

557.462 21.3 117.6.3
SECTION IV.—RIVERS AND FLOODS.

RIVERS AND FLOODS, MARCH, 1916.

By ALFRED J. HENRY, Professor in Charge River and Flood Division.

[Dated: Weather Bureau, April 29, 1916.]

Mississippi.—The flood in the lower Mississippi, which began in the latter part of January, 1916 (see this REVIEW for that month), gradually subsided during March, 1916, the river at Vicksburg, Miss., passing below flood stage on the 17th. Six days later it dropped below the flood stage at New Orleans, after being continuously in flood at that station since January 31, 1916, a period of 52 days. At Vicksburg the river was above flood stage a period of 63 days, one day longer than in 1912.

Fortunately the rainfall distribution during both February and March, 1916, in the watershed above Vicksburg was such as to permit a steady decline of the flood waters in practically all parts of the basin. A large part of the precipitation of March in northern districts was in the form of snow, as a consequence of which there was a fairly heavy snow cover in upper Michigan, northern New York, and northern New England as late as the 27th. Relatively high temperatures and moderate rains in the middle Mississippi Valley on the 26th–27th caused a light swell to pass down the river between Keokuk, Iowa, and Louisiana, Mo., as shown in Table 1. This swell did not reach the magnitude of a flood in the main river above Keokuk, Iowa, but the total precipitation over a region embracing northeastern Iowa, northwestern Illinois, and southwestern Wisconsin from the 21st to the 26th was great enough to produce flood stages in the tributary streams which subsided almost as quickly as they rose. The stage in the Galena River of Illinois is said to have been at least a foot higher than ever before recorded. The railroads in the flooded section suffered considerable loss to roadbed and tracks and also from a general suspension of traffic for three or four days. The damage in the flooded section probably amounted to \$50,000, of which about one-third was sustained by the railroads. Two lives were lost.

The warm weather and the rains mentioned in the above paragraph were associated with low No. VIII A, Chart III, this REVIEW. The same low, as it advanced over Michigan, was attended by rains averaging about 2 inches in depth over the State south of the Straits of Mackinac. This amount of rain and the melting of 3 to 4 inches of freshly fallen snow resting upon a frozen soil, caused a very rapid and excessive run-off and severe floods all over the Lower Peninsula. The flood in the Grand River at Grand Rapids, Mich., was the greatest since 1905, with the single exception of the April, 1912, flood. The flood in the Saginaw River and its tributaries was complicated by ice jams at several places that caused a temporary damming of the current and overflow of the lowlands that would otherwise have escaped. It is reported that thousands of acres of agricultural land in the Saginaw Valley were under from 2 to 8 feet of water, thus necessitating the removal of stock to higher ground. The damage to the land was probably very small, but a number of farm buildings will have to be renovated and put in order

before being again occupied. Some bridges were swept away and there was a suspension of railway traffic on the Jackson division of the Michigan Central, the Grand Rapids division of the Pere Marquette, also on the Grand Trunk for several days.

The weather conditions as described above also produced floods in the Fort Wayne (Ind.) and Columbus (Ohio) river districts. All of these floods were forecast. The stages reached in the Grand Rapids and Saginaw districts of Michigan and the Fort Wayne district of Indiana are given in Table 2, and for the rivers of Ohio in Tables 2 and 4.

Missouri River flood in the vicinity of Yankton, S. Dak.—A severe flood or overflow of the lowlands on both sides of the river occurred between the 7th and 13th, resulting in a very considerable loss of live stock, stored crops, and hay in stacks, also damage to farm buildings amounting probably to slightly more than \$200,000. Damage to railroad tracks and roadbed and to county roads and bridges will increase the total loss to about \$250,000.

The ice in the Missouri River during the winter of 1915–16, was somewhat thicker than usual. A warm spell in February caused the ice to break up at Sioux City, Iowa, and go out as early as February 21. At Yankton the river was nearly free of ice on February 23. At Pierre, the most northerly reporting station, the ice broke up February 24, but evidently gorged a short distance below that place and held until March 4, nine days later, when ice began running on an 18.6-foot stage at Pierre.

