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DESTRUCTIVE FLOODS IN THE UNITED STATES IN 1903

BY

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Destructive floods of the
United States in 1903

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DESTRUCTIVE FLOODS IN THE UNITED STATES IN 1903.[a]

By E. C. Murphy

INTRODUCTION.

Experience has shown that in the area of the United States great variations from normal climatic conditions must be expected; the temperature, or the wind velocity, or the precipitation, or all three combined, may vary from the normal by a considerable amount at any place and in any season of the year.

The year 1903 will long be remembered for its extreme local variations from normal climatic conditions. A cloud-burst at Heppner, Oreg., on June 14, caused the loss of 200 lives and a quarter of a million dollars' worth of property; a tornado and an excessive rainfall at Gainesville, Ga., caused a loss of 100 lives and of property valued at half a million dollars; the excessive rainfall of June 6 in South Carolina devastated Pacolet, Clifton, and Glendale, causing the loss of many lives and of property valued at $3,000,000, and tornadoes and excessive rainfall of the upper-central Mississippi Valley and lower Missouri Valley from May 16 to 30 resulted in the destruction of much property.

Nearly coincident in time with these extremes was the other extreme of small precipitation, with cold, backward spring, retarded growth of vegetation, forest fires, and very small flow of streams in New York and the New England States.

THE HEPPNER, OREG., FLOOD.

The flood of Willow Creek, Morrow County, Oreg., commonly spoken of as the "Heppner disaster," occurred on Sunday evening, June 14. It was due to one of those very heavy storms of short duration covering a very small area, so peculiar to the arid region, and popularly called a "cloud-burst." Such a storm is almost like the tornado in its suddenness, destructibility, and limited extent. The duration of this storm was only half an hour, and the resulting flood lasted

[a] The writer desires herewith to express his thanks to Mr. F. H. Newell, hydrographer in charge, and Mr. J. C. Hoyt, computer, for valuable suggestions and assistance in the preparation of this paper, and to Messrs. J. T. Whistler, B. S. Drane, and W. G. Russell for their reports on the floods in their respective districts.

for one-third of the time. The total flood volume at Heppner was found to be 1,100 acre-feet, and at Lexington 800 acre-feet.

The increased discharge at Heppner over that in Balm Creek was due principally to the water which enters Willow Creek below the mouth of Balm Creek, but partly to a small amount from shore. The flood volume near the mouth of Willow Creek was also computed and found to be 750 acre-feet.

It is very likely that the storm area was at least 20 square miles. Assuming that two-thirds of the rainfall reached Heppner, the total precipitation was approximately 1,600 acre-feet, which amounts to 1½ inches in depth over this area, a rate of rainfall of about 3 inches per hour.

The flood water was very heavily laden with silt and in color is said to have resembled molasses.

Effect of the flood.—As a result of the flood one-third of the town of Heppner was entirely destroyed, and about 200 lives were lost. It seems almost incredible that a flood of a depth of only 5 feet above the general road level of the town should cause such a loss of life. The explanation lies in the peculiar construction of the houses. Nearly all of the houses simply rested on posts or open foundations of stone. The water freely passed underneath, but could not so rapidly get to the inside of the houses, so they were lifted off their foundations and floated away like boats. The rapid velocity soon drove them against trees or other objects and crushed them to pieces. In such a swift current and among such masses of timber it was almost impossible for a person to get ashore.

The duration of the flood was so short that the only considerable scouring effect observed was at the mouth of Balm Creek, where the flood crossed Willow Creek and struck the opposite shore. At this point a new channel was formed.

In 1888 a similar flood, possibly a larger one, came down Hinton Creek, but did little damage, as there were only a few houses there at that time. In 1883 there was a large flood in Willow Creek, but reliable records are not available for the comparison of these floods with the one of 1903.

Lessons taught by the flood.—Storms of great violence, short duration, and affecting comparatively small areas are to be expected occasionally in all parts of the arid and semiarid region, as the bare, steep, nonabsorbent surface causes the resulting floods to be large, sudden, and very destructive. All streams should have an ample waterway under bridges and through towns, and all buildings should be out of reach of the flood. No building that can be lifted from its foundation and swept away should be allowed in the area of a possible flood. Buildings in the line of a flood, such as mills, warehouses, pumping stations, etc., should be protected from drift during high water.

