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THE FLOODING PATTERN IN ILLINOIS STREAM BOTTOMLANDS, HAS IT CHANGED SINCE PRIMITIVE TIME?

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ABSTRACT.—An analysis of discharge rates, flood pool levels, and frequencies of flooding in the upper Sangamon River bottomlands in east central Illinois, as registered on the Monticello river gage, shows that no significant differences due to man's influence occur between the flooding pattern at the present time and the period 1908 to 1920. In 1908, modification of upland drainage through organized drainage districts extended over approximately 9.7 to 12 per cent of the drainage basin; in 1920, 30 to 32 per cent; and at the present time, 50 per cent. The bottomland natural area in the Robert Allerton Park, three miles southwest of Monticello, may therefore be considered still to have an essentially primitive flooding pattern.

The biennial report of the Illinois Nature Preserves Commission for 1969-1970 lists a number of proposed and dedicated Nature Preserves that include streams and bottomland forest ecosystems. The vegetation and animal life in several of these areas may represent the closest approach to primitive biotic communities now possible to acquire, and with inclusion in the Nature Preserves System there is some guarantee that they will be maintained in a natural state relatively free of deliberate man-made disturbance. The flooding pattern over the bottomlands is determined, however, by regional precipitation, terrain, and agricultural practices extending far beyond the limits of the Preserves and are not under immediate control. The purpose of the present paper is to examine one such bottomland ecosystem to determine, if possible, the extent that the flooding pattern has changed since man settled in the area. This study also has relevance in relation to the establishment of a State Scenic River System and to the choice of rivers most nearly simulating natural conditions for inclusion in this System.

The Robert Allerton Park, located near Monticello in east-central Illinois and owned by the University of Illinois, contains over 600 acres of bottomland forest. The State of Illinois is proposing the construction of Oakley Reservoir, north of Lake Decatur, by the Army Corps of Engineers, which if completed, would alter the natural flooding pattern in the Park (Kendeigh *et al.* 1970). Proponents of the project argue that the flooding pattern is already considerably changed from the primitive, that the Park is not therefore a natural area of historic and evolutionary value, and that, consequently, further changes in the flooding pattern will not be of significance. Floods are thought now to be greater and to come at more frequent intervals, due to better drainage of the upland, and that the effect on runoff has been especially dramatic since about 1920 (Ackermann 1971).

We can only postulate what the drainage pattern was like in primitive times or even after man first began to cultivate the land. However, a comparison of the flooding pattern of the Sangamon River above Allerton Park before and after 1920 may furnish some indication of the direction of any changes that have occurred, and by projection backwards, the flooding pattern in primitive time might be reconstructed. A water level gage was first installed in the river at Monticello in 1908. Except for 1913 and the first half of

1914, data on rate of discharge and height of floodpools are available continuously to the present. The discharge rate during a flood on March 26, 1913, was estimated from the rainfall. There was no flood in 1914. The drainage basin above the Monticello gage is approximately 550 square miles (Mitchell 1954) and above Allerton Park about 600 square miles.

The upper Sangamon basin was part of an extensive area in east-cen-

TABLE 1.—Drainage districts in the Sangamon River watershed above Allerton Park (modified from Pickels and Leonard 1921 1929) 4.

Reference number	Name of district	County	Date organized	Area in acres
	Probably functional before 1908			
4	Hillsbury Slough Special	Champaign, Ford	1898	5,960
5	Wild Cat Special (including East Bend Mutual)	Champaign, Ford	1898	10,400
6	Big Slough Special	Champaign, Ford	1886	16,200
15	Goose Creek No. 3	Piatt	1903	1,740
	Other districts functional before 1920			
1	Sangamon	McLean	?	3,760
2	Sangamon and Drummer	Champaign, Ford	1909	7,720
3	Ford and Champaign Tile	Champaign, Ford	1913	500
9	Camp Creek Special	Champaign, Piatt	1906[1]	13,600
10	Newcomb Special	Champaign, Piatt	1908	6,400
11	Owl Creek	Champaign	1914	2,800
12	Lotus Special	Champaign, McLean, Piatt	1907	32,500
13	Goose Creek No. 1	Piatt	?	1,000
14	Goose Creek No. 2	Piatt	?	900
16	Goose Greek No. 4	Piatt	?	1,400
18	Willow Branch No. 10	Piatt	?	1,640
19	Willow Branch No. 4	Piatt	?	540
	Becoming functional between 1920 and 1929			
1	Sangamon (expanded in size)	McLean	?	3,100
7	Condit No. 1	Champaign	1881[2]	3,440
8	Jersey	Champaign	1925	400
17	DeWitt Special	DeWitt, Piatt	1909[3]	9,540

