By E. M. KEYSER

[Weather Bureau office, Spokane, Wash.]

The season of 1929 holds a unique place in fire-weather history in United States district forest No. 1. This district comprises northeastern Washington, northern Idaho, Montana, and northwestern South Dakota. Since forest fire records have been tabulated, the last 22 years, the four seasons, 1910, 1919, 1926, and 1929 are outstanding. These four years account for 87 per cent of the fire losses in the district since 1907.

Howard Flint, in charge of fire-control measures in the district, furnishes the following summary of fires for these four bad years. He cautions that the figures, for comparison purposes, should not be taken too literally, because of the changing conditions from year to year.

Year	Number of fires	Area burned	Suppression cost
		Acres	
1910	1,736	2,400,000	$795,280
1919	2,258	1,329,000	2,157,515
1926	1,307	340,800	1,133,220
1929	1,949	241,500	1,697,500

In view of the small acreage burned in 1929, only about 10 per cent of that of 1910, and the relatively large number of actual fires and high suppression cost, about 80 per cent of that of 1919, when war time prices were still in vogue, it seems opportune to inquire into the nature of the season's weather phenomena and to ascertain, if

[1] Presented at a meeting of the Northwest Scientific Association on Dec. 27, 1929.

practicable, in what respects they have differed from normal conditions and from those of the other bad fire years.

In this investigation, we have gone into the records of some 18 fire-weather and 16 cooperative stations in northern Idaho and western Montana, where is located most of the district's timber and have also drawn heavily on the Spokane records, which are fairly typical of weather throughout the district, and much more complete; also to make the comparisons of wider application, the records

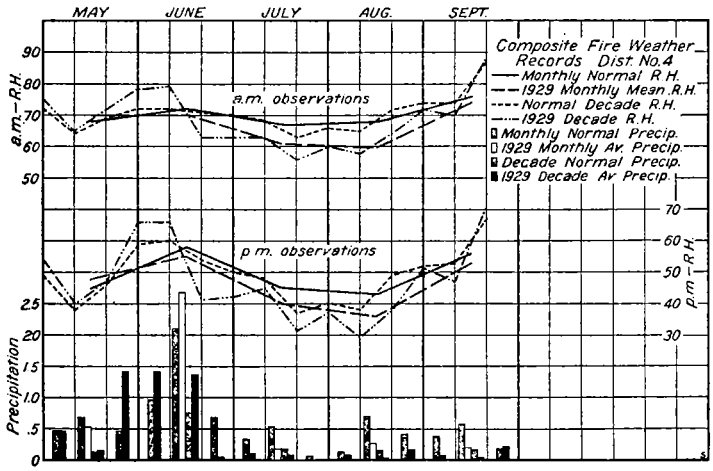

FIGURE 1

of other Weather Bureau offices in the Northwest and elsewhere have been consulted.

The Spokane records were used for sunshine and wind velocities. In Table 1, in comparing the bad fire years, we discover that 1929 for June, July, and August, averaged 79 per cent as against the 3-month normal of 76 per cent and the bad season average of 81 per cent. August, 1929, had *more* sunshine with its 94 per cent than any other summer month of the four bad years and June with its 59 per cent, *less* than any other of these months.

In Table 2, the wind velocities are seen to be below normal every month and below the bad season average. The August velocity of 4.8 miles was 16 per cent below the season normal and 20 per cent below the bad year average. The question arises, would this account for the unusual smokiness and increased difficulty of keeping in touch with the development and progress of going fires that month, which was an outstanding feature of the fire-control measures.

A glance at the temperature records, Table 3, reveals that in temperature, 1929 was not at all unusual. June averaged 1.5° below normal, August, 3.2° above normal, July being almost normal. The season itself ran 0.5° above the general normal and but 0.3° below the bad season average.

While Spokane normals were used for wind, sun, and temperature, the relative humidity and precipitation were measured at fire-weather stations and 3-year averages were computed. Mr. F. C. Crombie, fire-weather specialist, has kindly aided in this, going through the 1927, 1928, and 1929 records, computing means and then graphing both 8 a. m. and 5 p. m., relative humidity and rainfall, these being the hours at which readings were made.

A brief reference to the upper portion of graphs 1–8 (not reproduced) shows, in general, deficient humidity. However, at Avery and Savanac higher humidity is, unexpectedly, shown. But the Avery rise may possibly be accounted for by a more pronounced climb in humidity before the evening psychrometric readings were made. However, the Savanac plus readings are without adequate explanation. Composite graph (fig. 1) discloses that from May to the middle of the second decade in June the humidities were above the 3-year average and from then till the middle of the second decade in September they were below average. The maximum of the negative departure was at the end of the second decade in August. This also coincided with the increased fire-control difficulties.