THE SOUTH CAROLINA FLOOD.

A destructive flood occurred in Spartanburg County, S. C., on June 6, 1903. Considering the small area affected by the storm, the precipitation was very large and the loss of life and property great.

Character of country and streams.—In the twenty-four hours of the storm there was a rainfall of from 3½ to 5 inches in the counties of Cherokee, Spartanburg, Greenville, and the eastern half of Pickens, in South Carolina; and in the southern part of Rutherford, Polk, and Henderson counties, in North Carolina—a total area of 2,300 to 2,500 square miles. This region is situated on the southern slope of the Saluda Mountains. It does not extend up into the mountains, but includes the foothills and rolling country. About half of it is covered with timber; the remainder is cultivated and pasture land. The surface slopes are such that the water runs off rapidly and there is very little storage.

The streams that drain this area are Pacolet, North, South, and Middle Tiger, and Enoree rivers. These are tributaries of Broad River and enter it from the west. The upper tributaries of Saluda River, which flow to the west, rose to an unusual height, but little damage was done on them. Practically all the damage was confined to Spartanburg County, S. C.

The streams mentioned rise within a comparatively short distance of each other. North Fork of the Pacolet heads in Polk County, N. C.; all the others head in Greenville County, S. C. They are characterized by deep, narrow channels, with rapid fall. The Pacolet is said to have a fall of 500 feet from its head to Pacolet mills, a distance of 35 miles. There are no ponds or wide bottom lands to hold back the water in time of flood. The ground was soaked almost to saturation just previous to the flood, so that there was very little ground storage.

The storm.—During the week preceding this flood there was rain over this area almost daily; not hard rains, but gentle, penetrating showers, that nearly saturated the soil. On Friday, June 5, 1903, rains fell almost incessantly. In the evening the rain became more violent and continued until 4 a. m. without interruption.

[a] Prepared from report of B. S. Drane, assistant hydrographer.

The precipitation for the first six days of June, as reported to the United States Weather Bureau, is given in the following table:

Daily rainfall reported from Weather Bureau stations in and surrounding area of South Carolina flood for the first six days in June, 1903.

Station	June 1	June 2	June 3.	June 4	June 5.	June 6
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
Waynesville, N. C.	0.30	-------	0.10	0.40	0.80	0.08
Asheville, N. C.	.59	0.10		.06	.99	.62
Morganton, N. C.	.62	.86	14	1.50		1.13
Statesville, N. C.	.35	.54			.70	1.25
Hendersonville, N. C	.61	.74	40		1.22	1.50
Brevard, N. C.	1.60	.40		.30	2.00	2.10
Highlands, N. C.	1.10	1.57		1.28	3.20	1.21
Henrietta, N. C.	.19	1.44		Trace.	1.51	4.85
Charlotte, N. C.	Trace.	.51	.07	.10	.59	1.51
Liberty, S. C.	1.20	Trace.		.25	.55	2.03
Spartanburg, S. C.	Trace.	.90	.07		.35	5.05
Greenville, S. C.	.27	.80	.08		1.15	3.82
Gaffney, S. C.	-------	.10	.82	.09	.94	3.64
Santuc, S. C.	-------	1.15		.73	.87	.90
Rock Hill, S. C.	.04	1.17	.02	.33	1.15	1.99
Columbia, S. C.	.82	2.30	.12	.41	.22	2.33
Heath Springs, S. C.	.80	1.10	.01	.50	.60	1.44
Barksdale, S. C.	1.80	.60			2.75	1.23

Fig. 1 shows the location of some of these stations and the depth of rainfall reported at each on the morning of June 6, 1903. It is seen that the greatest precipitation in the twenty-four hours was at Spartanburg, diminishing in amount in every direction from that place, rapidly to the northwest and southeast and gradually to the northeast and southwest.

The precipitation northwest of Spartanburg was considerably greater than 5 inches. The washouts, landslides, and gullies cut by the flowing water indicate that the precipitation over the rain area was probably from 7 to 11 inches in the twenty-four hours preceding the morning of June 6, 1903. This region is included in an area that Prof. A. J. Henry, of the United States Weather Bureau, states is second in precipitation in the United States. The people who live in that region are accustomed to very heavy rains, and their estimates confirm the figures given above of the precipitation.