[1]Pickels and Leonard (1921) state that this district did not complete its ditches until 1911 and contained 13,600 acres, not 14,600 as called for in the original plans.

[2]Although the County Clerk states that a special report in his files indicates that the district was organized in 1881, no further records are available on it until 1959. Pickles and Leonard do not show it on their 1920 map but it is on their 1929 map.

[3]Pickles and Leonard (1921) report work in this district was not completed in 1920.

[4]Since going to press, Ray C. Dickerson's "Inventory of Illinois drainage and levee districts", Illinois Dept. Bus. Econ. Devel., Div. Water Nat. Res., 1971: x + 955, has become available. Dickerson gives "date organized" for "reference number" 1-1912 (expanded in 1925), 2-1908, 5-1886, 6-1880, 11,1911, 13-1905, 14-1905, 17-1910, and 18-1912.

tral Illinois acquired from the Indians in 1819. The human population in 1830 was less than two per square mile and had risen to an average of only about 30 per square mile in 1860. The upland prairie soil was demonstrated suitable for the growing of corn by 1850, and during the following decade agriculture more than doubled (Cole 1919).

Man's activities conceivably affected the rate of run-off from the uplands into the river by removal of the prairie grasses, tiling of the farmland, and deepening and straightening of the stream channels. The effect of removal of the grasses is mitigated to some extent by their replacement with farm crops over part of the year, and the removal of the grasses was probably not very important to the drainage as much as it allowed an increase in erosion of the soil. In the early days only the higher ground could be cultivated regularly, and water stood in the depressions "until it evaporated or found its way slowly through the soil to the natural channels" (Pickels and Leonard, 1921). In the upland, the percentage of the land having less than 2 per cent slope varied between counties from 40 to 80 (Warren and Van Praag 1948). Farmers sometimes improved the drainage from individual fields by tiling, but there is no evidence that this had much effect on drainage over large areas of land.

