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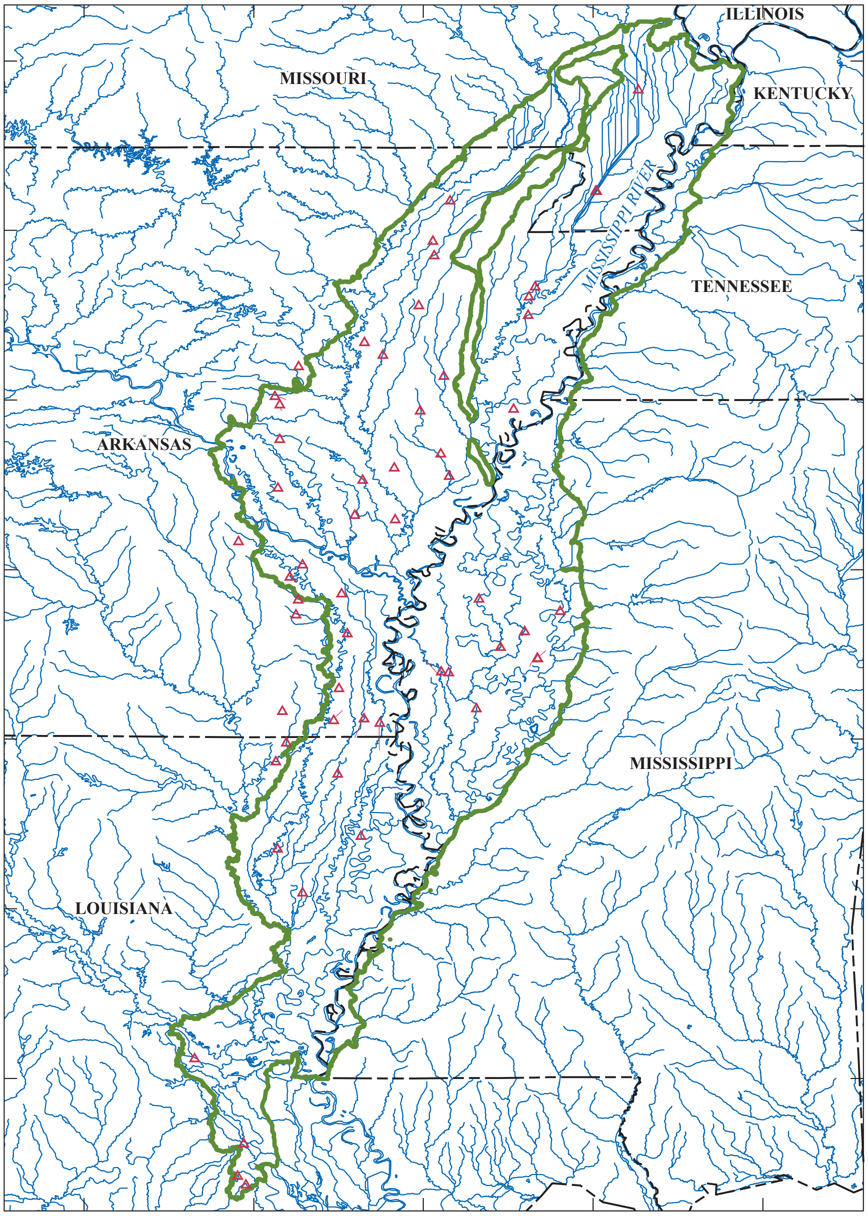
Magnitude and Frequency of Floods in the Alluvial Plain of the Lower Mississippi River, 2017



Scientific Investigations Report 2021–5046

U.S. Department of the Interior
U.S. Geological Survey

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Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
	Area	
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
	Hydraulic gradient	
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

°C = (°F – 32) / 1.8.

Datum

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Abbreviations

AEP	annual exceedance probability
EMA	Expected Moments Algorithm
GIS	geographic information system
GLS	generalized least squares
LP3	log-Pearson type III
MAP	Mississippi Alluvial Plain
MGB	multiple Grubbs-Beck test
MSE	mean square error
NWIS	National Water Information System
OLS	ordinary least squares
PILFs	potentially influential low floods
SEP	standard error of prediction
USGS	U.S. Geological Survey
WREG	weighted-multiple-linear regression program

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Abstract

Annual exceedance probability flows at gaged locations and regional regression equations used to estimate annual exceedance probability flows at ungaged locations were developed by the U.S. Geological Survey, in cooperation with the Mississippi Department of Transportation, to improve flood-frequency estimates at rural streams in the alluvial plain of the lower Mississippi River. These estimates were developed using current geospatial data, analytical methods, and annual peak-flow data through September 2017 at 58 streamgages in the alluvial plain of the lower Mississippi River, including 9 in Mississippi, 35 in Arkansas, 4 in Missouri, and 10 in Louisiana. Annual exceedance probability flows presented in this report incorporate streamflow data through the 2017 water year, 32 additional years of record since the previous study in 1985 of flood magnitude and frequency in the Mississippi portion of the alluvial plain of the lower Mississippi River. Ranges for standard error of prediction, average variance of prediction, and pseudo-R^2 are 45–61 percent, 0.035–0.059 (log cubic feet per second)^2, and 90–94 percent, respectively.