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The flood.—There are no gaging stations on the streams on which the damage was done by this flood. For about seven years the United States Geological Survey has maintained gaging stations on Broad

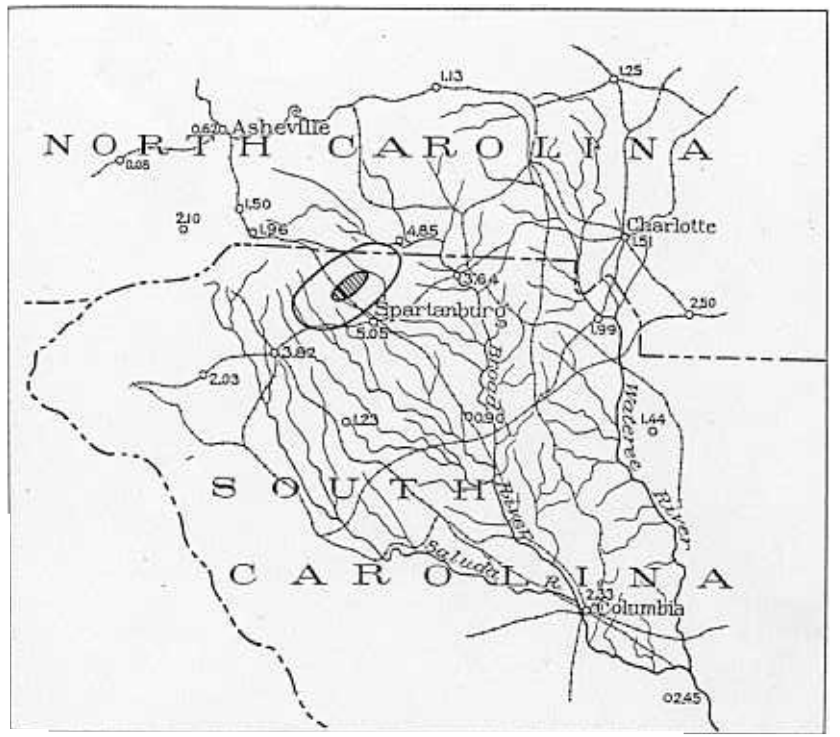


FIG. 1.—Map showing distribution of Weather Bureau stations, etc.

River at Alston, about 75 miles below Pacolet, and on the Saluda near Waterloo. The mean daily gage heights at each of these places from June 1 to 10 are given in the following table:

Mean daily gage heights, in feet, June 1 to 10, 1903.

Place.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Broad River at Alston, S. C.	5.90	7.55	8.70	6.65	7.30	13.60	27.20	26.70	17.30	9.90
Saluda River at Waterloo, S. C.	9.85	10.40	8.40	7.75	12.15	14	19.25	22.35	14.45	10.30

The highest water previous to this flood at these stations during these seven years was in 1901. At Alston, S. C., the maximum on June 7, 1903, was 29 feet, which is 5½ feet higher than in 1901. At Waterloo the maximum was 23.15 feet, which is 2¼ feet higher than in 1901.

These figures, while they convey some idea of the magnitude of this flood, are not definite, because these stations are far below where the

storm occurred and where the damage was done. Had there been a gaging station on Pacolet River near its mouth it would have shown a much greater difference between the flood readings of 1901 and 1903 than do the figures at the Alston station.

A few flood marks of the flood of 1852 still remain at points on these streams. At Fingerville the new mark is 3.7 feet higher than the old one. At Whitneys mill, on Lawsons Fork near Spartanburg, the new mark is 9.9 feet higher than the old one. On the main Pacolet and Middle Tiger rivers the new marks are about 10 feet higher than the old ones. On Enoree River the new mark is 1½ feet lower than the one of 1852.