At Chamberlain, S. Dak., the next station below Pierre, the ice broke up on the 5th at a stage 5 feet below flood stage. At Running Water, S. Dak., just below the mouth of the Niobrara, heavy ice was running on the 7th, with a stage of 18.8 feet, or nearly 3 feet above flood stage. The crest of this wave evidently reached Yankton, S. Dak., early the same day. At that point the river was bankful and carried a heavy burden of ice during the forenoon of the 7th, but it began to recede in the afternoon, falling several inches. Soon, however, it turned and again began to rise, adding 2 feet to a stage that was already serious. The gorge below Yankton continued to hold throughout the 8th to 11th, but gave way on the 12th. Meanwhile the overflow and back-water had created a very serious condition along the river between Springfield and Vermillion, similar in many respects to the memorable overflow of April, 1881, also caused by ice gorges. Table No. 3 shows but a single flood stage in connection with the very destructive overflow at and near Yankton.

Ohio River.—During February and March a considerable amount of snow had accumulated over the watersheds of the Allegheny and Beaver Rivers and a less amount over the watershed to the east of Pittsburgh. The low-pressure system No. VIII A, Chart III, before referred to as causing floods in Arizona, lower Michigan, and the middle Mississippi Valley, in its east-northeast course, was attended by relatively warm weather in the Pittsburgh, Pa., district on the 25th, continuing until the end

of the month. The Allegheny and the Beaver Rivers began to rise, due to snow water, on the 26th. On the two succeeding days moderate rains fell over the district. The Allegheny and Beaver were both above the flood stage but the former failed to reach flood stage at Pittsburgh by 0.2 foot, doubtless due to a fall in temperature that checked the snow melting above Pittsburgh.

The cessation of the rains on the 29th, together with the fall in temperature noted above, destroyed whatever chance of a severe flood then existed and, as it turned out, only a small flood resulted. The flood stage was not reached on the Ohio at Wheeling, but stages slightly above flood were reached from Parkersburg to Cincinnati and again in the Evansville district, but not in the intervening Louisville district except at a single station, Cloverport, Ky., nor at Cairo, Ill., although a stage of 44.5 feet, lacking 0.5 foot of flood stage, was reached at that place on April 8, 1916. This slight swell from the Ohio passed down the Mississippi during April but was not reinforced by flood waters from other tributaries of the main river and served mainly to prolong the period of high water below Memphis. The lower river, after falling to 35 feet at Vicksburg, began to again rise and reached a second crest of 45.2 feet on April 26, after which date a fall set in.

Susquehanna River.—In the watershed above Binghamton, N. Y., on the north branch of the Susquehanna the average depth of the snow cover on March 23 was 24.7 inches, with a water equivalent of about 35 per cent. During the ensuing week the snow cover disappeared at an average rate of an inch daily and considerable water found its way into the streams. Fortunately the weather conditions during the closing days of the month were favorable to a gradual and moderate run-off. Flood stages in the Susquehanna and the Hudson are shown in Table 5. The weather conditions over the watershed of the Hudson were similar to those which prevailed over the Susquehanna watershed during the closing days of the month. The most noteworthy feature was the absence of heavy rains, which greatly mitigated the flood conditions on both rivers.

In the Harrisburg district of the Susquehanna, which includes both the north and west branches of the river below Binghamton, and the Juniata, the ice broke up and went out on moderately high stages. The rainfall in this district was also light except on the 28th and, all in all, the breaking up of the ice during the spring of 1916 was attended by the minimum amount of flooding.

The property loss in the Binghamton district was about \$5,000; in the Harrisburg district probably as much as \$200,000, a large part of which was in the loss of wages of employees, due to the shutting down of various industrial plants.

Rivers in the Denver, Colo., district.—The prevailing mild temperatures during the month melted practically all snow in unprotected localities below 8,000 feet. All streams were swollen, and in localities in the mountains on the western slope the stages reached were almost as high as the crest stages of last year.

Salt River of Arizona.—A low-pressure system, No. VIII A of Chart III, moving eastward passed north of Arizona and caused a two-days' rain over the State and doubtless the melting of some snow at the higher altitudes. The Salt River reached and passed flood stage at Tempe on the 24th, but the rise soon subsided. The damage was nominal.

Willamette River.—Heavy rains during the closing days of the month, in conjunction with a high stage in the

lower Columbia, conspired to produce flood stages in the Willamette and other Oregon rivers, as shown in Table 6. Owing to the advance notice given of this flood the damage was nominal.

Flood losses during March.

