THE DISTRIBUTION OF PRECIPITATION IN RELA-TION TO THE MISSISSIPPI BASIN FLOODS OF 1927.¹

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From the time Noah built the Ark and saved his family and a family each of all the fowls of the air, of the beasts of the field, and of every creeping thing, history has been replete with records of man struggling to prevent the waters of the deep from encompassing him.

In nearly all river valleys of the world, periodic floods are more or less frequent. In 1913 a record-breaking flood spread over the Ohio River Basin and extended into the lower basin of the Mississippi River. The year 1922 was another notable flood period but 1927 broke all previous high water records in the lower Mississippi and in many of its tributaries. The question of how to prevent the recurrence of such a disaster has been, and is, occupying the minds of the people. Legislative committees of the National Congress have been busy for weeks working on possible legislation to aid in flood control. Numerous and varied are the recommendations proposed. The states of the west are asking for reservoirs to store the storm waters in their territory and furnish water for irrigation and at the same time aid in flood prevention. The farmers along the Mississippi River are asking for stronger and higher levees to permit them to cultivate in safety the rich bottom lands.

To plan an adequate flood prevention program, it is necessary first of all to determine the causes of the flood conditions. It was in an attempt to discover the relation of the distribution of precipitation to the flood conditions that this study was begun. This paper confines itself to the particular conditions of the Mississippi Basin floods of 1927.

The floods of 1927 may be said to have had their beginning in the late summer of 1926. The precipitation of August, 1926, exceeded the normal precipitation for August in nearly all of the Mississippi drainage basin lying east of the river and in most of Missouri, Arkansas, and Louisiana west of the river. In the southern parts of Indiana and Illinois, in most of Kentucky, and in parts of northwestern Tennessee the excess was over four inches, reaching over six inches in the extreme lower part of the Ohio drainage area. From 60 per cent to 80 per cent of this heavy precipitation occurred from August 12 to 25. The Ohio River formed about the central axis of the belt of heaviest precipitation, hence there resulted a rapid rise in the Ohio, which, at Louisville, began

¹The chief sources of information for this paper are the Climatological Data by Sections, the Monthly Weather Review and the Daily Weather Maps. Unpublished blue print data of river stages were furnished by the Mississippi River Commission, and personal letters were received from a score of U. S. Weather Bureau Section Directors in the Mississippi drainage area. To all these men grateful recognition is due.

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on August 16 and reached its peak August 25, a rise of 27 feet. At Cairo, a crest with a 19-foot rise, occurred on August 30.

The beginning of high water in August was followed in an area extending from Oklahoma and Texas to Pennsylvania, and from the Ohio River to the Great Lakes by one of the rainiest Septembers on record. (Fig. I.) For Kansas it was the wettest month in three years. The eastern part of the state averaged from four to eight inches above normal² the precipitation occurring mainly in three periods of excessive rains on Sept. 3 to 5, 12 to 15, and 26 to 30.

In Missouri, it was the wettest September on record, and has been exceeded but three times in 56 years by the precipitation of any month.^{*} In the northeast plain, drainage directly into the Mississippi and lower Missouri, there were but six days that were generally without rain during the month. Thirty-three stations reported over 10 inches for the month, while one reported 18 inches.

The precipitation of Oklahoma was more than double the normal, occurring chiefly in three periods like that of Missouri. One station reported 7.8 inches falling in 24 hours, while 35 other stations reported over 2.5 inches during the same length of time.

In Iowa, the rainfall record exceeded by one inch that of any month during the 56 years of record.⁴ Heavy downpours were general, especially on Sept. 1, 8, 18 and 19, when 88 station reports gave over two inches in 24 hours.

Illinois had the wettest month, both in terms of the number of rainy days and in the total amount since 1879. It likewise was noted for widespread periods of heavy downpours in 24 hour periods, reaching as much as 6.43 inches.⁵

Indiana and Ohio had the wettest month for which records have been kept. For Indiana, it was two and one-half times the normal for the month and well distributed. The farmers chafed under these wet weather conditions that caused their grain to remain in the field and rot. Motorists rebelled at being held up by high water on the roadways, but little did either think that what they were enduring was but the prelude to the great drama to be enacted some months later in the unprecedented high waters of the lower Mississippi. However, had this area of excessive precipitation (fig. 1) been 100 miles farther south with the Ohio River forming the axis of the belt, there would probably have occurred at this time the greatest floods the Ohio River has ever known.

A word may not be amiss at this point in regard to the general weather conditions of the month. The outstanding facts were the pronounced "lows" that successively crossed the continent and developed into low troughs reaching from Texas to the Great Lakes, and even to the lower St. Lawrence Valley. The month was ushered in with a low center in the Montana-Dakota region and an extension of it southward to Texas. The northern part moved eastward, forming a long, low trough and carrying heavy precipitation to the Atlantic Coast. In the southern

² Climatological Data for Kansas, September, 1926.

