

SECTION IV.—RIVERS AND FLOODS.

THE FLOODS OF MAY AND JUNE, 1915, IN THE MISSOURI VALLEY.

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[Dated: Weather Bureau, Washington, D. C., July 30, 1915.]

A period of wet weather of far-reaching effect began in the middle Missouri Valley about May 18, 1915. Showers, many of them quite heavy, were almost of daily occurrence from the 18th to the 28th. The weather for a month or more previous to the beginning of the rains had been deficient in rainfall and the ground was thoroughly dry.

The tributaries of the Kansas River did not overflow their banks in spite of the continuous rains of May, but they became almost bank full and the soil throughout the watershed was so thoroughly soaked that the run-off was greatly augmented and the probabilities of flood stages in case of further rains was greatly increased. The rains of May 26-27-28 brought about the expected, and the Missouri River at Kansas City passed above the flood stage (22 feet) on May 28 and continued above until the end of the month. On June 12, due to additional rains, it passed above the flood stage and again on June 18, remaining above until the 28th. At the close of the month the river had fallen to 20.7 feet, but additional rains caused it to be in flood the greater part of July, and at this writing, July 30, it is 1 foot above the flood stage.

Between Kansas City and its mouth the Missouri River was above flood stage for the dates set forth in the table below.

TABLE 1.—Flood stages in Missouri River, June, 1915.

Missouri River at—	Flood stage.	Above flood stage.		Crest.	
		From—	To—	Stage.	Date.
	Feet.			Feet.	
Kansas City, Mo.....	22.0	12th.....	13th.....	23.7	12th.
		18th.....	28th.....	27.0	21st.
Waverly, Mo.....	22.0	13th.....	13th.....	22.3	13th.
		19th.....	28th.....	24.7	23d.
Boonville, Mo.....	21.0	1st.....	6th.....	24.6	1st.
		13th.....	15th.....	21.5	14th.
Hermann, Mo.....	21.0	21st.....	28th.....	22.5	23d.
		1st.....	7th.....	25.9	2d.
		15th.....	16th.....	21.2	15th.
		21st.....	30th.....	23.5	25th.

TABLE 2.—Flood stages in Kansas River and tributaries for June, 1915.

River.	Station.	Flood stage.	Above flood stage.		Crest	
			From—	To—	Stage.	Date.
		Feet.			Feet.	
Solomon.....	Beloit, Kans.....	18.0	5th.....	8th.....	32.3	6th.
			18th.....	23d.....	32.4	10th.
Smoky Hill.....	Lindsborg, Kans.....	20.0			18.1	26th.
Republican.....	Clay Center, Kans.....	18.0	18th.....	25th.....	26.2	21st.
Big Blue.....	Beatrice, Nebr.....	16.0			0.8	8th.
Kansas.....	Wamego, Kans.....	18.0	20th.....	21st.....	20.3	20th.
			11th.....	12th.....	22.4	11th.
Do.....	Topeka, Kans.....	21.0	19th.....	21st.....	23.8	20th.
			24th.....	25th.....	21.9	24th.

The Mississippi River.—The effect of the June, 1915, rains over the watershed of the middle Mississippi combined with the effect of the Missouri, was not sufficient to produce more than a moderate flood between Quincy, Ill.,

and Cape Girardeau, Mo., as may be seen from Table 3, following.

TABLE 3.—Flood in the Mississippi, June, 1915.

Mississippi River at—	Flood stage.	Above flood stage.		Crest.	
		From—	To—	Stage.	Date.
	Feet.			Feet.	
Quincy, Ill.....	14.0	3d.....	12th.....	15.2	8
Hannibal, Mo.....	13.0	1st.....	13th.....	15.4	8
		1st.....	16th.....	20.2	4
Grafton, Ill.....	18.0	23d.....	29th.....	20.3	24
		1st.....	6th.....	31.3	3
St. Louis, Mo.....	30.0	23d.....	30th.....	31.6	24
		1st.....	19th.....	33.7	6
Cape Girardeau, Mo.....	30.0	23d.....	30th.....	33.0	30
Arkansas City, Ark.....	42.0	9th.....	30th.....	44.9	16

Floods elsewhere than in Missouri and Mississippi Rivers.—Flood stages were reached at one or more places on the rivers as shown in the table below:

TABLE 4.—Flood stages elsewhere in the United States, June 1915.