Since precipitation plays such a prominent part in fire-control measures, we have gone more extensively into the precipitation records in our investigations. The graphs above-mentioned, show clearly that the 1929 May precipitation was below the 3-year average, June precipitation, as a whole, considerably above the 3-year average, and precipitation for the remainder of the season including last decade of June to last decade of September much below the 3-year average. The last decade of July was the driest of the season, one station only, Salmon Mountain, reporting as much as a trace.

A more detailed study of the records of some 16 Idaho and Montana cooperative weather stations located in the

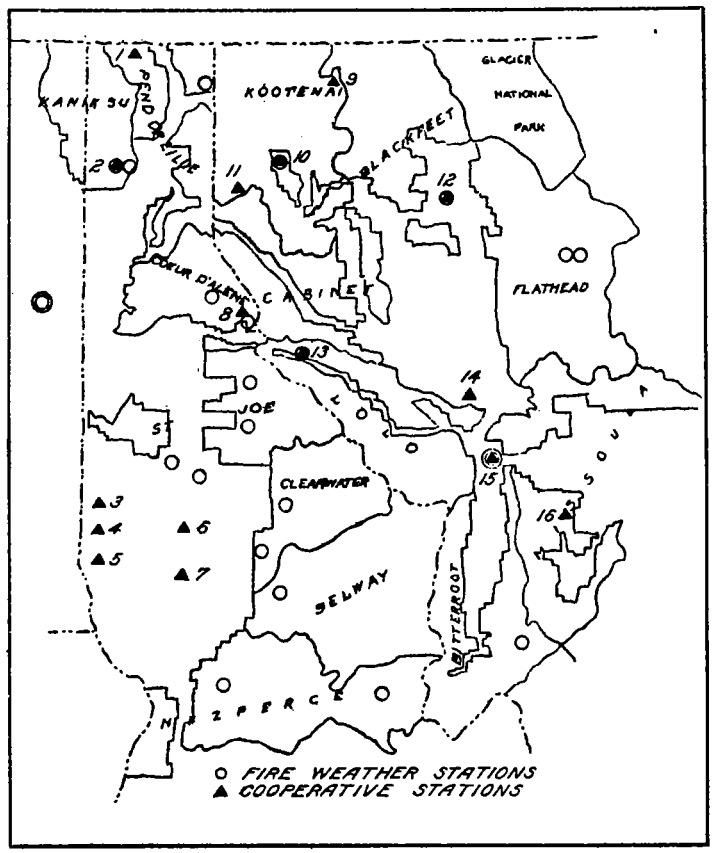

FIGURE 2.—Weather Bureau fire-weather district No. 4 (part of U. S. Forest Service district No. 1). The names of the stations corresponding to the numbers may be found in the text

principal timber sections of the district (fig. 2) permitted some interesting deductions (Table 4). It is seen that the 1929 fire season was preceded by an average of only 11.52 inches from September to May, inclusive, 36 per cent less than the normal average rainfall for these stations for the 9-month period. Then came the fire-season 3-month average of 2.70 inches, which was 28 per cent under normal notwithstanding June's precipitation was

112 per cent of normal. It will be seen that July and August had less than 25 per cent of the normal.

Cooperative stations furnishing meteorological data are as follows:

In Idaho:

1. Port Hill.
2. Priest River Experiment Station.
3. Pot Latch.
4. Moscow.
5. Lewiston.
6. Orofino.
7. Nezperce.
8. Kellogg.

In Montana:

9. Fortine.
10. Libby.
11. Heron.
12. Kalispell.
13. Haugen.
14. St. Ignatius.
15. Missoula.
16. Phillipsburg.

Comparing precipitation findings from the cooperative stations, average elevation of 2,641 feet, with those of the fire-weather stations, average elevation 4,188 feet, we are impressed with the similarity of results. (Table 5.) Both records show excessive rainfall in June and deficient in July and August and for the season as a whole. The shortages at the cooperative stations in July and August were 68 and 81 per cent as against 67 and 61 per cent, respectively, at the fire-weather stations.

In comparing the 1929 general conditions with those of the other three bad years, interesting facts stand out. 1929 had less sunshine than any of them except 1910, although more than normal. It had less wind than any of them and less than normal. It had lower seasonal temperature than any of them, but the highest August temperature and the smallest rainfall of any of the four bad years. It was preceded by a drier 9-month period than any of the bad years. Also June and July low temperatures and deficient sunshine tended to prolong the effects of June's heavy precipitation. But once the effects of this temporarily excessive moisture were overcome, the tendency of the preseason 9-month rain shortage was soon accentuated by the excessive August sunshine, high temperature, low wind, and general lack of rain. The conditions in individual forests can not be gone into here, but there existed in the latter part of July and the first two decades of August a widespread, dangerous condition, culminating in the unprecedented August conflagrations.