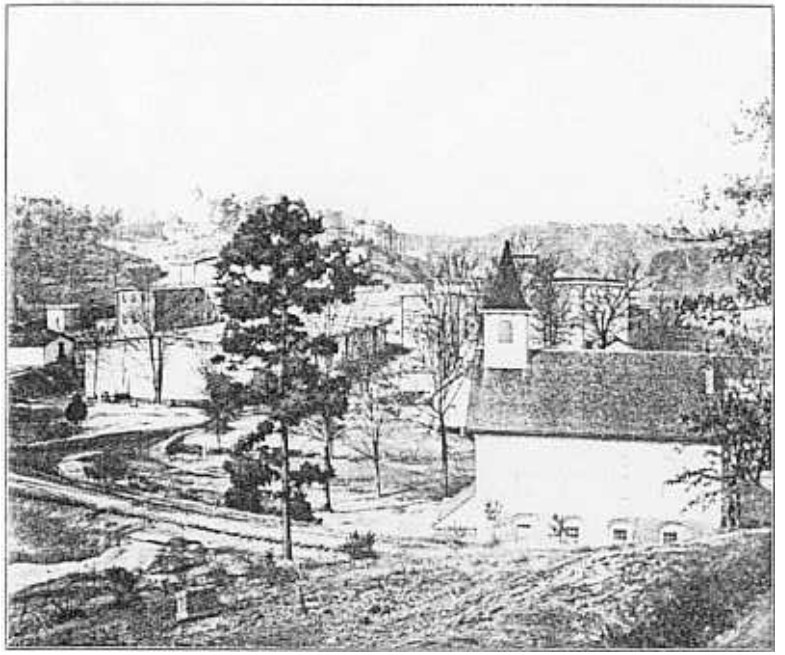
For computing the discharge a section was taken above the dam at Pacolet. The pond at this point is shallow and the section rather narrow, and it is therefore believed that the current was fairly uniform. On the right bank the high-water mark was found in a garden, and is undoubtedly reliable. This gives a difference in elevation between high and low water of 24.4 feet and a flood section of 6,150 square feet. At gaging stations during floods, when the section was similar and the slope similar or not so great, the mean velocity has been observed to be as much as 5.78 feet per second. Assuming this velocity and using the area of section given above, the discharge at this place is 35,547 second-feet. The drainage area of the Pacolet at this place is about 400 square miles. The estimated discharge is equivalent to a run-off of 88.9 second-feet per square mile.

The flood of Catawba River of May, 1901, which caused great destruction of farming land, had an estimated run-off per square mile of 51.8 second-feet at the Catawba, N. C., station, and of 44.4 second-feet at the Rockhill, S. C., station. The estimated run-off at Pacolet during the 1903 flood is seen to exceed that of 1901 at the Catawba by 70 per cent and at Rockhill by 100 per cent. It is possible, however, that the estimated run-off at Pacolet is too great. The method of obtaining the mean velocity was not very reliable.

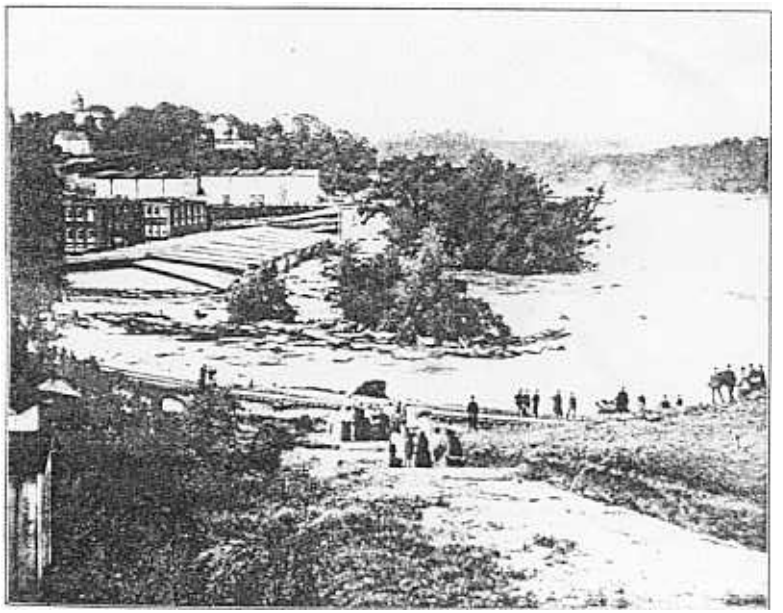
Destruction wrought by the flood.—There was some destruction of property on Tiger River, but the largest amount was on Pacolet River, at Clifton mills and Pacolet mills. The destruction of the Clifton mills is thus described in the report of Mr. B. S. Drane:

Clifton mill No. 3, known as "Converse mill," stood just above the bridge over which the main line of the Southern Railway crosses Pacolet River. It was built in 1890 and 1895, and as completed was a four-story mill 496 feet long and 100 feet wide. It was valued at $1,000,000 and contained 50,100 spindles.