Rivers and stations.	Flood stage.	Crest.	
		Stage.	Date.
	Feet.	Feet.	
North Canadian:			
Reno Junction, Okla.....	8.0	9.1	10
Canton, Okla.....	3.0	6.0	7
Neosho:			
Fort Gibson, Okla.....	22.0	23.0	1 and 29
Iola, Kans.....	10.0	11.0	12
Oswego, Kans.....	20.0	21.7	1 and 16
Black:			
Black Rock, Ark.....	14.0	14.3	3
White:			
Georgetown, Ark.....	22.0	22.1	4
Arkansas:			
Fort Smith, Ark.....	32.0	25.7	1
Dardanelle, Ark.....	20.0	26.6	1
Little Rock, Ark.....	23.0	25.4	1
Pine Bluff, Ark.....	25.0	26.9	2
Red:			
Denison, Tex.....	22.0	24.5	9
Arthur City, Tex.....	27.0	33.7	10
Fulton, Ark.....	28.0	28.6	1
		30.2	15
Sulphur:			
Springbank, Ark.....	29.0	39.1	10
Rio Grande:			
San Marcial, N. Mex.....	11.0	13.8	5
		15.7	1
		16.1	9
El Paso, Tex.....	15.0	15.3	30
Trinity:			
Bridgeport, Tex.....	20.0	28.9	8
Fort Worth, Tex.....	20.0	37.6	10
Dallas, Tex.....	25.0	37.7	12
Brazos:			
Brazos, Tex.....	12.0	20.0	8
Kopperl, Tex.....	21.0	22.0	9
Waco, Tex.....	22.0	25.7	9
Grand:			
State Bridge, Colo.....	9.0	9.5	2
Neuse:			
Neuse, N. C.....	12.0	17.6	5
Smithfield, N. C.....	13.0	16.8	7
Cape Fear:			
Fayetteville, N. C.....	35.0	40.2	4
Elizabethtown, N. C.....	20.0	32.0	5
Great Pee Dee:			
Cheraw, S. C.....	27.0	30.0	4
Catawba:			
Catawba, S. C.....	11.0	11.0	2
Wateree:			
Camden, S. C.....	24.0	25.8	3
Santee:			
Rimini, S. C.....	12.0	13.5	6
Ferguson, S. C.....	12.0	13.3	8
Stanton:			
Randolph, Va.....	21.0	22.2	3
Potomac:			
Cumberland, Md.....	8.0	10.3	3
Kings:			
Piedra, Cal.....	12.0	13.3	1
San Joaquin:			
Lathrop, Cal.....	17.0	17.1	4 and 12

Meteorological conditions associated with the rains.

Whatever may be the ultimate cause or causes of long-continued rains over the Plains States—particularly over Kansas and Nebraska—the immediate visible cause, referring to surface conditions only, is the immediate pressure distribution. This may be roughly characterized as a development of lows over the Middle Plateau region generally west of the Continental Divide, and a movement of such lows thence southeastward to the Texas Panhandle, thence northeastward to the Lake region with their paths converging over northwestern Missouri or northeastern Kansas. If the Lake region is occupied by areas of high pressure, which in the spring of the year often appear to exert a retarding influence on lows advancing from the southwest, the conditions for heavy and often continuous rains in the Missouri Valley are ideal. The great flood of May, 1903, when the rainfall for the month was greater than for the corresponding month of 1915, was due to the meanderings of a single low during the 10 days from May 21 to May 31. (See MONTHLY WEATHER REVIEW, May, 1903, Charts XI-XXII.)

The heavy rains of May, 1892, when the average for eastern Kansas was 8.72 inches as against 8.59 inches for May, 1915, are clearly traceable to the fact that five lows crossed eastern Kansas in that month. (See MONTHLY WEATHER REVIEW, May, 1892, Chart I.)

