

RIVERS AND FLOODS

[River and Flood Division, MERRILL BERNARD in charge]

By BENNETT SWENSON

During July 1938 precipitation was above normal generally east of the Mississippi River (except over the Great Lakes region), portions of Texas and the Great Basin, and over the middle and extreme upper Missouri Basin. Thus the rainfall was uniformly above normal over large areas during a month which usually has rainfall of a showery type and therefore spotted. Resulting floods, consequently, were more numerous and widespread than usually occur in July.

Atlantic slope and East Gulf drainage.—Heavy rains during most of the last 10 days of July over this entire area caused light to moderate flooding in many of the streams from the James River southward. However, no damages of great consequence were reported.

Missouri Basin.—Normal or slightly higher precipitation during the winter months—December to February—in the upper reaches of the Missouri River watershed, with above-normal precipitation in March in every State except North Dakota, set the stage for at least a normal flow in the river during the snow run-off period, May to July. At the end of March, according to the report in the Climatological Data for Montana, there was about a normal depth of snow in practically all headwater tributary watersheds. The moisture content, however, was high and the ground wet and unfrozen under the snow. In April, the precipitation continued near or above normal, except in North Dakota and Montana, and in May there was an abundance of moisture, being 145 percent of normal in Montana.

The Yellowstone River reached a peak stage of 12.0 feet at Miles City, Mont., on June 26, which is equivalent to approximately 65,000 second-feet when considered in terms of volume discharge. A large portion of the run-off from the upper reaches of the Missouri River was impounded by Fort Peck Dam and a maximum flow of only between 16,000 and 18,000 second-feet was released to pass on down the river.

On July 2 the Missouri River at Williston, N. Dak., reached a stage of 10.9 feet with a flow of about 95,000 second-feet. Prior to this, however, heavy rains in southwestern North Dakota and northwestern South Dakota occurred and the run-off combined with the gradually-rising Missouri River to produce a stage of 12.6 feet at Pierre, S. Dak., on June 30, the flow at this stage being approximately 126,000 second-feet. As this water moved downstream, stages were high in the Big Sioux River and the total flow produced a stage of 12.6 feet at Sioux City, Iowa, on July 3. A number of fairly definite waves proceeded downstream, culminating in gradually higher stages at Omaha and Nebraska City. While the crest of the wave referred to above, 12.6 feet at Pierre, was moving slowly downstream from Sioux City, heavy rains occurred during the period July 2-7 in the area adjacent to the Missouri River between Sioux City and Nebraska City which, when the run-off was added to the water already present, caused increasing stages to the extent that there was considerable overflow in that reach of the river. This overflow resulted in a retardation in the movement of the crest and permitted more or less piling up below Sioux City as the waves continued to come from above that point; so that the combined effect of the numerous

flood waves moving downstream and the heavy rains at critical periods produced stages below Sioux City which were the highest since 1927. The crest stage of 18.1 feet at Blair, Nebr., on July 10-11, was the highest July stage of record. At Nebraska City the river rose to bankful stage, 15 feet, during the night of July 3 and remained above until about midday of July 18, with a crest stage of 17.9 feet on July 12. At a stage of 16.5 feet at Nebraska City there is considerable overflow, especially of the east bank, but it is not extremely damaging; above 17.0 feet the overflow becomes serious.

The last wave of any importance to move downstream during this period of high water caused stages of 11.3 feet at Williston, N. Dak., on July 6 and 7, and 14.4 feet at Bismarck N. Dak., on July 8. Both of these stages were the highest reported from these stations during the period of high water and the resulting flow was slightly in excess of 100,000 second-feet. However, as this wave traversed the various reaches of the river, it seemed to flatten out more than the others and when it combined with the slowly moving mass of water below Sioux City it served only to slow up the rate of fall and extend the period of overflow at stations below.

At St. Joseph, Mo., the crest of the high water was reached on July 17 with a stage of 17.0 feet, which is flood stage at that point. The great floods of record in the Missouri River produced stages at St. Joseph as follows:¹

Year	Stage	Date
	<i>Feet</i>	
1881.....	27.2	Apr. 29
1903.....	20.5	June 2
1908.....	20.4	June 15
1909.....	18.8	July 11
1910.....	17.6	Mar. 23
1912.....	18.4	Apr. 15
1915.....	17.7	July 21
1927.....	17.6	May 16
1938.....	17.0	July 17

On the 16th of July the crest of the high water was practically at Kansas City. The stage on that morning was 18.0 feet and it was expected to round off at 18.1 feet and begin a slow decline. But, during the night of July 16, a torrential downpour occurred in the northeastern portion of the State of Kansas and along the Missouri River in Missouri which caused a very sudden and sustained rise at Kansas City, which is of interest due to the fact that it occurred at that particular and critical time.