The Farm Drainage Act, passed by the State Legislature in 1879, en-

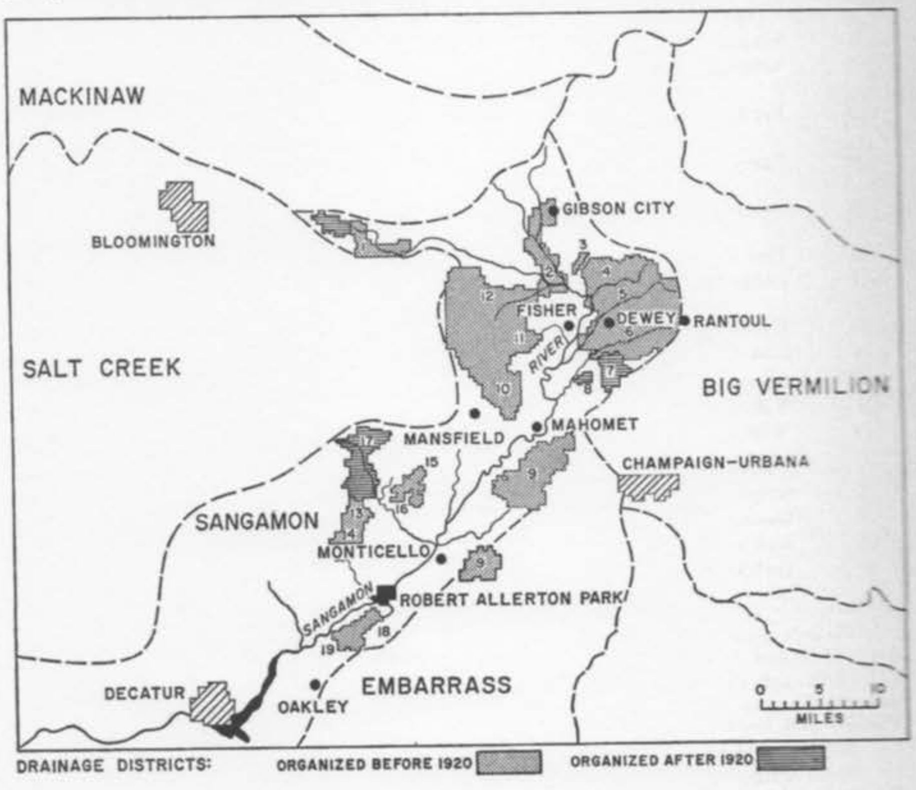

FIGURE 1.—Drainage districts in upper Sangamon River basin (modified from Pickels and Leonard 1921, 1929).

couraged the deepening of streams by dredging, straightening of channels, and construction of open ditches where previously there had been none. This permitted more thorough and deeper tiling of farmland and the cultivation of lands earlier impossible because of saturated soils throughout the year. Table I lists drainage districts in the Sangamon River basin above Allerton Park previous to 1929 and figure 1 maps their location and distribution.

Of the 19 drainage districts, only 4 were apparently functional before 1908. The acreage of these 4 districts constitutes only 8.9 per cent of the drainage basin above Allerton Park. Even if the 6 additional districts established before 1920 but whose exact dates of organization are unknown were functional before 1908, this would be only 11 per cent of the basin area. The amount of time elapsing from a drainage district being organized and becoming entirely functional varied but required at least several months and sometimes years. By 1920, the 16 organized and probably functional districts covered 28 per cent of the basin or if the DeWitt Special is included, 30 per cent. By 1929, the coverage was 32 per cent. At the present time, roughly 45 per cent of the basin is covered by drainage districts, although there is uncertainty as to how well they are being maintained. This percentage is less than in some other parts of the State. Pickels and Leonard (1921) state that "fully 75 per cent of the area north of the river between Decatur and Monticello is either within districts or is now [1920] being incorporated within districts . . ." For the area above the Monticello rain gage, the drainage districts in 1908 covered 9.7 or possibly 12 per cent; in 1920, 30 or 32 per cent; in 1929, 35 per cent; and at the present time 50 per cent.

Fortunately, there was a period of heavy rains in April and May of 1908 that produced a recorded flood on the river gage at Monticello, and the magnitude of these rains was almost exactly duplicated during December, 1949, and January, 1950. A comparison of the rate of water flow, height attained, and duration of these two floods nearly 42 years apart is of interest, since one came mostly before and the other after the modification of drainage in the upland farmland. If the ground were frozen during the winter of 1949-50, the run-off would have been accelerated, but temperatures averaged above freezing for the months of December and January, in fact they were several degrees higher than normal (Table 2).

Graphs of these two floods are very similar, both at the Monticello gage and as projected for the Allerton Park bridge (fig. 2). The 1908 flood reached a higher discharge rate (9600 cfs) and flood level (638 ft), while the 1949-50 flood, with a lower peak discharge rate (7600 cfs) and height (637.6 ft), persisted a little longer. Fluctuations in the pool stage elevation are related to the daily patterns of rainfall and are proportional to their magnitudes.

TABLE 2.—Weather statistics at time of 1908 and 1949-50 floods.