Missouri in South Dakota and Nebraska.....	\$250,000
Susquehanna.....	205,000
Mississippi in Iowa, Illinois, and Missouri.....	187,600
Total loss.....	642,600
Estimated saving by warnings.....	30,500

TABLE 1.—Floods in the upper Mississippi River and tributaries, March, 1916.

River.	Station.	Flood stage.	Above flood stage.		Crest.	
			From—	To—	Stage.	Date.
		<i>Feet.</i>			<i>Feet.</i>	
Mississippi.....	Keokuk, Iowa.....	14.0	28	15	16.4	Mar. 31
Do.....	Warsaw, Ill.....	17.0	28	(*)	19.0	31
Do.....	Quincy, Ill.....	14.0	28	(*)	18.0	31
Do.....	Hannibal, Mo.....	13.0	28	(*)	18.2	31
Do.....	Louisiana, Mo.....	12.0	29	(*)	15.8	31
Wisconsin.....	Knowlton, Wis.....	12.0	31	(*)	14.3	31
Des Moines.....	Ottumwa, Iowa.....	10.0	27	(*)	10.7	27
Do.....	Boone, Iowa.....	12.0	27	28	15.5	27
Illinois.....	Morris, Ill.....	13.0	28	29	13.0	29
Do.....	La Salle, Ill.....	18.0	26	(*)	22.6	29
Do.....	Peoria, Ill.....	16.0	30	(*)	17.2	31
Do.....	Beardstown, Ill.....	12.0	1	19	14.7	1
Do.....	do.....	12.0	28	(*)	13.0	31

¹ April.

² Continued into April.

TABLE 2.—Floods in the rivers of the Great Lakes drainage basin, March, 1916.

River.	Station.	Flood stage.	Above flood stage.		Crest.	
			From—	To—	Stage.	Date.
		<i>Feet.</i>			<i>Feet.</i>	
Sandusky.....	Upper Sandusky, Ohio.....	13.0	27	28	14.4	Mar. 28
Do.....	Tiffin, Ohio.....	10.0	27	29	12.0	29
Do.....	Fremont, Ohio.....	10.0	27	28	11.3	27
Maumee.....	Fort Wayne, Ind.....	15.0	27	31	18.3	30
Do.....	Napoleon, Ohio.....	10.0	28	30	12.2	29
Auglaize.....	Dehance, Ohio.....	10.0	28	29	12.2	29
St. Joseph.....	Montpelier, Ohio.....	10.0	27	30	13.2	28
Saginaw.....	Saginaw, Mich.....	19.1	28	31	24.3	31
Shiawassee.....	Wosso, Mich.....	8.0	28	29	8.3	29
Do.....	Chesaning, Mich.....	15.0	28	28	15.1	28
Flint.....	Flint, Mich.....	14.0	28	31	18.5	29
Do.....	Fosters, Mich.....	18.0	29	29	18.0	29
Cass.....	Vassar, Mich.....	14.0	29	31	18.9	30
Tittabawassee.....	Midland, Mich.....	12.0	27	31	23.4	28
Do.....	Paines, Mich.....	20.0	29	29	20.2	28
Chippewa.....	Mount Pleasant, Mich.....	11.0	27	31	13.9	29
Pine.....	Alma, Mich.....	7.0	27	31	10.7	28
Grand.....	East Lansing, Mich.....	6.5	28	28	6.5	28
Do.....	East Lansing, Mich.....	7.5	26	31	11.6	27
Do.....	Lansing, Mich.....	10.8	27	30	14.5	28
Do.....	Ionia, Mich.....	22.0	28	30	23.5	29
Do.....	Grand Rapids, Mich.....	11.0	28	31	15.8	30

TABLE 3.—Floods in the Missouri River and tributaries, March, 1916.

River.	Station.	Flood stage.	Above flood stage.		Crest.	
			From—	To—	Stage.	Date.
		<i>Feet.</i>			<i>Feet.</i>	
Missouri.....	Williston, N. Dak.....	24.0	31	31	25.0	Mar. 31
Do.....	Bismarck, N. Dak.....	14.0	19	21	15.3	20
Do.....	Running Water, S. Dak.....	16.0	7	7	18.3	7
Milk.....	Havre, Mont.....	9.0	8	17	17.2	12
Little Missouri.....	Medora, N. Dak.....	9.0	16	16	9.1	16
James.....	Huron, S. Dak.....	9.0	14	28	10.5	22
Grand.....	Chillicothe, Mo.....	18.0	27	29	21.1	28

TABLE 4.—Floods in the Ohio River and tributaries, March, 1916.