The river was noticed to be about 8 feet above low water at midnight, but did not appear to be rising, and caused no anxiety. At 3.30 a. m. Mr. Kirby, master machinist of the mill, upon going down, saw that the water was beginning to rise into the wheelhouse. Getting assistance, he began to remove belts and ropes, but before any headway had been made the water forced him to leave. By 4.30 the rise was beginning to be rapid, and in a few minutes the water was flowing over the right end of the dam and breaking on the boiler houses and shops. These were wrecked before 5 o'clock. A little after 5 the brick stack, 137 feet high, was washed down with the part of the dam immediately behind it; it fell



A. PACOLET BEFORE THE FLOOD OF 190



B. PACOLET DURING THE FLOOD OF 190

on the corner of the mill. The mill began to wash down immediately, and the wreck was practically complete by 6 o'clock. The mill was washed entirely away, except for the three-story picker room. Shops, boiler houses, wheelhouse, and 16 cottages were also carried away.

The dam here had a section of 27 feet height, 27 feet base, and 11 feet crest. The construction was said to have been hasty and of materials much inferior to those usual on this river. The crest was broken off irregularly to a depth averaging 10 feet for 100 feet from the right bank, and to a depth of 7 feet for the next 40 feet. One footbridge and one county bridge, of wood, were carried away from just below the mill.

About 1½ miles below was the original Clifton mill, known as "No. 1." It was built in 1880, and had 27,500 spindles. At this point the rise was not alarming at 2 o'clock a. m. The rapid rise began at some time between half past 4 and 5. Just after 5 the water rose 2 feet in ten minutes, according to the assistant superintendent. The first thing to be carried away was a large hall. This floated off at about 5.45 and was hurled down into the upper corner of the mill, which stood out into the stream. The blow broke in part of the corner of the mill, but the destruction of the mill did not begin until the wreckage from above began to come down thickly, a little after 6 o'clock. Large timbers were then dashed into the projecting corner and the mill began to settle down gradually, little by little, beginning at this end. Altogether about 110 feet of the main building and the wheelhouse were totally wrecked. The machinery on the two lower floors was severely damaged throughout the length of the mill by the water, mud, and drift. The dam was uninjured, except for the tearing off of the wooden apron. Fifteen cottages were carried away from this mill village. About 8 o'clock the water began very slowly to fall.

Clifton mill No. 2, known as "Dexter mill," was a little over a mile from Clifton, was built in 1888, and had 30,500 spindles.

This mill stood on a point on the left bank. Just opposite the mill the right bank is steep and high, while on the left bank a ridge extends out on the point almost to the mill. Above the mill, on either side of the river, the hills open out, and there the greater part of the mill village stood. Also on the point on the left bank below the mill were many cottages.

The rise here began to alarm the watchman at 3 a. m., and at 3.30 it began to be rapid. One of the watchmen noticed that the rise was 1 foot in five minutes at about 4 o'clock. The alarm was sent out among the operatives at once. Most of them refused to realize that they were in any danger and would not make any effort to save themselves and their property until the water surrounded them. There were many narrow escapes, but at least 52 persons were lost here, most of them women and children. There was a deep deposit of sand and silt over the point below the mill where most of the lives were lost. Toward the end of the week following the disaster this began to crack as it dried. Searching parties kept watch of these cracks, and wherever flies were seen to crawl down them they dug. Several human bodies were found in this way.

At about twenty minutes past 4 the covered wooden highway bridge was washed down. The cotton warehouses and some of the cottages began to go about 6 o'clock, but the mill stood until 7. At that time the wreckage was coming down thickly from the upper mills. Exactly as at the Clifton mill above, the outer upstream corner was torn down. This mill was L-shaped, a wing extending shoreward from the lower end. When the mill was surrounded by the flood the heavy wreckage from above was hurled into this extension, tearing down the middle of it and practically filling the whole with driftwood. The machinery throughout the two lower floors of this mill was largely destroyed by the sand and drift thrown into it. All the cotton and cloth warehouses here were washed

away; 42 of the company's cottages and 6 belonging to outsiders were wrecked and carried away.