This storm was produced by a cold front which was advancing southeastward across Nebraska on July 16, and upon which a warm wave developed. As this frontal system moved southeastward, heavy rains occurred, the heaviest being in the area between Concordia, Kans., and Kansas City, Mo. This seemed to be very much in line with the path traveled by that portion of the frontal system where the warm wave was active.

Examination of the stages which prevailed during this high water and their comparison with the flood stages for the different Missouri River stations would, no doubt,

¹ From St. Joseph, Mo., station annual and Weather Bureau publication "Daily River Stages."

suggest that this was not a serious overflow. Such an examination would reveal the following:

Station	Flood stage	Crest
	<i>Feet</i>	<i>Feet</i>
Sioux City.....	19	12.7
Omaha.....	19	18.8
Nebraska City.....	15	17.9
St. Joseph.....	17	17.0
Kansas City.....	22	19.2

This, however, does not define the whole nor the true high-water picture and there was a considerable amount of overflow elsewhere than in the vicinity of Nebraska City, although it was here that it was most serious. Many thousand acres of valuable grain, corn, and tobacco land were flooded and the water spread out 3 to 5 miles from its regular channel in some places. With no high water in the Missouri for several years, many farms have extended their cultivation to low ground, and naturally this added to the total of lost acres.

Another interesting sidelight in connection with this high water was the relatively small amount of water which moved downstream when the instantaneous discharge is considered. A discharge measurement made at the peak stage at Nebraska City showed a movement of only 127,000 cubic feet per second, whereas in times past as much as nearly 200,000 second-feet have been recorded with stages much lower. No later than last March, when the wave of water resulting from an ice gorge above Bismarck, N. Dak., was passing downstream, it was determined that at 16.6 feet there was a flow of 125,000 second-feet. A tabulation of the stages with corresponding discharges for the March rise and this one shows clearly the difference in the flow in the Missouri River which is due, not only to the variations in the slope with each wave, but also to the shifting nature of the river bed as well.

Station	March 1938		July 1938	
	Stage	Discharge ¹	Stage	Discharge ²
	<i>Feet</i>	<i>Second-feet</i>	<i>Feet</i>	<i>Second-feet</i>
Bismarck.....	20.5	220,000	14.4	110,000
Pierre.....	12.9	170,000	12.6	125,000
Yankton.....	9.2	141,000	10.1	116,000
Omaha.....	18.3	130,000	18.8	125,000
Nebraska City.....	16.6	125,000	17.9	127,000

¹ From measurements made by the U. S. Geological Survey and rating curves constructed therefrom.

Ohio Basin.—Heavy rainfall over the upper Wabash and West Fork of White Rivers late in June followed by excessive rains over portions of the same area on July 1 and 2 and over the middle and lower portions of the basin on July 2 caused considerable overflow.

The official in charge of the Indianapolis office states that floods of the severity of this June-July overflow are comparatively rare in midsummer. There are no official records of any July stages as high as those of this year in the Wabash Valley. At Mount Carmel, Ill., on the Wabash River, where the records began in 1889, the highest previous July stage (16.3 feet in 1915) is 3.6 feet below that of July 11, 1938, and at Elliston, Ind., on the West Fork of White River, where the stage was 26.1 feet on July 4, 1938, the highest previous July stage since 1908 was 23.1 feet in 1915.

West Gulf of Mexico drainage.—Floods occurred in the Colorado, Nueces, and Rio Grande Rivers near the end of July, but as flood stages continued into August a report will be made later.

Estimated flood losses by drainage basins during July 1938 are as follows:

Atlantic slope drainage:	
Savannah River.....	\$4,500
East Gulf of Mexico drainage:	
Apalachicola River.....	5,200
Missouri Basin:	
Missouri River.....	\$ 1,132,635
Ohio Basin:	
Wabash River.....	934,500
West Fork of White River.....	909,225
East Fork of White River.....	145,900
White River.....	324,000
North Fork of Holston River.....	15,700
Columbia Basin:	
Deer Lodge County, Mont.....	250,000
Total.....	3,721,660

¹ \$39,000 occurred in Montana; 3 lives lost.

