CENTRAL REGION TECHNICAL ATTACHMENT 94-03

PROBABILITY OF FLOODING IN SUCCEEDING YEARS FOR THE MISSISSIPPI RIVER AT ST. LOUIS, MISSOURI

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I.   Introduction

A historic year for flooding in the Midwest was 1993. Record flood crests occurred at over 100 locations in a nine state area. At St. Louis, the Mississippi River crested at 49.4 feet on August 1, 1993, breaking the old record of 43.2 feet set in 1973. Fifty deaths occurred as a result of the massive flooding and over $15 billion in damages occurred.

A question often raised is whether flooding in a given year, such as at St. Louis in 1993, increases the probability for flooding at the same location the following year. If so, what magnitude of flooding can be expected, based on historical records?

2.   Procedures and Data

Flood stage for the Mississippi River at St. Louis is 30 feet. The flow corresponding to this flood stage is approximately 540,000 cubic feet per second (cfs). Stage/discharge relationships shift with time so this is an approximate value.

The Mississippi River at St. Louis has 134 years of river flow data dating back to 1844. Some 15 years of record are incomplete during that period. An examination of the 134 years of data shows that in 55 years, the flow at St. Louis has exceeded 540,000 cfs (i.e., flood stage). Thus, the probability of flooding in any given year, based on records through 1993, is 55/134 or 41.0 percent (Table 1) for the Mississippi River at St. Louis.

Next, the 55 years which contained flows greater than 540,000 cfs were examined. Consecutive years of flooding were noted, such as 1909 following 1908, 1952 following 1951, etc. Out of 55 years, this situation occurred 27 times. Thus, for the Mississippi River at St. Louis, if flows exceed 540,000 cfs in one year, the empirical probability is 27/55 or 49.1 percent that the following year will also have flows greater than 540,000 cfs. This is 8.1 percent greater than the long term average.

TABLE 1

YEARS BETWEEN 1844 AND 1993 IN WHICH THE FLOW OF THE MISSISSIPPI RIVER AT ST. LOUIS HAS EXCEEDED 540,000 CFS (FLOOD STAGE OF 30 FT.)

1993	1952	1909
1990	1951	1908
1987	1948	1905
1986	1947	1904
1985	1945	1903
1984	1944	1897
1983	1943	1893
1982	1942	1892
1979	1935	1888
1978	1929	1884
1974	1928	1883
1973	1927	1882
1970	1922	1881
1969	1920	1876
1965	1917	1875
1962	1916	1869
1961	1915	1867
1960	1912	1862
		1844

Table 2 shows just the largest fifteen peak flows for the Mississippi River at St. Louis and the flow for the following year. It can be seen that in twelve out of the fifteen years, the flow in the following year exceeded flood flow. In a year where peak flows exceed 743,400 cfs (1993 flow was 1,030,000 cfs) at St. Louis, the probability is, therefore, 12/15 or 80 percent that the following year will have flows which exceed 540,000 cfs. This is 39 percent greater than the long term average.

TABLE 2

THE TOP 15 YEARS OF PEAK FLOWS OF THE MISSISSIPPI RIVER AT ST. LOUIS AND THE PEAK FLOWS FOR THE FOLLOWING YEAR

No.	Year	Flow	Following Year	Flow	% of Previous Years Peak Flow
1	1903[1]	1,019,000 cfs	1904	777,600 cfs	76%
2	1892	926,500	1893	700,000	76
3	1927	889,300	1928	552,000	62
4	1883	862,800	1884	543,600	63
5	1909	860,600	1910	416,400	48
6	1973	852,000	1974	584,000	69
7	1908	850,000	1909	860,000	101
8	1944	844,000	1945	610,000	72
9	1943	840,000	1944	844,000	100
10	1881	822,000	1882	739,200	90
11	1922	785,900	1923	341,200	43
12	1947	783,000	1948	633,000	81
13	1951	782,000	1952	684,000	87
14	1904	777,600	1905	613,200	79
15	1917	743,400	1918	324,000	44
					mean = 73

[1] 1844, with a peak flow estimated at 1,300,000 cfs, is not included because 1845 flows are unknown.

3.   Results

The probability of flooding in any given year for the Mississippi River at St. Louis is 41 percent based on the historical record. The probability for flooding of the Mississippi River at St. Louis for the year following a previous flood year, utilizing the entire period of record, is 49.1 percent. The situation becomes more ominous, however, if we only examine years where the flow at St. Louis exceeded 740,000 cfs. In that case, the probability jumps to an incredible 80 percent that the following year will have flows of at least 540,000 cfs at St. Louis.

If historical averages are followed in 1994 at St. Louis, a flow of about 73 percent of last years peak would be expected (Table 2). Last years (1993) peak flow of the Mississippi River at St. Louis was 1,030,000 cfs. A flow of 750,000 cfs (1,030,000 x .73), should it occur in 1994, would result in a peak stage at St. Louis of about 40 feet and it would rank as the 17th largest flood to occur at St. Louis.

Of course, circumstances resulting in flood conditions at any location are complex. Some of the variables involved are long term while others are short term. Flooding for a major river such as the Mississippi River generally involves significant precipitation over a large area for a significant period of time. Soil moisture conditions and base flows for various rivers and tributaries must be high for flood conditions to develop. These attributes tend to perpetuate themselves for months at a time. For example, significant fall precipitation increases soil moisture and raises base flows, thus setting the stage for flooding the following year should sufficient rain and snow melt occur. Thus, it is not a major surprise that the probability for flooding is increased in a year following a previous flood year. Based on historical data, therefore, it seems likely that the Mississippi River will exceed flood stage at St. Louis in 1994. But will 1993/1994 follow the pattern of 1908/1909 or will it be more like 1922/1923? Only time will tell!