After bending to the left about the point on which the mill stands the river formerly bent to the right again around a low point on the right bank. During this flood the water overflowed this low point and cut a new channel over it, abandoning the old one. The crescent-shaped island left is about 400 yards long and 100 wide.

Several lines of the Southern Railway were tied up for about a week. The main line from Charlotte, N. C., to Atlanta, Ga., passing through Spartanburg, was broken by the washing away of a bridge over Lawsons Fork of Pacolet River. The Charleston and Western Carolina Railway, also entering Spartanburg, lost its bridge over Tiger River.

What purports to be a very conservative estimate of the financial loss due to the freshet is given as follows:

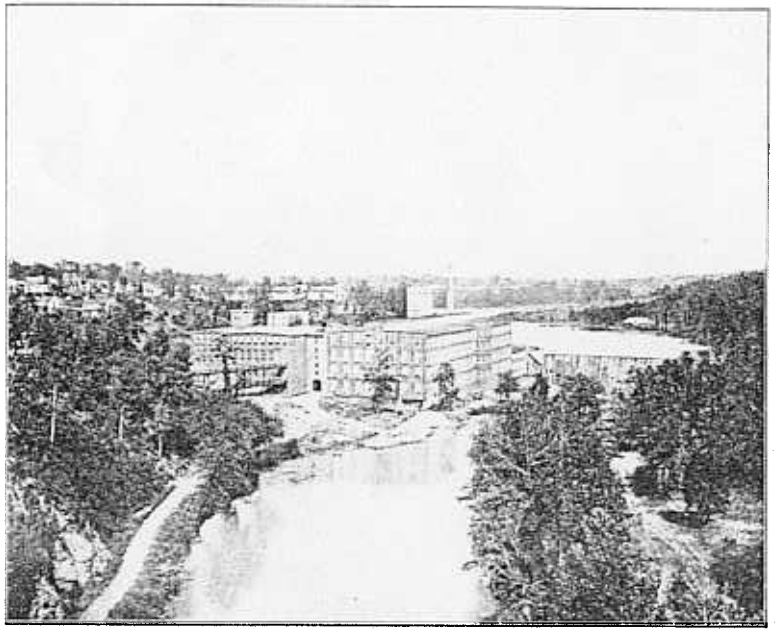
Estimate of losses caused by South Carolina flood.

Clifton mills, Nos. 1, 2, and 3	$1,750,000
Pacolet mills, Nos. 1, 2, and 3	1,250,000
Glendale mills	30,000
Mary Louise mills	18,000
Whitney mills	5,000
Fingerville mills	8,000
Tucapau mills	10,000
Tiger mills	8,000
Two other mills	20,000
Bridges	15,000
Spartanburg Electric Railway Company	30,000
Southern Railway Company	300,000
Not included above (lands and crops ruined, etc.), at least	6,000
Total	3,450,000

These figures do not include the loss due to the interruption of railway traffic, the stoppage of large industries throwing thousands of operatives out of employment, the loss to the various trades and commercial enterprises, and, worst of all, the loss of over 50 lives.

Lessons taught by the flood.—Very heavy storms, covering small or large areas, are to be expected on the southern and eastern slopes of the Appalachian Mountains. Floods much greater and more destructive than ordinary result from these storms.

Ample unobstructed waterway must be provided for streams through towns. Usually the greater part of the destruction wrought is due to the failure of a temporary dam formed by drift in front of a bridge. Drift of all kinds collecting in front of a bridge forms a dam, raises the water several feet higher than it would have been without the obstruction, finally the pressure on the obstruction becomes so great that it is swept away, and the resulting wave destroys other bridges and buildings that otherwise would not have been injured. The washing out of a dam by the water cutting a channel around one end of it



A. CLIFTON BEFORE THE FLOOD OF 1903.

B. CLIFTON AFTER THE FLOOD OF 1903.

is often the cause of a great wave that sweeps away bridges and buildings below that otherwise would not have been injured.

Buildings that can be lifted from their foundations and swept away should not be allowed in the path of a possible flood.

Mills, power stations, and other buildings on the banks of streams should be protected from the destructive action of drift during high water.