Introduction

Improved flood-frequency information is important for the effective management of flood plains, including the safe and economic design of bridges, culverts, dams, levees, and other structures near streams. The last flood-frequency study of the Mississippi Alluvial Plain (MAP) was published more than 35 years ago for the streamgages located in Mississippi (Landers, 1985). Since that time, improvements in statistical techniques, specifically the Expected Moments Algorithm (EMA) and the multiple Grubbs-Beck (MGB) test for potentially influential low floods, have increased the accuracy of flood-frequency estimates (Cohn and others, 1997, 2013). The EMA allows for the incorporation of censored observations, historical flood data, low outliers, and uncertain data points in the flood-frequency analysis. The MGB test is recommended for use with the EMA as it increases the accuracy of peak-flow statistics by objectively and systematically detecting and removing low, highly influential peak flows.

The unique topography and hydrology of the MAP region—characterized by broad, widely meandering stream courses with low channel slopes, abundant channel and overbank storage in abandoned meander belts, oxbow lakes, swamps, and extensive hydrologic alteration of natural stream courses by channelization and levees—make the region highly susceptible to flood damage because floodwaters cover a larger area for a greater length of time for a given flood magnitude than in surrounding regions. The distinct topography and hydrology of the MAP warrant a unique flood-frequency analysis for the region.

In 2019, the U.S. Geological Survey (USGS), in cooperation with the Mississippi Department of Transportation, began a study to update annual exceedance probability (AEP) flows for selected streamgages in the MAP and regression equations for estimating AEP flows at ungaged locations in the region using recent geospatial data, current analytical methods, and additional annual peak-flow data through the 2017 water year.[1] The AEP flows and regression equations will be incorporated into the USGS StreamStats application, an online tool that provides flood-response planners and water managers with the ability to delineate the drainage basin at a selected location on a stream, generate basin characteristics, and estimate flow statistics (U.S. Geological Survey, 2017a).

Purpose and Scope

The purpose of this report is to document updates to (1) AEP flows, using annual peak-flow data through the 2017 water year, for 58 selected streamgages in the MAP in Mississippi, Missouri, Arkansas, and Louisiana; and (2) regression equations used to estimate AEP flows at ungaged locations on streams in the MAP. Peak-flow data used in support of the analysis were downloaded from the USGS National Water Information System (NWIS) database (U.S. Geological Survey, 2017b); geographic information system (GIS)-generated basin characteristics for the MAP were generated using the USGS StreamStats application (U.S. Geological Survey, 2017a; https://streamstats.usgs.gov/ss/). Six gages

[1]The water year is the annual period from October 1 through September 30 and is designated by the year in which the period ends. For example, the 2013 water year is from October 1, 2012, through September 30, 2013.

from outside the boundary of the study area were included in the study because these gages possess characteristics consistent with those in the study area.

Description of Study Area

The study area (fig. 1) includes the MAP with selected streamgages in Mississippi, Arkansas, Missouri, and Louisiana. Rainfall in the MAP generally is associated with the movement of warm and cold fronts across the States from November through April and isolated thunderstorms from May through October. From June through September, tropical storms or hurricanes occasionally enter the States along the Gulf Coast and produce unusually large amounts of rainfall. The average annual precipitation for the MAP is 51.77 inches (U.S. Climate Data, 2020). The average annual high and low temperatures are 75 and 52 degrees Fahrenheit, respectively (U.S. Climate Data, 2020). The topography of the MAP region is characterized by broad, widely meandering stream courses with low channel slopes, large amounts of channel and overbank storage in abandoned meander belts, oxbow lakes, swamps, and extensive alteration of natural channel courses by channelization and levees.

Previous Investigations

Wilson and Trotter (1961) developed techniques for estimating the magnitude and frequency of floods for streams in Mississippi. Colson and Hudson (1976) used a multiple-linear regression model to update those techniques. Wilson and Trotter (1961) and Colson and Hudson (1976) updated the flood frequency for the entire State of Mississippi, including the MAP. Landers (1985) used linear regressions to develop updated techniques for estimating the magnitude and frequency of floods for streams in the alluvial plain of the lower Mississippi River. In the report, Landers also expressed the need for a separate flood frequency analysis for the MAP. Recent publications for subsections of the MAP region are Southard and Veilleux (2014) and Wagner and others (2016). These two reports also contain updated Bayesian generalized least-squares (GLS) regional skew values for the subsections of the MAP represented.

Basin Characteristics and Flood-Frequency Analysis

Basin Characteristics

Basin characteristics for the streamgages used in this study were obtained from the USGS map-based web application StreamStats (U.S. Geological Survey, 2017a). The following basin characteristics were tested for statistical significance in the GLS regression analysis:

- Contributing drainage area (*A*), in square miles, upstream from the streamgage.
- Main channel slope (*S*), in feet per mile, between points 10 and 85 percent of the distance from the streamgage to the basin divide.
- Main channel length (*L*), in miles, between the streamgage and the basin divide.
- Lag-time factor (*T*), defined by the ratio $L/S^{0.5}$, with *L* and *S* defined above.
- Storage (*St*), in percent, defined as the percentage of the total contributing drainage area covered by lakes, ponds, and swamps.
- Basin shape ratio (L^2/A), of the longest flow path length to drainage area. The length of the longest flow path (*L*) is squared and divided by the drainage area for the basin *(A)*. This ratio is essentially a basin shape factor with *L* and *A* defined above.

Initial GLS regression analyses were performed for all streamgages included in the study (table 1) and incorporated multiple combinations of the aforementioned explanatory variables. The combination of drainage area, slope, and basin shape yielded the lowest standard errors of prediction and therefore were used to estimate AEPs at ungaged locations in the MAP. The drainage areas of the 58 streamgages range from 0.03 to 2,370 square miles (mi^2), slopes range from 0.36 to 31.74 feet per mile, and basin shape ratios range from 1.24 to 75.97.