Table of flood stages during July 1938

[All dates in July unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE					
James:	<i>Feet</i>			<i>Feet</i>	
Columbia, Va.....	10	23	26	19.0	24
Richmond, Va.....	8	25	25	8.1	25
Roanoke:					
Randolph, Va.....	21	23	26	23.4	25
Weldon, N. C.....	31	23	30	44.1	28
Williamston, N. C.....	10	(¹) 26	(²) 9	13.7	31
Tar:					
Rocky Mount, N. C.....	8	26	(³)	11.0	30
Tarboro, N. C.....	18	30	(⁴)	20.2	Aug. 1
Greenville, N. C.....	13	28	(⁵)	15.0	Aug. 2
Little: Kenly, N. C.....	8	26	28	9.2	27
Neuse:					
Neuse, N. C.....	14	24	(⁶)	22.0	29
Smithfield, N. C.....	13	25	(⁷)	19.5	31
Goldsboro, N. C.....	14	(⁸) 27	Aug. 5	17.2	1
Kinston, N. C.....	14	(⁹) 27	Aug. 8	19.2	Aug. 4
Haw: Moncure, N. C.....	20	25	27	15.2	4
Cape Fear:					
Fayetteville, N. C.....	35	26	28	25.0	26
Lock No. 2, Elizabethtown, N. C.....	20	25	31	25.0	26
Peedee:					
Cheraw, S. C.....	30	25	27	33.7	26
Mars Bluff Bridge, S. C.....	17	26	Aug. 3	30.3	31
Poston, S. C.....	18	31	Aug. 6	19.6	Aug. 3
Saluda:					
Pelzer, S. C.....	6	22	24	8.0	23
Chappells, S. C.....	15	25	27	16.9	27
Broad: Blairs, S. C.....	14	24	26	17.5	26
Santee:					
Rimini, S. C.....	12	25	(¹⁰)	14.4	31
Ferguson, S. C.....	12	28	(¹¹)	13.4	Aug. 1
Broad: Carlton, Ga.....	15	25	25	15.9	25
Savannah:					
Butler Creek, Ga.....	21	24	28	23.4	26-27
Clyo, Ga.....	11	30	(¹²)	(¹³)	
Oconee: Milledgeville, Ga.....	20	26	28	22.5	27
Altamaha: Charlotte, Ga.....	12	28	(¹⁴)	12.5	31
EAST GULF OF MEXICO DRAINAGE					
Apalachicola: Blountstown, Fla.....	15	27	Aug. 1	18.0	29
Choctawhatchee: Caryville, Fla.....	12	31	31	12.1	31
Oostanula: Resaca, Ga.....	22	24	27	23.2	26
Chaha: Centerville, Ala.....	23	25	25	24.5	25
MISSISSIPPI SYSTEM					
<i>Upper Mississippi Basin</i>					
Rock: Moline, Ill.....	10	3	9	10.6	6
Illinois:					
Peru, Ill.....	17	6	6	17.0	6
Havana, Ill.....	14	8	16	14.4	10-11
Beardstown, Ill.....	14	9	13	14.2	10-11

¹ Continued from June.
² Continued into August.
³ Estimated.
⁴ Crest occurred in June.

Table of flood stages during July 1938—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM—continued					
<i>Missouri Basin</i>					
Big Blue: Blue Rapids, Kans.	Feet 20	17	17	Feet 21.0	17
Missouri:					
Blair, Nebr.	18	10	11	18.1	10-11
Nebraska City, Nebr.	15	3	18	17.9	12
St. Joseph, Mo.	17	17	17	17.0	17
<i>Ohio Basin</i>					
Little Miami: Kings Mills, Ohio.	17	14	14	20.9	14
West Fork of White:					
Elliston, Ind.	18	2	8	26.1	6
Edwardsport, Ind.	12	(1)	10	18.9	8
East Fork of White: Seymour, Ind.	14	5	6	15.0	6
White:					
Petersburg, Ind.	16	9	11	17.4	10
Hazleton, Ind.	16	9	12	18.0	11
Wabash:					
Wabash, Ind.	12	1	2	13.7	2
La Fayette, Ind.	11	(1)	5	17.0	3
Covington, Ind.	16	(1)	7	22.2	3
Terre Haute, Ind.	14	(1)	9	20.9	4
Vincennes, Ind.	14	5	12	18.7	9
Mt. Carmel, Ill.	19	9	12	19.9	11
New Harmony, Ind.	15	11	13	15.7	13
Big Pigeon: Newport, Tenn.	6	24	24	7.0	24
French Broad: Oldtown (near Newport), Tenn.	6	23	24	9.2	24