Apropos the theory that 1929's dry season is only another step in the general drying up of the Northwest, comparisons have been prepared showing annual precipitation by decades. Spokane has almost five complete decades of records. Her successive decade averages have gradually diminished. In 15 northern Idaho and western Montana stations the decade of 1911–1920 showed more precipitation than that of 1921–1930, to date or to end of 1930, considering 1930 a normal year.[2] Only two stations, Moscow and Sand Point, showed the reverse. For 1901–1910 and 1891–1900 decades, Port Hill, St. Maries, Libby, and Kalispell showed larger amounts in earlier decades. But Lewiston and Missoula records beginning in 1881 do not show such unbroken increase backward.

Furthermore, to get a more complete orientation in the matter of rainfall decline, we examined the decade averages of various well-distributed stations of long record all over the United States (Table 6). Nine decades of St. Paul, St. Louis, and New Orleans averages lend little argument to a general "drying up" theory. Neither do 8 San Francisco decades, 6 New York and Portland, nor 5 Los Angeles decades confirm a gradual dessication theory for any part of the country. It is true that a number of low 1921–1930 averages are discoverable, but this is true for St. Paul, St. Louis, Los Angeles, and San Francisco as well as our district No. 1 stations. Also, although not included in the table unprecendentedly low decade averages were found at Walla Walla, Boise, and Seattle in 1921–1930.

But we may conclude, that in spite of many 1929 dry spots in the Northwest and elsewhere and many last-decade low averages, any dessication tendency is not at all convincing.[3] The tables show that, in the past, low decade precipitation average has been followed by high decade averages. This is true in various parts of the country. As noted, not all northwestern stations have their lowest decade average in 1921–1930. The Northwest is a part of the great North American Continent and will share, as the decades accumulate, in the general distribution of the continent's rainfall. As the permanent and semipermanent HIGHS and LOWS to the west and northwest of us vary their migrations, water-laden clouds will be borne over the Northwest again and increasing precipitation will prevent many recurrences of the bad fire season of 1929.

TABLE 1.—*Percentage of sunshine at Spokane during bad fire-weather seasons*

Year	June		July		August		Season	
	Normal	Actual	Normal	Actual	Normal	Actual	Normal	Actual
1910		75		88		74		78
1919	70	88	81	89	77	81	76	84
1926		78		92		75		82
1929		59		85		94		79

Summary

Average for 3-month period	76
Average 4 bad seasons	81
Percentage for 1929	79

TABLE 2.—*Average wind velocities at Spokane during bad fire-weather seasons*

[Miles per hour]

Year	June		July		August		Season	
	Normal	Actual	Normal	Actual	Normal	Actual	Normal	Actual
1910		7.4		6.4		5.7		6.5
1919	6.4	6.6	5.7	5.9	5.0	5.6	5.7	6.0
1926		5.8		6.1		5.4		5.8
1929		6.0		5.4		4.8		5.4

Summary

Average for 3-month period	5.7
Average 4 bad seasons	6.0
Average for season of 1929	5.4

[2] It is impracticable as this goes to press to say whether 1930 in the far Northwest will or will not be a normal year.—*Ed.*

[3] See in this connection Henry, A. J., Weather Abnormalities in the United States (seventh note) trend of precipitation this REVIEW 58: 249–250.

TABLE 3.—*Mean temperature of bad fire seasons, district No. 1, from eight Idaho and eight Montana cooperative stations*

Year	June		July		August	
	Normal	Actual	Normal	Actual	Normal	Actual
1910	°	° 60.2	°	° 68.2	°	° 61.6
1919	° 59.2	59.4	° 65.8	67.1	° 64.4	65.1
1926		61.3		69.2		64.1
1929		57.5		65.7		67.6

SUMMARY

Fire season normal (June, July, August)	63.1
Bad season average	63.9
The 1929, 3-month average	63.6
1929 departure from normal	+.5
1929 departure from bad season average	−.3

TABLE 4.—*Average precipitation (inches) of bad fire seasons, district No. 1, from eight Idaho and eight Montana cooperative stations, average elevation, 2,641 feet*

Year	Precipitation for the preceding 9 months		June		July		August	
	Normal	Actual	Normal	Actual	Normal	Actual	Normal	Actual
1910		17.42		0.74		0.24		0.42
1919	17.84	17.81	1.84	.33	0.98	.22	0.94	.96
1926		13.23		1.74		.49		2.29
1929		11.52		2.21		.31		.18