The quality of GIS-derived basin characteristics for the MAP is a condition of the low channel slopes, large amounts of channel and overbank storage, and extensive hydraulic alteration characteristic of stream courses in the region. Because of these factors, GIS-derived basin characteristics require extra quality assurance to ensure that they are accurate. Special care should be taken with locations having drainage areas less than 1 mi^2; the basin boundaries might require editing in StreamStats to yield the correct basin polygons, and therefore characteristics, for the desired locations.

Flood-Frequency Analysis

Fifty-eight streamgages operated by the USGS in the MAP—9 in Mississippi, 35 in Arkansas, 4 in Missouri, and 10 in Louisiana—that had 10 or more years of annual peak-flow data through the 2017 water year were considered for use in the regression analysis. The streamgages were either continuous-record or crest-stage gages. Continuous-record gages are equipped with instrumentation that records the height of the water surface above the gage datum, or stage, of the water body at fixed time intervals. The stage data are transmitted by satellite to USGS offices where flow from stage-streamflow rating is applied to each stage value. Crest-stage gages record only the peak stages of floods; flow from a stage-streamflow rating is then applied to the peak stage for the year.

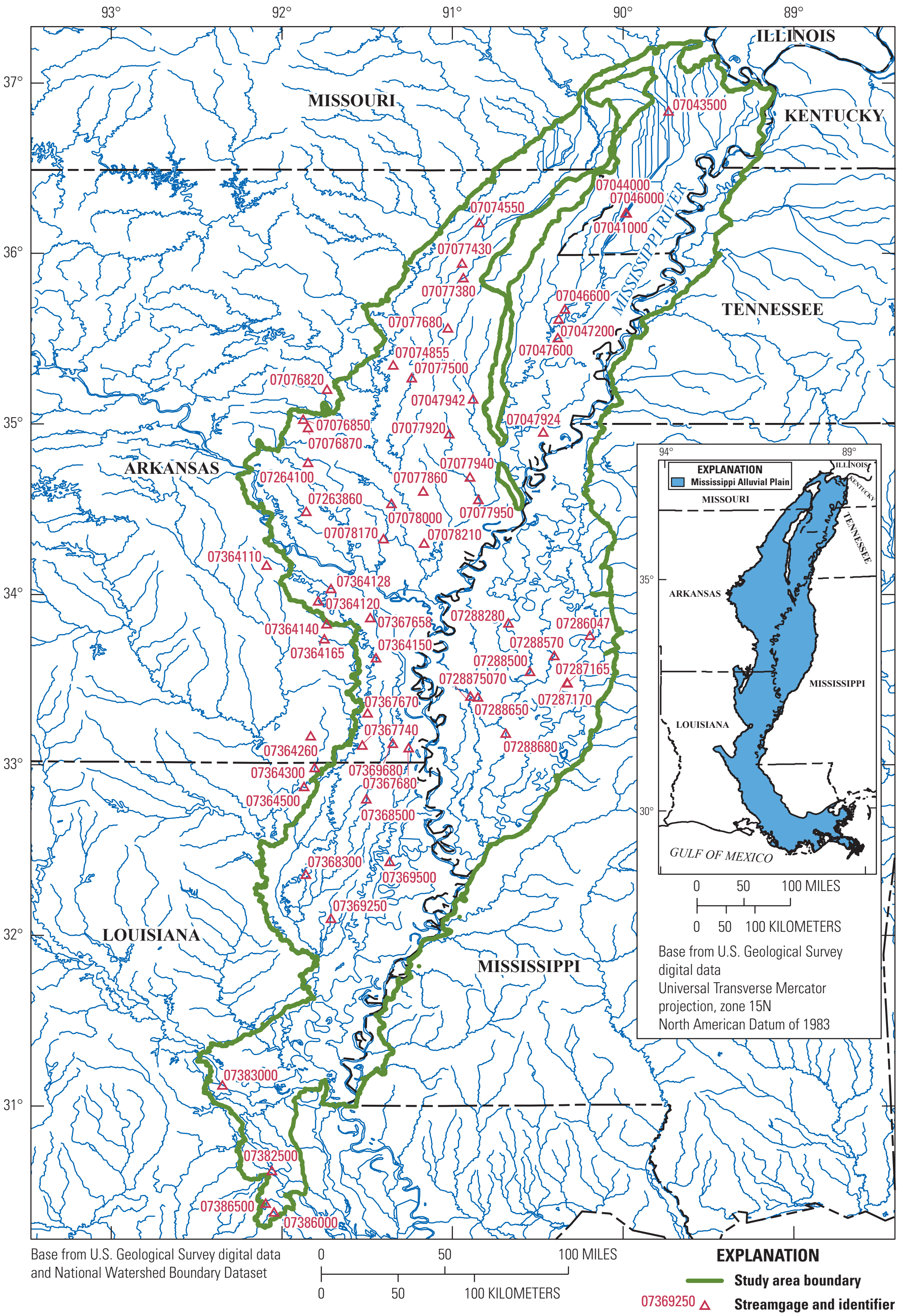

Figure 1. Locations of streamgages used in regional regression analysis in the alluvial plain of the lower Mississippi River.

Table 1. Information and selected basin characteristics for U.S. Geological Survey streamgages in Mississippi, Arkansas, Missouri, and Louisiana that were used in the regional regression analysis.