Table of flood stages during July 1938—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM—continued					
<i>Ohio Basin—Continued</i>					
Tennessee:					
Widows Bar Lock, Ala.: Upper gage.	Feet 17	26	26	Feet 17.1	26
Florence, Ala.	18	28	29	18.4	29
WEST GULF OF MEXICO DRAINAGE					
Colorado:					
Marble Falls, Tex.	21	22	28	36.4	25
Austin, Tex.	21	23	27	33.0	25
Nueces: Cotulla, Tex.	16	30	Aug. 1	17.0	31
Rio Grande:					
Del Rio, Tex.	15	23	26	20.2	24
Eagle Pass, Tex.	16	23	27	24.2	24
Rio Grande City, Tex.	21	26	29	24.9	28
Hidalgo, Tex.	21	28	31	22.2	30
Mercedes, Tex.	21	28	Aug. 1	21.9	31
Brownsville, Tex.	18	Aug. 1	Aug. 2	18.1	Aug. 2
PACIFIC SLOPE DRAINAGE					
<i>Columbia Basin</i>					
Columbia: Vancouver, Wash.	15	(1)	8	(4)	-----

¹ Continued from June.
⁴ Crest occurred in June.

WEATHER ON THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, I. R. TANNERHILL in charge]

NORTH ATLANTIC OCEAN, JULY 1938

By H. C. HUNTER

Atmospheric pressure.—Most of the North Atlantic area had pressure greater than normal, though the departures were small. A slight deficiency appeared in the far southwestern part, and a more marked one extended from the vicinity of the British Isles northward to Greenland; in this latter area the station at Reykjavik, Iceland, reported a mean pressure 0.15 inch less than normal. During most of the first half of July the Azores HIGH was displaced somewhat to eastward of its average position, but during the second half, to westward, toward Bermuda.

The extremes of pressure in trustworthy available vessel reports were 30.66 and 29.29 inches. The higher reading was noted more than 200 miles to north-northwestward of Horta during the forenoon of the 4th by the British steamship *Tucurinca*. The Dutch liner *Statendam* recorded the lower reading when 100 miles south of the southernmost point of Ireland, about noon of the 7th.

TABLE 1.—Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, July 1938

Station	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	Inch	Inches		Inches	
Julianehaab, Greenland	29.77	-0.03	30.12	3	29.40	26
Reykjavik, Ice. and	29.69	- .15	30.06	7	29.21	23
Lerwick, Shetland Islands	29.79	- .01	30.15	16	29.47	30
Valencia, Ireland	29.94	- .04	30.24	16, 18	28.59	30
Lisbon, Portugal	30.12	+ .10	30.33	3	29.92	14
Madeira	30.12	+ .07	30.39	7	29.97	20
Horta, Azores	30.33	+ .06	30.64	3	29.94	30
Belle Isle, Newfoundland	29.96	+ .07	30.32	2	29.58	16
Halifax, Nova Scotia	30.02	+ .07	30.26	23-25	29.72	4
Nantucket	30.00	+ .02	30.21	22	29.75	2
Hatteras	30.06	+ .05	30.21	22	29.81	3
Bermuda	30.21	+ .03	30.34	29	29.94	4
Turks Island	30.04	- .03	30.19	9	29.92	5
Key West	30.02	- .01	30.14	9	29.89	5
New Orleans	29.99	- .01	30.17	10	29.81	5

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Cyclones and gales.—Three storm areas of moderate importance affected the northeastern part of the North Atlantic during the first half of July. Otherwise the month had no features of special importance.

On the 3d a Low was centered nearly over the south coast of Iceland, whence it traveled at first southeastward, so that by the morning of the 5th it was over Great Britain as a well-developed storm. Thereafter it moved northeastward and reached southern Norway late on the 6th. Several vessels encountered fresh to strong gales, mostly within the southwest quadrant of this low. The American liner *Washington*, New York to Cobh, met strong winds on the 4th, the day before arrival at Cobh, and press reports state a few passengers suffered minor injuries.

In the southwestward extension of the low just mentioned there was a marked new development by the 6th, and a well-formed storm appeared some distance to the southwestward of Ireland. This storm advanced toward the east-northeast, so that the center was near Lands End early on the 7th, with considerable intensity. Thereafter its course was almost northward and the morning of the 9th found it centered over the northern part of the North Sea, with slightly less energy. Several vessels met fresh gales connected with this storm, and the American steamship *Nemaha* encountered a whole gale on the 6th, near 42° N., 18° W.

The third storm center of moment was located to south-eastward of Cape Farewell on the morning of the 12th. It moved to the eastward, approximately on the 60th parallel, and gained in strength for a time. Late on the 13th it turned more toward the north over waters east of Iceland, and on the 15th was centered near Jan Mayen Island, where there are very few reporting vessels. However, on the 13th the American liner *Scarpenn*, near 56° N., 26° W., reported force 10 (whole gale), the second and final instance of such force this month over Atlantic waters.

During the last 2 days of the month squally weather was encountered in the Caribbean Sea, not far to south-