River.	Station.	Flood stage.	Above flood stage.		Crest.	
			From—	To—	Stage.	Date.
Ohio.....	Beaver Dam, Pa.....	Feet. 30.0	29	30	Feet. 32.5	Mar. 29
Do.....	Marletta, Ohio.....	33.0	29	31	35.6	30
Do.....	Parkersburg, W. Va.....	38.0	30	31	37.1	30
Do.....	Point Pleasant, W. Va.....	40.0	30	31	43.0	31
Do.....	Dam No. 28 (Hogsett), W. Va.....	46.3	31	31	46.3	31
Do.....	Catlettsburg, Ky.....	50.0	31	31	50.1	31
Do.....	Portsmouth, Ohio.....	50.0	30	31	53.2	31
Do.....	Maysville, Ky.....	50.0	31	31	51.4	31
Do.....	Cincinnati, Ohio.....	50.0	31	13	53.2	31
Allegheny.....	Clean, N. Y.....	12.0	28	31	15.1	29
Do.....	Warren, Pa.....	12.0	29	31	14.0	30
Do.....	Franklin, Pa.....	15.0	29	31	17.1	29
Do.....	Parker, Pa.....	18.0	29	31	19.5	29
Do.....	Mosgrove, Pa.....	20.0	28	31	22.5	29
Do.....	Freeport, Pa.....	22.0	28	31	25.8	28
Do.....	Lock and Dam No. 3, Springdale, Pa.....	27.0	29	30	29.8	29
Do.....	Harris Island Dam, Pa.....	22.0	29	30	24.2	29
Clarion.....	Clarion, Pa.....	12.0	28	28	13.4	28
Stony Creek.....	Johnstown, Pa.....	10.0	28	28	10.5	28
Kiskiminetas.....	Saltsburg, Pa.....	8.0	28	28	8.7	28
Monongahela.....	Greensboro, Pa.....	20.0	22	22	20.5	22
Youghiogheny.....	Confluence, Pa.....	10.0	22	22	10.5	22
Beaver.....	Beaver Falls, Pa.....	10.6	27	27	10.8	27
Shanango.....	Sharon, Pa.....	9.0	26	30	12.0	28
Mahoning.....	Youngstown, Ohio.....	7.0	26	28	8.9	27
Muskingum.....	Zanesville, Ohio.....	25.0	28	28	25.1	28
Do.....	McConnelsville, Ohio.....	22.0	28	30	24.5	30
Do.....	Marletta, Ohio.....	32.0	29	31	37.1	30
Walhonding.....	Walhonding, Ohio.....	8.0	23	24	9.8	23
Do.....	do.....	8.0	28	29	11.2	28
Tuscarawas.....	Norris Point, Ohio.....	8.0	23	29	11.2	24
Do.....	Coshocton, Ohio.....	8.0	23	30	11.7	28
Scioto.....	Larus, Ohio.....	11.0	23	23	12.6	23
Do.....	do.....	11.0	27	27	13.2	27
Do.....	do.....	10.0	27	30	13.9	29
Do.....	Prospect, Ohio.....	10.0	27	28	12.2	27
Do.....	Bellpoint, Ohio.....	9.0	27	27	9.0	27
Do.....	Dublin, Ohio.....	8.0	27	27	9.0	27
Do.....	Columbus, Ohio.....	17.0	27	28	19.8	27
Do.....	Circleville, Ohio.....	6.0	23	31	13.2	29
Do.....	Chillicothe, Ohio.....	14.5	24	24	15.6	24
Do.....	do.....	14.5	28	30	21.8	29
Ontangy.....	Delaware, Ohio.....	9.0	22	22	10.5	22
Do.....	do.....	9.0	27	28	11.4	27
Darby Creek.....	Fox, Ohio.....	8.0	27	28	15.1	28
Deer Creek.....	Williamsport, Ohio.....	8.0	27	27	8.7	27
Paint Creek.....	Paint Creek, Ohio.....	14.0	27	27	16.0	27
Little Miami.....	Kings Mills, Ohio.....	17.0	27	27	17.0	27
Miami.....	Tadmor, Ohio.....	12.0	28	28	13.6	28
Wabash.....	La Fayette, Ind.....	11.0	24	25	11.5	24
Do.....	do.....	11.0	28	31	14.8	30

¹ April.