1908	Precipitation	Mean temperature	1949-50	Precipitation	Mean temperature	Departure from normal
March	3.20 in.	43.0°F.	November	1.00 in.	43.6°F.	+ 2.7°F.
April	5.00	50.3	December	5.00	36.3	+ 6.1
May	7.83	61.9	January	7.62	34.4	+ 7.5

Another comparison may be made for identical months in 1908 and 1927 when total rainfall was also nearly the same.

	1908	1927
March	3.20 in.	3.84 in.
April	5.00	6.48
May	7.83	5.01
Total	16.03	15.33

The pool-stage elevations for these two years (fig. 3) at the Monticello river gage criss-cross in an irregular manner, correlated with the daily pattern of rainfall. These rainfall data were obtained at Urbana which is not in the Sangamon drainage basin but is the nearest weather station where daily records are available. These two figures do not show any important change in the flood pattern induced by the artifical upland drainage.

The average frequency of floods per year after 1920 is slightly greater than it is for the 13 years from 1908 through 1920 (Table 3), but the difference is not statistically significant (P = > 0.5). The difference is correlated, however, with an average annual precipitation before 1920 of 33.3 inches and after 1920 of 37.5 inches. The average annual frequency of floods for the last 13 years (1953 through 1965) was only 2.1. The average annual precipitation for this latter period was 34.7 inches.

There were 7 large floods with stream flows exceeding peak discharge rates of 7000 cfs from 1908 through 1920 or an average of one

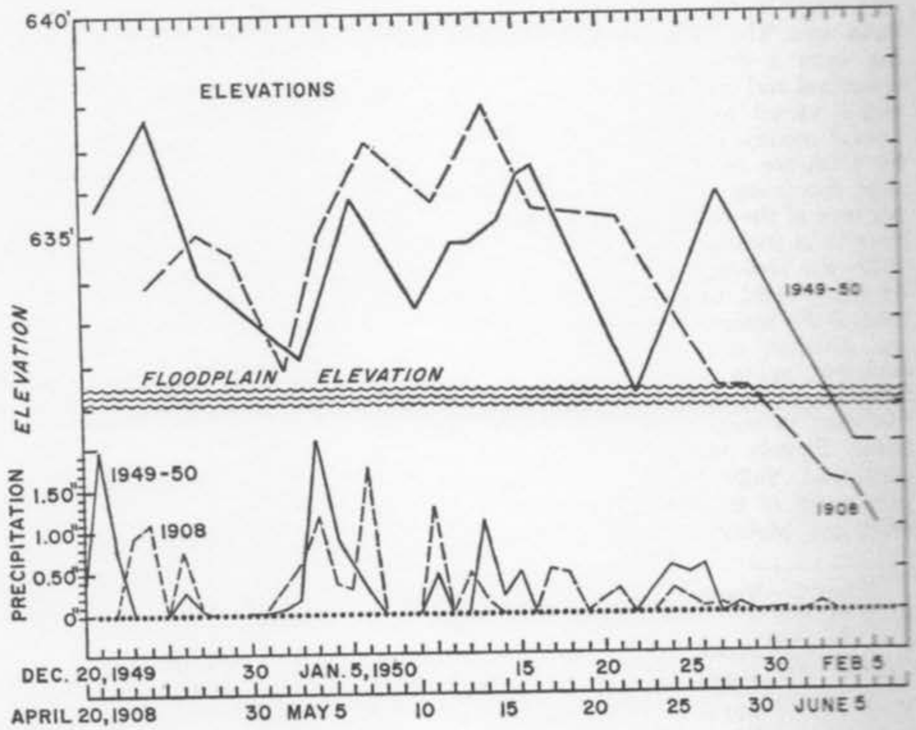

FIGURE 2.—Comparison of pool-stage elevations of the 1908 and 1949-50 floods at Allerton Park bridge as calculated by the Army Corps of Engineers, Chicago Office, July, 1968.

TABLE 3.—Frequency of floods (> 1800 cfs) during calendar years.