[Data in this table are available from the U.S. Geological Survey National Water Information System database (https://waterdata.usgs.gov/nwis) and StreamStats (https://streamstats.usgs.gov/ss/). Dates shown as month, day, and year or as month and year if exact date is not known. Horizontal coordinate information is referenced to the North American Datum of 1983. USGS, U.S. Geological Survey; GIS, geographic information system; mi^2, square mile; ft/mi, foot per mile]

USGS streamgage number	GIS drainage area (mi^2)	Slope 10 to 85 (ft/mi)	Basin shape ratio	Latitude of streamgage (decimal degrees)	Longitude of streamgage (decimal degrees)	Beginning date	Ending date	Number of peak flows
07041000	119	1.10	17.34	36.23654444	−89.9823583	4/21/1927	4/2/1979	53
07043500	436	0.86	10.38	36.83452778	−89.7300556	6/1945	5/1/2017	71
07044000	113	0.97	12.83	36.23633056	−89.9783778	4/25/1927	4/3/1979	53
07046000	98.4	1.12	7.59	36.23621944	−89.9769556	4/29/1927	4/3/1979	53
07046600	2,110	0.83	14.09	35.67194444	−90.3380556	3/12/1939	2/1/1994	55
07047200	1.91	0.36	5.13	35.61285756	−90.3751012	11/22/1961	10/21/1984	24
07047600	332	0.51	13.71	35.50508234	−90.3801007	2/5/1939	4/10/1993	50
07047924	0.53	8.88	3.63	34.95203899	−90.4667681	3/11/1963	8/14/1982	20
07047942	534	3.17	8.80	35.1447222	−90.8780556	12/26/1970	5/2/2017	45
07074550	6.08	1.87	5.61	36.1792342	−90.841506	5/7/1961	8/16/1981	21
07074855	5.97	3.22	6.93	35.34369565	−91.3440173	2/26/1962	6/6/1981	20
07076820	4.99	31.73	4.97	35.2011968	−91.7323596	5/6/1961	5/26/1981	21
07076850	155	7.84	8.44	35.02508737	−91.8731964	2/28/1962	6/26/1976	15
07076870	23.05	12.11	4.31	34.9767548	−91.8440284	3/30/1961	4/21/2004	44
07077380	691	0.99	9.37	35.8575	−90.9330556	2/22/1938	5/4/2017	68
07077430	0.26	4.09	6.13	35.94146158	−90.9426193	5/27/1963	4/22/2004	39
07077500	1,030	0.83	21.56	35.2697222	−91.2363889	4/18/1921	5/2/2017	87
07077680	7.86	0.74	8.23	35.5617472	−91.023732	5/6/1961	7/22/1980	20
07077860	10.4	2.16	5.46	34.6050979	−91.1701214	12/16/1961	4/8/1983	22
07077920	34.3	1.24	10.56	34.93953848	−91.0153972	3/31/1961	4/22/2004	44
07077940	36.2	2.60	4.12	34.68787606	−90.8959485	1/22/1962	12/19/2002	31
07077950	374	0.81	13.39	34.55565564	−90.8456691	2/25/1971	4/16/1993	23
07078000	176	1.37	10.76	34.53204204	−91.3556799	7/5/1936	1/17/1954	19
07078170	1.87	3.28	9.45	34.32593217	−91.4017892	3/30/1961	11/22/1979	20
07078210	0.39	8.78	4.75	34.3006567	−91.16261689	4/28/1963	6/11/1986	24
07263860	3.49	4.30	3.21	34.485651	−91.8537468	7/15/1963	12/8/1978	17
07264100	8.38	3.56	4.32	34.77231326	−91.8429149	3/30/1961	4/5/1986	26
07286047	0.032	1.23	1.24	33.7584492	−90.191753	12/9/1966	7/29/1977	11
07287165	0.088	1.65	1.82	33.48206464	−90.3250846	4/20/1966	12/3/1983	17
07287170	0.15	0.99	1.67	33.4792869	−90.3223068	9/11/1966	12/3/1983	17
07288280	572	1.28	11.73	33.8325	−90.67	4/11/1993	9/3/2017	25
07288500	791	1.31	18.66	33.5473397	−90.5431441	2/6/1936	1/23/2017	63
07288570	266	0.65	12.78	33.6403947	−90.4014763	4/10/1938	5/6/1991	48
07288650	479	0.81	9.60	33.39666667	−90.8477778	1/12/1946	1/20/2017	61
07288680	2,370	0.80	13.79	33.18401178	−90.6862058	2/16/1948	12/7/1983	37
07364110	0.76	31.74	3.54	34.1689873	−92.0868094	3/30/1961	7/17/2004	41
07364120	214	2.17	39.63	33.96121248	−91.7848537	5/3/1942	3/31/1980	32
07364128	107	1.56	8.30	34.03397778	−91.70975	4/22/1991	2/5/2004	14

Table 1. Information and selected basin characteristics for U.S. Geological Survey streamgages in Mississippi, Arkansas, Missouri, and Louisiana that were used in the regional regression analysis.—Continued

[Data in this table are available from the U.S. Geological Survey National Water Information System database (https://waterdata.usgs.gov/nwis) and StreamStats (https://streamstats.usgs.gov/ss/). Dates shown as month, day, and year or as month and year if exact date is not known. Horizontal coordinate information is referenced to the North American Datum of 1983. USGS, U.S. Geological Survey; GIS, geographic information system; mi², square mile; ft/mi, foot per mile]