In May of the current year two lows, moving as shown on Chart IA of this issue of the REVIEW, were the visible cause of the heavy rains of the last ten days of May. On Chart IA have been also plotted the tracks of the two lows in June, and also (in red) the tracks of the highs that were associated with them, thus assembling on one chart the paths of the highs and lows chiefly concerned with the rainstorms. The general principles illustrated by the movements shown on Chart IA are familiar to forecasters and others, and have been stated in the beginning of this note. In connection with the May lows (17th and 25th), it will be seen that both of them failed to reach the Lake regions, the first one dissipated over Iowa and the second travelled far to the south, while No. III (June 11) moved quite rapidly northeastward; it gave but a short period of rain. The low of June 16, No. IV, also moved with considerable speed, apparently because its advance was not obstructed by a high. One of the highs charted apparently came from the region of Hudson Bay. It is known by experience that highs from that or even other regions of the north or northwest in the late spring or early summer often lodge over the Great Lakes and sometimes exert a strong retarding influence upon the movement of lows that may threaten to advance from the west or southwest.

In the last 29 years there have been three occasions in the month of May when the atmospheric conditions tended toward heavy and continued precipitation in the middle Missouri Valley, or about one year in ten. The same rule holds for June, but not for April or July.

Forecasting of floods.

In general, the floods enumerated in the foregoing were successfully forecast and a very material public service was thus rendered, especially in the densely populated suburbs of Kansas City along the river bottoms; also in the rich and prosperous farming communities along the Missouri River. The forecasts for the Kansas City district were made by P. Connor, of the Kansas City Station; those for the Missouri, east of Kansas City, by Montrose W. Hayes, of the St. Louis station.

Hydrographs for typical points on several principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.

LOSS BY FLOODS IN KANSAS RIVER AND TRIBUTARIES, JUNE, 1915.

By P. CONNOR, Local Forecaster.

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The northern half of Kansas suffered very heavy losses during June, due to the occurrence of severe local storms with exasperating frequency, which were attended by torrential rains, causing the smaller streams to rise with extraordinary suddenness, overflowing contiguous land, carrying away bridges, and later producing floods in the larger rivers.

Aside from the small streams which immediately responded to the local downpours, the first river to overflow its banks was the Solomon, which rose from 2.6 feet on the 3d to 32.3 feet in early morning of the 6th at Beloit, Kans., breaking the high water record by 1.1 feet. The rainfall which produced this flood fell in places remote from reporting stations, so that the rapidly rising river at Beloit was the first intimation. Warnings were promptly telegraphed to Minneapolis, Kans., and Solomon City on the 5th, and the slow movement of the crest in that river afforded time for protection of property. The river subsided to normal by the 10th.

The territory overflowed in Mitchell County was estimated at from 50 to 60 square miles with an added 20 miles due to overflow of creeks, approximately 48,000 acres in all, with damage close to one million dollars. From Mitchell County to Solomon City the damage has been estimated at \$350,000.

A recurrence of local storms on the 17th, giving 5.78 inches of rain at Beloit from 8 a. m. to 5 p. m., caused a rise in the river at that place from 4.3 feet at 7 a. m. of the 17th to 23.4 feet at 7 a. m. of the 18th and to 32.4 feet, or 1.2 feet above high water mark, at 6 p. m. on the 19th, remaining out of its banks until afternoon of the 22d.

Warnings were telegraphed Beloit, Delphos, Minneapolis, Bennington, and Solomon City on the 17th advising of a second overflow of the valley. The same area was inundated by the second flood, but there was little to prey upon. It only made the damage more complete and delayed reclamation and farm operations.

Rains from 4½ to 6 and 8 inches on the 17th and 19th at and above Concordia caused the greatest flood known in the Republican Valley from Superior, Nebr., to Junction City, Kans., where the Republican joins the Smoky Hill to form the Kansas River. Warnings of this flood were telegraphed on the 17th to towns from Junction City to Concordia, and again on the 20th Clay Center and Junction City were advised that a pronounced flood was imminent.

The area inundated was 2 to 6 miles wide from Superior to Junction City. At Clay Center the maximum stage was 26.2 feet at 11 a. m. 21st, the highest previous water being 24.8 feet in 1903. There was no gage at Concordia, the river having separated itself from the city in 1903 by at least a mile, but the observer, Mr. John W. Byram, writes: "The crest of the flood passed in night of the 20th. The district under water was the richest and most fertile in this section of the country, consisting of vast fields of