Period	1908-20	1921-65	1953-65
Number of years	13	45	13
0/year	1	5	1
1	4	8	6
2	1	6	2
3	2	5	2
4	3	7	0
5	2	3	1
6		7	1
7		2	
8		1	
9		1	
Mean ± S.E.	2.6±0.47	3.4±0.36	2.1±0.49

every 1.9 years. There were only 13 such floods for the period from 1921 through 1965, or an average of one every 4.2 years. There were 5 such floods from 1953 through 1965 or one every 2.6 years.

Statistical analysis of these floods before 1920 and after 1920 shows a significant correlation between the discharge rate and the total rainfall of the month in which the flood occurred (the flood of October 4, 1926, is, however, correlated with rainfall in September rather than October). The two equations are:

1908-1920: $Y = 10{,}000 + 629\ (X - 5.6)$, SE: ± 1,200

1921-1965: $Y = 11{,}200 + 876\ (X - 5.6)$, SE: ± 1,000

The letter Y is the mean peak stream flow in cubic feet per second (cfs), the letter X is monthly precipitation in inches, and SE is the stardard error of the estimate. Neither the difference in the coefficients (629 cfs/1 in. before 1920 and 876 cfs/1 in. after 1920) nor the Y values are statistically significant ($P = > 0.5$). The mean peak discharge for the period 1953 through 1965 was 10,670 cfs. This analysis again shows that large floods depend on rainfall and not on changes that have been made in the upland drainage.

In a report prepared for the City of Decatur (Warren and Van Praag, 1948), mean annual precipitation over the drainage basin above the river gage at Monticello was calculated for the period 1909 through 1946, except for 1913, by averaging data obtained at weather stations in Monticello, Urbana, Rantoul, Gibson

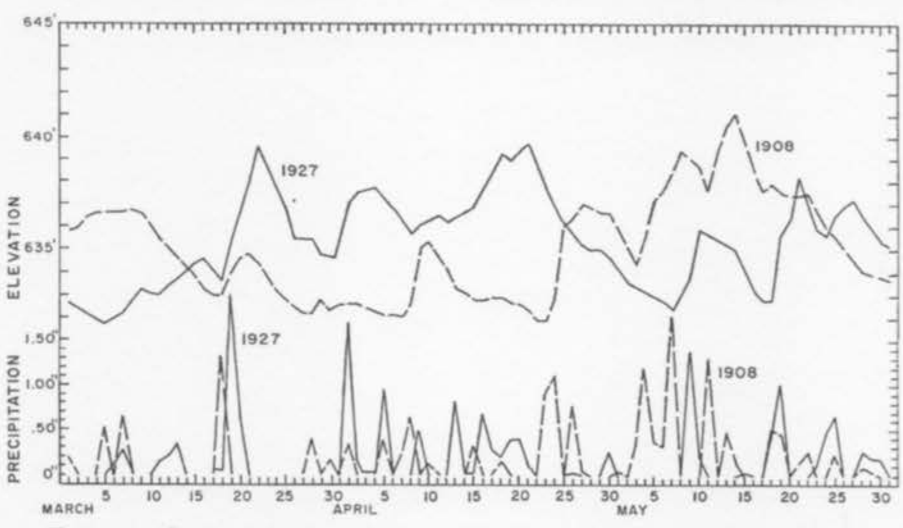

FIGURE 3.—Comparison of pool state elevations of the 1908 and 1927 floods at Monticello.

City, and LeRoy. The data for each station was weighted in proportion to the area of the watershed covered by each. The total annual discharge at Monticello of water down the river was then calculated in terms of "runoff depth in inches over the watershed". The mean annual runoff for the entire period, 9.97 inches, is given as 27.3 per cent of the mean annual precipitation, 36.15 inches. The percentage of runoff increases, however, the heavier the precipitation. With a precipitation of 25 inches, runoff is only 13.6 per cent; with a precipitation of 45 inches, it amounts to 34.2 per cent. The total runoff is plotted against the mean precipitation over the watershed each year in fig. 4. There is considerable scatter in the points and no consistent difference between years before and after 1920 as to whether they fall above or below the mean rate. Runoff has not been altered by the establishment of drainage districts.