USGS streamgage number	GIS drainage area (mi²)	Slope 10 to 85 (ft/mi)	Basin shape ratio	Latitude of streamgage (decimal degrees)	Longitude of streamgage (decimal degrees)	Beginning date	Ending date	Number of peak flows
07364140	36	16.45	4.50	33.82482634	−91.7351298	4/8/1993	3/1/2004	11
07364150	608	1.29	60.00	33.62777778	−91.4458333	4/13/1905	6/11/2017	81
07364165	18.2	12.75	4.07	33.73899468	−91.7476299	5/27/1963	12/28/1982	21
07364260	21.1	6.63	5.25	33.17012176	−91.8279064	12/16/1961	12/27/1982	22
07364300	274	2.91	8.47	32.9820721	−91.8056818	4/7/1956	1/22/2017	27
07364500	1,622	0.84	75.97	32.87235338	−91.8679054	4/1/1927	4/16/1980	53
07367658	1.31	4.60	3.87	33.86315944	−91.4795674	3/30/1961	7/2/1986	26
07367670	2.44	1.99	3.12	33.3042843	−91.4937318	2/20/1961	12/27/1982	23
07367680	571	0.80	26.60	33.12416667	−91.3477778	3/31/1939	3/11/2016	57
07367740	2.20	3.22	4.44	33.11540059	−91.5253976	5/27/1963	10/7/1984	23
07368300	0.15	3.51	8.51	32.35709119	−91.8570728	2/10/1966	2/1/1981	16
07368500	36.9	0.92	8.85	32.798743	−91.5015072	12/9/1940	3/5/1977	37
07369250	0.40	4.53	3.32	32.09876548	−91.7084587	5/23/1955	5/1/1967	13
07369500	309	1.10	6.38	32.43208704	−91.36678139	5/15/1927	4/3/2017	84
07369680	528	1.06	18.93	33.10027778	−91.2544444	12/1931	8/9/2017	80
07382500	715	1.00	7.45	30.61825175	−92.0556741	8/12/1940	5/8/2017	72
07383000	78.9	1.16	5.12	31.1196322	−92.3445769	4/19/1943	6/3/1905	37
07386000	37.1	2.20	3.14	30.37658758	−92.0431756	8/1940	3/2/1964	21
07386500	19.0	1.80	6.72	30.42797613	−92.0917879	3/25/1943	5/16/1970	28
0728875070	79.9	0.51	28.24	33.4011111	−90.8919444	12/17/2001	7/22/2014	13

Annual peak-flow data for the streamgages were downloaded from the USGS National Water Information System (NWIS) database (U.S. Geological Survey, 2017b). Annual peak-flow records were evaluated for extensive regulation, diversion, and urbanization by inspecting NWIS peak-flow qualification codes. Annual peaks affected by extensive regulation or diversion were not considered for use in the study and removed from the dataset. Streamgages having basins with more than 10 percent of the drainage area covered by an impervious surface were considered urbanized and were not included in this study. Annual peak flows for the 58 streamgages were analyzed using version 7.3 of USGS peak-flow analysis software PeakFQ (U.S. Geological Survey, 2014).

Following the guidelines set forth in Bulletin 17C (England and others, 2019), a log-Pearson type III (LP3) mathematical probability distribution was fit to the annual peak-flow data from each streamgage and then used to estimate streamflow values corresponding to a range of annual exceedance probabilities (0.5, 0.2, 0.1, 0.04, 0.02, 0.01, 0.005, 0.002). The LP3 is a three-parameter distribution that requires estimates of the mean, standard deviation, and skew coefficient (that is, the “moments”) of the population of base 10 logarithms of annual peak flows at each streamgage (Parrett and others, 2011). EMA improves upon the standard LP3 method by allowing for the incorporation of “flood knowledge,” historic data and peaks, censored observations, and uncertain data points by using perception thresholds and flow intervals to represent such data (Cohn and others, 1997). In an EMA analysis, perception thresholds are used to describe such “flood knowledge” in each year within the annual peak-flow record and represent the observable range in floods (England and others, 2019). If no historic, censored, or interval data are incorporated, the EMA method produces estimates of the three LP3 moments that are identical to those produced by the standard LP3 method described in Bulletin 17B (Interagency Advisory Committee on Water Data, 1982). For streamgages in the part of the MAP in Arkansas, Louisiana, and Missouri, regional skew had been updated within the past 10 years (Southard and Veilleux, 2014; Wagner and others, 2016), and that regional skew value and corresponding MSE (−0.17 and 0.121, respectively) were used to weight the station skew. For streamgages in the part of the MAP in Mississippi, skew values were not available from Bulletin 17C; therefore, generalized skew (#) and the corresponding mean square error (MSE) values (#) from Bulletin 17B were used to weight the station skew.

The basic equation for fitting the LP3 distribution to a measured series of annual peak flows is

$$\log Q_p = \overline{X} + K_p S, \qquad (1)$$

where

Q_p is the *P*-percent AEP flow, in cubic feet per second;

$\overline{X}$ is the mean of the logarithms of the annual peak flows;

K_p is a factor based on the skew coefficient and the given percentage of annual exceedance probability, which can be obtained from appendix 3 of Bulletin 17B (Interagency Advisory Committee on Water Data, 1982); and

S is the standard deviation of the logarithms of the annual peak flows.

The term “recurrence interval, in years” is commonly used to characterize flood frequency (for example, a “50-year flood”); however, the USGS and other Federal agencies now refer to the *P*-percent chance of occurrence (AEP). For example, the 0.02 AEP ($Q_{2percent}$) has a 2-percent chance of occurring in any given year and corresponds to a recurrence interval of 50 years (reciprocal of the AEP; Griffis and Stedinger, 2007).

The MGB test, a generalization of the Grubbs-Beck method, provides a standard procedure for identifying multiple low outliers referred to as potentially influential low floods (PILFs; Cohn and others, 2013). PILFs are annual peaks that meet three criteria: (1) their magnitude is much smaller than the flood quantile of interest; (2) they occur below a statistically significant break in the flood-frequency plot; and (3) they can have excessive influence on the estimated frequency of large floods. PILFs were excluded from the AEP flow computations for the streamgages used in the study.