SUMMARY

Fire season normal (June, July, August)	3.76
Bad fire-season average	2.54
Total of 1929 monthly averages (June, July, August)	2.70
1929 departure from fire-season normal	−1.06
1929 departure from bad season average	+.16

TABLE 5.—*A comparison, June, July, and August, 1929, precipitation averages (inches) as obtained at 16 cooperative stations, average elevation 2,641 feet and those obtained at 18 fire-weather stations, average elevation, 4,188 feet*

Month	16 cooperative stations			18 fire-weather stations		
	Normal	Actual	Departure	Normal	Actual	Departure
June	1.84	2.21	+0.37	2.10	2.69	+0.59
July	.98	.31	−.67	.54	.18	−.36
August	.94	.18	−.76	.70	.27	−.43
The season	3.76	2.70	−1.06	3.34	3.14	−.20

TABLE 6.—*Precipitation averages by decades Weather Bureau stations outside district No. 1*

Decades	Spokane	St. Paul	St. Louis	New York	New Orleans	Los Angeles	San Francisco	Portland
1841–1850		14.49	45.34		53.64			
1851–1860		12.06	45.73		51.46		22.22	
1861–1870		14.80	40.76				24.89	
1871–1880		16.63	37.13	42.81	65.47		24.32	53.19
1881–1890	18.46	12.49	39.85	48.06	60.18	18.74	24.60	45.75
1891–1900	18.28	13.78	36.12	42.45	48.40	12.03	19.51	39.16
1901–1910	16.14	15.58	36.52	43.48	55.89	15.39	20.72	41.02
1911–1920	14.03	14.96	37.93	40.01	63.02	15.20	20.82	39.57
1921–1930	13.79	12.72	38.33	41.32	63.16	12.82	20.72	37.38

(Stations outside the State of Washington have a basis of less than 9 years in the last decade. The Spokane value, on the basis of normal precipitation in 1930). At this writing, October 17, 1930, it would seem as if 1930 will be a year of less than normal precipitation.

DISASTROUS FIRE WEATHER OF SEPTEMBER, 1929

By CHARLES I. DAGUE, FIRE WEATHER SERVICE

[Weather Bureau Office, Portland, Oreg.]

The outstanding features of the fire-weather season for 1929 were its extreme dryness, its length, and the heavy fire losses in September, and subsequently thereto, west of the Cascades in Oregon and Washington. It was by far the most severe and most strenuous season within the history of organized forest-fire protection in these two States, and probably for as far back as we have any record or knowledge of forest fires for these sections. There have been seasons with heavier fire losses, but they were before the time of organized protection. The extreme southwestern portion of Oregon and of northwestern California sustained their heaviest forest fire losses for the season during the last decade in November and the first week in December.

The worst drought in the history of Weather Bureau records prevailed from June 20 to December 7, not only in Oregon and Washington, but in all the far Western States as well. November was the fifth successive month with deficient precipitation, the average for the five months in Oregon, June to November, being 1.81 inches which is only 20 per cent of the normal; precipitation at the regular Weather Bureau stations in the far Western States averaged only 27 per cent of the normal for this 5-month period. It is also interesting to note in this connection that the average precipitation for November in Oregon was only 8 per cent of the normal, the normal for 94 stations being 4.52 inches. Of the 19 months ending with November, 1929, 17 months were drier than normal, with the total precipitation for this 19-month period in Oregon being only 62 per cent of the normal. Thus both the years of 1928 and 1929 were very dry, being climaxed by one of the worst droughts of record in the far West as well as by far the most critical fire weather conditions known.

Maj. Edward H. Bowie, district forecaster at San Francisco, Calif., in his paper on the Long Dry Season of 1929 in the Far West, published in the MONTHLY WEATHER REVIEW for November, 1929, very aptly explained the anomalies that caused the dry weather for the normally dry months of July and August to continue on through September, October, November, and the first week in December. These anomalies were due to the continuation through September and October of high or relatively high barometric pressure over the North Pacific Ocean in latitudes where ordinarily found only in the summer seasons, and of extraordinarily high barometric pressure in November in general along and off the West Coast, over the Plateau Region and western Canada. The cyclones of the North Pacific Ocean were unable to penetrate these high barometric pressures and their systems of winds, and were forced to move instead, along the northern periphery of the high pressure area in high latitudes. It was not until the barometric pressure rose in high latitudes, notably the Bering Sea and western Alaska, and decreased over the northeast Pacific Ocean, and northerly winds gave way to southerly and westerly, at the beginning of the second week in December, that the long dry season came to an end.

The fire-weather season for 1929 in Oregon was somewhat below normal up to the forepart of September, with