³ Climatological Data for Missouri, September, 1926.

⁴ Climatological Data for Iowa, September, 1926.

⁵ Climatological Data for Illinois, September, 1926.

part of the trough, another low center developed which took four days to pass the Great Lakes as it slowly moved eastward. It was followed by a "high" which crossed the area in a day and in turn was followed by another low which developed into a long low trough where heavy precipitation occurred along the wind shift line. This sort of succession was repeated about every three or four days well into October and was responsible for the heavy precipitation of September, and that which continued into the following month.

The inevitable result of such widespread and unusual rains was the general high waters in the district. Disastrous floods occurred in the Floyd, Big Sioux, and Raccoon rivers of Iowa, following the especially heavy rains there Sept. 17 and 18. High water in the Illinois River began with the heavy rains of Aug. 31, which were followed with scarcely a break by those of September and early October, so that not until the last of November was the entire river out of flood stage.⁶ The Wabash River was in flood stage from Lafayette, southward. The soils were saturated, and heavy rains fell in short periods; i. e., at Terre Haute on Oct. 8-9, 5.16 inches of rain fell in 8 hours and 52 minutes. The river rose so rapidly that it was impossible for forecasts of the rise to be given.⁷ Nearly bank full stages occurred in the Missouri, but little actual flood conditions resulted. Two destructive floods occurred in the Grand River of Missouri, and a moderate one in the Osage. The Mississippi River was near flood stage from Quincy to the mouth of the Ohio River from early September to the last of October. The crest of this rise was reached at St. Louis about Oct. 20 and then gradually decreased there until the last of January. The lower Mississippi, fed by these bank-full tributaries, reached flood stage about the middle of October, then decreased during November. The Arkansas passed flood stage at Ft. Smith on Oct. 4 and Pine Bluff on Oct. 12.8 The Ohio River experienced rhythmic rise and fall but did not approach flood stage except near its mouth until the last of December, in spite of the fact that the State of Ohio has had but three wetter Octobers in 100 years, and that the Ohio River basin had a slight excess of precipitation for October throughout most of its area. It was not characterized, however, by the extreme downpours that were responsible for the flood conditions farther west.

The areas of excess precipitation in November were in the upper Mississippi and Missouri basins, and in the area south of the Ohio River and east of the Mississippi. This excess for the month was not large, but in the Cumberland and Tennessee river basins it occurred in the latter half of the month, and was followed in Tennessee by the wettest December on record. The average for the state was 10.69 inches, of which eight inches fell from Dec. 20 to 28, inclusive. On Dec. 21, 21 stations reported over three inches fall, seven of these reporting over five inches in 24 hours. In the Tennessee basin of northern Alabama the precipitation for the month ranged from 10 to 15 inches, occurring

⁶ Mo. Weather Rev. vol. 54, p. 401. Sept., 1926.

⁷ Mo. Weather Rev. vol. 54, p. 443-445. Oct., 1926.

⁸ Climatological Data, Arkansas. Oct., 1926.





March, 1927. (Adapted from Monthly Weather Review for March, 1927.)

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chiefly during the latter part of the month. In some of this area over 10 inches fell in less than a week. Excessive high stages in the Tennessee and Cumberland rivers with great loss of property was the result. With precipitation below normal during the first half of January in the Ohio, Cumberland, and Tennessee basins, the waters rapidly receded, and by the last of January they and the Arkansas were all in low water stages.

Heavy rains in the lower Ohio River Basin and an excess throughout its course in the latter half of January caused another rapid rise of the Ohio and its tributaries, reaching a crest of 55 feet at Louisville on Jan. 30. Excess precipitation in February was confined to the upper Tennessee and Ohio River basins, to the lower Mississippi, and to the Mississippi-Missouri basin of the Great Plains. The high waters of the previous months had by this time brought the lower Mississippi to flood stage, while the tributary streams returned to low water stages.