Regression Analysis

AEP estimates obtained from flood-frequency analysis of annual peak-flow data from the 58 selected USGS streamgages were related to basin characteristics using ordinary least-squares multiple linear regression to evaluate the statistical significance of each basin characteristic (Wagner and others, 2016). The USGS weighted-multiple-linear regression program (WREG) version 1.05 was then used to complete the final GLS regression analysis (Eng and others, 2009; U.S. Geological Survey, 2013). In GLS regression, streamgages are weighted according to differences in streamflow record length, the variance of streamflow measurements in the record, and spatial cross-correlation of concurrent flows among streamgages.

Performance metrics for the GLS regression were reviewed. Standard error of prediction of the GLS models ranged from 45 to 61 percent (table 2). Pseudo coefficients of determination (pseudo-R^2) of the models ranged from 90 to 94 percent. Standard model error ranged from 43 to 57 percent. Streamgages that had high leverage or influence on the regression model were identified. The leverage metric is used to compare the values of independent variables at one streamgage to the values of the same variables at all other streamgages, whereas influence is used to determine if a streamgage had a high influence on the estimated regression values (Eng and others, 2009). A streamgage may exhibit high leverage because its independent variables differ substantially from those of other streamgages in the dataset, but the same streamgage may not exhibit high influence on the regression model. Conversely, a streamgage that exhibits high influence may not exhibit high leverage. Sometimes high leverage or influence is indicative of incorrect values for one or more independent variables. One streamgage (07287505) was removed because of high influence on model performance metrics.

Application of Regression Equations for Estimating Annual Exceedance Probability Streamflows in the Mississippi Alluvial Plain

When applying the regression equations, users are advised not to interpret the empirical results as exact. Regression equations are statistical models that must be interpreted and applied within the limits of the data used to generate the models and with the understanding that the results are best-fit estimates that have an associated variance. Methods for estimating AEP flows in the MAP differ between gaged locations, ungaged locations on gaged streams, and locations on ungaged streams.

Estimating Annual Exceedance Probability Flows

Annual exceedance probability flow estimations are considered for gaged locations, ungaged locations on gaged streams, and locations on ungaged streams.

Table 2. Final regional regression equations for estimating annual exceedance probability flows for rural streams in the alluvial plain of the lower Mississippi River and generalized least-squares regression model diagnostics.

[Delta flood region -58 streamgages. MSE, mean square error; ft^3/s, cubic foot per second; AVP, average variance of prediction; SEP, standard error of prediction; pseudo-R^2, pseudo coefficient of determination; $Q_{\#\#\%}$, annual exceedance probability flow; A, contributing drainage area, in square miles; S, slope from StreamStats, in feet per mile; B, basin shape ratio, L^2/A]

Annual exceedance probability flow equation	MSE (log ft^3/s)	AVP (log ft^3/s)^2	SEP (percent)	Pseudo-R^2 (percent)
$Q_{50\%}=207(A)^{0.676}(S)^{0.159}(B)^{-0.390}$	0.034	0.035	45	94
$Q_{20\%}=259(A)^{0.683}(S)^{0.272}(B)^{-0.374}$	0.034	0.035	45	94
$Q_{10\%}=290(A)^{0.684}(S)^{0.328}(B)^{-0.362}$	0.037	0.037	46	94
$Q_{4\%}=328(A)^{0.684}(S)^{0.387}(B)^{-0.348}$	0.042	0.041	50	93
$Q_{2\%}=354(A)^{0.684}(S)^{0.423}(B)^{-0.336}$	0.046	0.045	52	93
$Q_{1\%}=378(A)^{0.683}(S)^{0.455}(B)^{-0.326}$	0.050	0.049	55	92
$Q_{0.5\%}=403(A)^{0.682}(S)^{0.485}(B)^{-0.319}$	0.055	0.053	57	91
$Q_{0.2\%}=436(A)^{0.682}(S)^{0.520}(B)^{-0.312}$	0.061	0.059	61	90

Gaged Locations

The accuracy of AEP flows at streamgages, determined using EMA, can be further improved by weighting with flows predicted using the regression equations. If AEP flows estimated using EMA and the regression equations are assumed to be independent and are weighted in inverse proportion to the associated variances, the variance of the weighted estimate will be less than the variance of either of the independent estimates. Once the variances have been computed, the two independent flow estimates can be weighted by using the following equation:

$$\log_{10} Q_{P(g)w} = \frac{V_{p,P(g)r} * \log_{10} Q_{P(g)s} + V_{p,P(g)s} * \log_{10} Q_{P(g)r}}{V_{p,P(g)s} + V_{p,P(g)r}}, \quad (2)$$

where

$Q_{P(g)w}$ is the weighted flow estimate for the selected AEP, in cubic feet per second;

$V_{p,P(g)r}$ is the variance of prediction corresponding to the regression equation for the selected AEP, in log units;

$Q_{P(g)s}$ is the flow estimate, determined using EMA, for the selected AEP, in cubic feet per second;

$V_{p,P(g)s}$ is the variance of prediction from EMA for the selected AEP, in log units; and

$Q_{P(g)r}$ is the flow estimate, determined using the regression equation for the selected AEP, in cubic feet per second.

For all streamgages used in the study, the AEP flow estimates determined using EMA were weighted with the AEP flow estimates determined using the regression equations to compute a final set of weighted AEP flows (table 3).