A study similar to this but in greater detail was published in 1929 for the upper portions of the Des Moines and Iowa Rivers in Iowa (Woodward and Nagler 1929). The original vegetation and terrain were similar to east-central Illinois. Stream flow measurements were begun in 1903 before the Drainage Law was passed in 1904 and well before the drainage districts were mostly completed in 1917. Stream flow records were compared for the years 1903 through 1906, prior to the drainage modifications, with the years 1918 through 1923 when well over one-third of the land, and in some regions nearly all the agricultural land, was subjected to artifical drainage. The authors state, "a critical examination

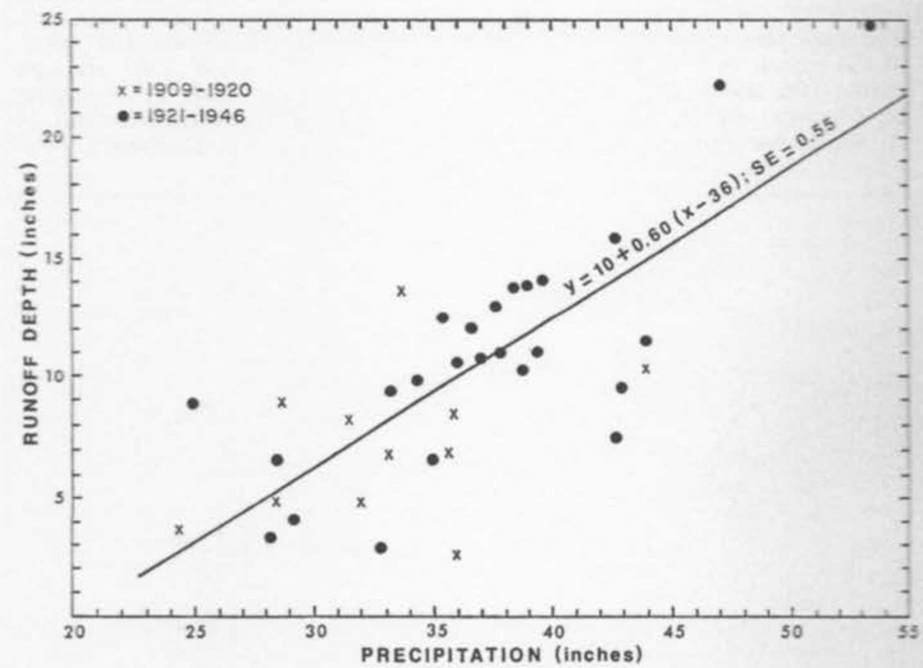

Figure 4.—Relation between depth of annual runoff and annual mean precipitation over the Sangamon River watershed above Monticello (data from Warren and Van Praag 1948).

of the records of these two streams shows that during flood periods there have been no significant change in their behavior which may be attributed to drainage. The total run-off from storms of like precipitation, the maximum rates of discharge, and the rain-water storage conditions within the basins seem to have been unaltered by the extensive drainage operations." This study fully substantiates the findings for the Sangamon River basin.

Why the altered upland drainage has no apparent effect on the flooding pattern is difficult to explain. The water table undoubtedly lies deeper in the ground now than it did in primitive time. After rains, probably more of the water now soaks into the ground rather than running into depressions and evaporating. Perhaps one effect compensates quantitatively for the other so that the net effect on the flooding pattern is the same.

In summary, there is no evidence available to show any significant change in the flooding pattern of Allerton Park since 1908. The fact that no significant change in the flooding pattern in the upper Sangamon River bottomlands can be demonstrated after 1920, when man had made the greatest alteration in the upland drainage, and before these alterations had been completed, indicates that essentially a natural primitive flood pattern still persists in the upper Sangamon River bottomlands. This gives added evidence for the characterization of Allerton Park as a natural area, and added weight for protecting natural areas throughout the State from any deliberate future modification by man.

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