In March a large excess of rainfall occurred throughout nearly the whole of the Mississippi Basin, except in the upper Arkansas and upper Red River basins. The center of the greatest excess was in the immediate vicinity of the Mississippi River from Cairo to Memphis. (Fig. 2.) Western Tennessee, draining directly into the Mississippi and Tennessee rivers, reported unusual downpours on Mar. 8, 9, 12, 13, and 18 to 21. Half the stations reported over three inches of rainfall on March 12, the other half reporting over two inches. Floods in the Tennessee extended upstream to Florence, Ala., inundating 23,000 acres in the valley of the Tennessee River. In the lower Ohio, flood stages were reached throughout the course of the river below Louisville, and in its tributaries. Only in the Wabash and Green rivers, however, were the floods serious.⁹

The precipitation of April was very heavy in the middle and lower Mississippi valley and its adjoining territory. (Fig. 3.) The rainfall in this area between Apr. 1 and 20 probably exceeded all previous records, both in total amounts and in the length of period in which rains were of almost daily occurrence. The monthly amounts were from 10 to 15 inches over most of the area.¹⁰ In Kentucky, Tennessee, and Mississippi the heavy precipitation was confined to the western part of the states draining directly into the Mississippi River. In Arkansas, the average for the state was 12.93 inches, the highest of any month on record. Some stations reported as much as 23.8 inches, and 24 hour records of rainfall reached 11.40 inches.¹¹ Local excessive rains occurred in Louisiana. New Orleans reported over 14 inches on Apr. 15 and 16.¹²

The precipitation areas of May showed about the same general distribution of regions of excess as April, but with less extremes. A deficiency occurred in the lower Mississippi Basin and in the upper waters of the Arkansas and the Red rivers. (Fig. 4.)

The precipitation of June was slightly above normal for most of the Mississippi Basin south of the Ohio and Missouri rivers. It had the

⁹ Mo. Weather Rev. vol. 55, p. 143-144, Mar., 1927.

¹⁰ Mo. Weather Rev. vol. 55, p. 197, Apr., 1927.

¹¹ Climatic Data for Arkansas, Apr., 1927.

¹² Mo. Weather Review, vol. 55, p. 195, Apr., 1927.

effect of keeping high water in the lower Mississippi. In July, however, throughout nearly all of the Mississippi basin precipitation was below normal, except in the upper Arkansas and Kansas river areas. In the Arkansas River Valley just as the people who had been driven out of their homes for weeks had returned and had made a beginning of the work of rehabilitation, excessive precipitation brought another threat of disaster. This was the first month since July, 1926, that a marked excess of precipitation had not occurred throughout a large part of the Mississippi Basin, practically every instance of which was noted for unusually heavy downpours in short periods of time.

Let us now note the effects of these in a general way upon the Mississippi River stages. Bank full stage of the Mississippi River at St. Louis was reached Oct. 1, 1926, and continued to Oct. 17. This was the immediate effect of the unusual heavy precipitation throughout this area during September and early October. (Fig. 1.) Throughout the three succeeding months the belts of heavier precipitation lay to the southward of St. Louis, hence the Mississippi here declined until the last of January.

Cairo, Ill., was on the southward margin of the belt of heavy September and October rains, and though the river rose from the accretion of waters from the north, the river did not reach flood stage there until it received the flood waters of the Ohio, Tennessee, and Cumberland rivers in the early part of January.

At Columbus, Ky., and Memphis, Tenn., flood stage was recorded Jan. 3, and at Greenville, Miss., Jan. 11. From Cairo to the gulf, nearly all gage stations on the Mississippi showed flood or near flood stages by the middle of January. North of Cairo, after the rise of September and early October, flood stage was not approached again until late March. A deficiency of precipitation north of the mouth of the Arkansas River during February showed its effect in decreased readings of the stream gages in that section of the river. In the lower course, the Mississippi continued to rise.

It is to be remembered that March, April, and May are months of normally high water, due to the melting of accumulated snows of winter and the usually heavier rains of those months. In 1927, this normal high water condition was accentuated by the abnormal fall season precipitation and the unusually heavy rains of December and January. Then through March, April, and May there was concentrated in the main Mississippi Valley a more or less continued period of excessive rainfall. Flood conditions reached throughout nearly the whole of the region south of the Ohio a higher stage than ever before recorded. Levees broke in many places on both sides of the river, inundating some 20,000 square miles of fertile land, destroying millions of property, and taking a toll of many lives. It was not until the middle of July that the waters receded within the banks of the main channel, and the work of rehabilitation was begun.

Under such conditions as those enumerated above, it is doubtful if any system of dikes and reservoirs yet conceived could have wholly prevented the disaster. It is obvious that storage dams in the western part of the basin that might aid irrigation would have had no part in the prevention of the floods of the Mississippi in 1927. The heavy rains did not occur in that portion of the area. How small a part storage dams might have played in the head waters of the Ohio River system is indicated by the fact that in March, floods occurred in the Ohio below Louisville, and in the Cumberland and Tennessee rivers below Nashville and Florence, respectively. These, like most of the very high waters of the Mississippi, were due to extreme downpours in the immediate vicinity of the valleys of the streams, and in the narrower portions of their basins. All the above seems to indicate that flood prevention is a problem of many angles, and one to challenge the best and most mature thought of the nation.