Ungaged Locations on Gaged Streams

AEP flows for a streamgage can be transferred to an ungaged location on the same stream by using the area-weighting method (eq. 3). If the drainage area at an ungaged location is within 50 percent of the drainage area at a streamgage (drainage area ratio is more than 0.5 or less than 1.5) (Ries and Dillow, 2006), the drainage area ratio can be calculated as

$$Q_{P(u)} = \left(\frac{A_{(u)}}{A_{(g)}}\right)^{b} Q_{P(g)w}, \quad (3)$$

where

$Q_{P(u)}$ is the flow estimate corresponding to the selected *P*-percent AEP at the ungaged location, *u*, in cubic feet per second;

$A_{(u)}$ is the drainage area at the ungaged location, in square miles;

$A_{(g)}$ is the drainage area at the upstream or downstream streamgage, in square miles;

b is the exponent of the drainage area given below; and

$Q_{P(g)w}$ is the weighted flow estimate corresponding to the selected *P*-percent AEP for the upstream or downstream streamgage, in cubic feet per second.

Table 3. Annual exceedance probability flows for 58 U.S. Geological Survey streamgages used in regional regression analysis based on data through the 2017 water year.

[Flows are in cubic feet per second. USGS, U.S. Geological Survey; %, percent; Miss., Mississippi; Mo., Missouri; La., Louisiana; Ark., Arkansas; no., number; trib., tributary; St., State; Hw, highway; nr, near; Rs, research; Pd, pond; Byu, Bayou; COE, U.S. Army Corps of Engineers; EMA, Expected Moments Algorithm; RRE, regional regression equation; weighted, weighted estimate computed using equation 2; @, at; %, percent]

USGS streamgage number	USGS streamgage name	Method	Annual exceedance probability flow							
			50%	20%	10%	4%	2%	1%	0.5%	0.2%
07041000	Little River ditch 81 near Kennett, Mo.	EMA	2,000	2,530	2,840	3,200	3,440	3,670	3,880	4,160
		RRE	1,750	2,390	2,810	3,330	3,710	4,070	4,440	4,900
		Weighted	2,000	2,530	2,840	3,200	3,450	3,680	3,900	4,180
07043500	Little River ditch no. 1 near Morehouse, Mo.	EMA	6,440	8,550	9,820	11,300	12,300	13,300	14,200	15,300
		RRE	4,940	6,560	7,590	8,790	9,640	10,400	11,200	12,200
		Weighted	6,420	8,520	9,780	11,200	12,300	13,200	14,100	15,200
07044000	Little River ditch 251 near Kennett, Mo.	EMA	9,730	12,200	13,600	15,200	16,300	17,400	18,400	19,700
		RRE	1,860	2,490	2,900	3,400	3,760	4,100	4,440	4,860
		Weighted	9,590	12,000	13,300	14,800	15,800	16,900	17,700	18,800
07046000	Little River ditch 259 near Kennett, Mo.	EMA	1,870	2,700	3,250	3,940	4,440	4,930	5,420	6,070
		RRE	2,130	2,870	3,340	3,920	4,340	4,730	5,120	5,610
		Weighted	1,880	2,710	3,250	3,930	4,430	4,920	5,400	6,030
07046600	Right hand chute of Little River @ Rivervale, Ark.	EMA	14,000	22,300	28,100	35,500	41,000	46,700	52,200	59,700
		RRE	12,600	17,000	19,700	22,900	25,200	27,400	29,400	32,100
		Weighted	13,900	22,100	27,600	34,600	39,600	44,600	49,300	55,500
07047200	Ditch no. 45 near Lepanto, Ark.	EMA	166	197	214	233	246	258	269	282
		RRE	144	166	179	195	207	217	227	239
		Weighted	166	196	214	233	245	257	268	281
07047600	Tyronza River near Tyronza, Ark.	EMA	4,540	5,930	6,820	7,930	8,750	9,550	10,400	11,400
		RRE	3,390	4,270	4,790	5,410	5,850	6,250	6,640	7,110
		Weighted	4,520	5,900	6,780	7,840	8,630	9,380	10,100	11,100
07047924	Crooked Bayou trib at St Hw 149 at Hughes, Ark.	EMA	111	204	280	391	484	586	698	863
		RRE	116	187	242	316	375	436	500	589
		Weighted	112	201	272	371	450	534	621	745
07047942	LAnguille River near Colt, Ark.	EMA	5,830	9,250	11,600	14,500	16,700	18,900	21,100	24,000
		RRE	7,430	11,400	14,200	17,700	20,300	23,000	25,600	29,200
		Weighted	5,890	9,330	11,700	14,700	17,000	19,300	21,500	24,600
07074550	Village Creek near Okean, Ark.	EMA	217	505	778	1,230	1,640	2,120	2,690	3,560
		RRE	395	552	658	789	887	984	1,080	1,210

Table 3. Annual exceedance probability flows for 58 U.S. Geological Survey streamgages used in regional regression analysis based on data through the 2017 water year.—Continued

[Flows are in cubic feet per second. USGS, U.S. Geological Survey; %, percent; Miss., Mississippi; Mo., Missouri; La., Louisiana; Ark., Arkansas; no., number; trib., tributary; St., State; Hw, highway; nr, near; Rs, research; Pd, pond; Byu, Bayou; COE, U.S. Army Corps of Engineers; EMA, Expected Moments Algorithm; RRE, regional regression equation; weighted, weighted estimate computed using equation 2; @, at; %, percent]