TABLE 5.—Floods in the Susquehanna and Hudson Rivers and tributaries, March, 1916.

River.	Station.	Flood stage.	Above flood stage.		Crest.	
			From—	To—	Stage.	Date.
Susquehanna.....	Oneonta, N. Y.....	Feet. 10.0	30	17	16.7	12
Do.....	Bainbridge, N. Y.....	11.0	30	17	16.9	12
Do.....	Binghamton, N. Y.....	14.0	31	13	16.5	12
Do.....	Towanda, Pa.....	16.0	31	31	17.4	31
Do.....	Wilkes-Barre, Pa.....	20.0	29	31	24.8	31
Do.....	Williamsport, Pa.....	20.0	29	29	20.5	29
Do.....	Harrisburg, Pa.....	17.0	29	31	18.6	29
Unadilla.....	New Berlin, N. Y.....	8.0	31	13	11.9	12
Chenango.....	Sherburne, N. Y.....	8.0	31	13	9.0	12
Hudson.....	Albany, N. Y.....	12.0	31	31	12.2	31
Do.....	Castleton, N. Y.....	10.0	31	31	10.4	31
Mohawk.....	Tribes Hill, N. Y.....	16.0	29	29	18.2	29
Do.....	Schenectady, N. Y.....	15.0	31	31	16.0	31

¹ April.

TABLE 6.—Floods in the rivers of the Pacific slope, March, 1916.

River.	Station.	Flood stage.	Above flood stage.		Crest.	
			From—	To—	Stage.	Date.
Columbia.....	Vancouver, Wash.....	Feet. 15.0	26	30	Feet. 17.1	28
Willamette.....	Oregon City, Oreg.....	12.0	27	29	12.9	28
Do.....	Portland, Oreg.....	15.0	24	31	19.5	28
Santiam.....	Jefferson, Oreg.....	10.0	26	27	10.0	26 & 27
Yamhill.....	McMinnville, Oreg.....	35.0	27	28	40.2	27
Clackamas.....	Casadero, Oreg.....	8.0	26	27	10.0	26
Tualatin.....	Tualatin, Oreg.....	15.0	28	30	19.5	28
San Joaquin.....	Lathrop, Cal.....	17.0	23	24	17.7	23
Salt.....	Tempe, Ariz.....	7.0	24	27	11.4	24

TABLE 7.—Miscellaneous floods during March, 1916.

River.	Station.	Flood stage.	Above flood stage.		Crest.	
			From—	To—	Stage.	Date.
Potomac.....	Cumberland, Md.....	Feet. 8.0	23	23	Feet. 8.8	23
Santee.....	Rimini, S. C.....	12.0	2	13	13.4	6 & 7
Do.....	Ferguson, S. C.....	12.0	1	17	13.4	8
Neosho.....	Fort Gibson, Okla.....	22.0	27	27	22.0	27
Rio Grande.....	San Marcial, N. Mex.....	11.0	24	24	14.3	24

MEAN LAKE LEVELS DURING MARCH, 1916.

By UNITED STATES LAKE SURVEY.

[Dated: Detroit, Mich., Apr. 5, 1916.]

The following data are reported in the "Notice to Mariners" of the above date:

Data.	Lakes.			
	Superior.	Michigan & Huron.	Erie.	Ontario.
Mean level during March, 1916:				
Above mean sea level at New York.....	Feet. 602.17	Feet. 579.43	Feet. 571.84	Feet. 245.46
Above or below—				
Mean stage of February, 1916.....	-0.27	+0.01	-0.15	+0.05
Mean stage of March, 1915.....	+0.70	-0.12	+0.43	+0.19
Average stage for March, last 10 years.....	+0.60	-0.57	+0.07	-0.43
Highest recorded March stage.....	-0.11	-3.47	-2.01	-2.35
Lowest recorded March stage.....	+1.51	+0.37	+1.01	+1.16
Average relation of the March level to:				
February level.....	-0.2	0.0	+0.1	+0.2
April level.....	0.0	-0.2	-0.6	-0.5