USGS streamgage number	USGS streamgage name	Method	Annual exceedance probability flow							
			50%	20%	10%	4%	2%	1%	0.5%	0.2%
		Weighted	248	517	738	1,040	1,280	1,510	1,730	2,030
07074855	Cypress Cr. trib. near Augusta Ark.	EMA	317	484	604	762	883	1,010	1,140	1,320
		RRE	393	583	719	893	1,030	1,160	1,300	1,480
		Weighted	322	492	616	780	906	1,040	1,170	1,360
07076820	Gum Springs Creek near Higginson, Ark.	EMA	782	1,150	1,390	1,700	1,920	2,150	2,370	2,660
		RRE	570	1,090	1,520	2,150	2,680	3,240	3,870	4,780
		Weighted	772	1,140	1,400	1,750	2,010	2,290	2,590	2,980
07076850	Cypress Bayou near Beebe, Ark.	EMA	6,170	10,900	14,500	19,300	23,100	27,000	31,000	36,600
		RRE	3,780	6,380	8,320	10,900	13,000	15,100	17,300	20,400
		Weighted	5,150	8,130	10,100	12,800	15,000	17,200	19,500	22,800
07076870	Pigeon Roost Creek at Butlerville, Ark.	EMA	1,970	3,940	5,510	7,740	9,550	11,500	13,500	16,300
		RRE	1,450	2,510	3,330	4,440	5,320	6,240	7,210	8,590
		Weighted	1,920	3,780	5,220	7,200	8,720	10,300	11,800	13,900
07077380	Cache River at Egypt, Ark.	EMA	4,650	5,940	6,760	7,780	8,530	9,250	9,980	10,900
		RRE	7,180	9,710	11,300	13,200	14,500	15,800	17,000	18,600
		Weighted	4,660	5,970	6,810	7,850	8,630	9,390	10,200	11,200
07077430	Willow Ditch near Egypt, Ark.	EMA	36	62	83	115	142	173	207	257
		RRE	51	77	95	120	139	158	179	206
		Weighted	37	63	84	116	142	170	200	243
07077500	Cache River at Patterson, Ark.	EMA	6,350	9,100	11,000	13,400	15,300	17,200	19,100	21,700
		RRE	6,610	8,890	10,400	12,100	13,400	14,600	15,700	17,200
		Weighted	6,360	9,100	11,000	13,400	15,200	17,000	18,900	21,400
07077680	Three Mile Creek near Amagon, Ark.	EMA	320	372	402	435	456	476	495	520
		RRE	350	443	504	575	628	679	726	787
		Weighted	320	373	403	437	460	481	502	528
07077860	Boat gunwale slash near Holly Grove, Ark.	EMA	368	451	500	556	594	631	665	710
		RRE	587	836	1,000	1,220	1,370	1,530	1,690	1,890
		Weighted	372	456	509	571	617	660	704	759
07077920	Big Creek at Goodwin, Ark.	EMA	507	724	863	1,030	1,150	1,260	1,380	1,520
		RRE	933	1,270	1,490	1,770	1,970	2,160	2,360	2,600

Table 3. Annual exceedance probability flows for 58 U.S. Geological Survey streamgages used in regional regression analysis based on data through the 2017 water year.—Continued

[Flows are in cubic feet per second. USGS, U.S. Geological Survey; %, percent; Miss., Mississippi; Mo., Missouri; La., Louisiana; Ark., Arkansas; no., number; trib., tributary; St., State; Hw, highway; nr, near; Rs, research; Pd, pond; Byu, Bayou; COE, U.S. Army Corps of Engineers; EMA, Expected Moments Algorithm; RRE, regional regression equation; weighted, weighted estimate computed using equation 2; @, at; %, percent]

USGS streamgage number	USGS streamgage name	Method	Annual exceedance probability flow							
			50%	20%	10%	4%	2%	1%	0.5%	0.2%
		Weighted	515	737	880	1,060	1,180	1,310	1,440	1,600
07077940	Spring Creek near Aubrey, Ark.	EMA	1,470	1,750	1,910	2,090	2,220	2,330	2,440	2,580
		RRE	1,570	2,290	2,770	3,390	3,840	4,280	4,720	5,320
		Weighted	1,470	1,750	1,920	2,120	2,250	2,380	2,510	2,660
07077950	Big Creek at Poplar Grove	EMA	3,250	4,580	5,430	6,460	7,180	7,890	8,570	9,460
		RRE	3,990	5,280	6,100	7,080	7,780	8,430	9,080	9,890
		Weighted	3,330	4,690	5,570	6,610	7,340	8,060	8,740	9,610
07078000	Lagrue Bayou near Stuttgart, Ark.	EMA	2,370	3,980	5,140	6,670	7,830	9,020	10,200	11,800
		RRE	2,840	3,950	4,690	5,580	6,240	6,870	7,500	8,320
		Weighted	2,420	3,980	5,070	6,470	7,490	8,490	9,460	10,700
07078170	Little Lagrue Bayou trib near Dewitt, Ark.	EMA	184	214	231	251	264	276	288	302
		RRE	159	237	292	366	422	479	537	615
		Weighted	184	214	232	252	266	280	293	309
07078210	Tarleton Creek Tributary at Ethel, Ark.	EMA	67	115	154	212	261	315	376	466
		RRE	84	137	177	232	276	322	370	437
		Weighted	68	118	157	215	264	317	374	457
07263860	Mile Branch near Tomberlin, Ark.	EMA	393	484	537	598	641	681	718	764
		RRE	385	583	723	906	1,040	1,180	1,320	1,520
		Weighted	392	486	541	609	659	708	757	819
07264100	White Oak Branch near Lonoke, Ark.	EMA	857	1,240	1,480	1,770	1,990	2,190	2,390	2,640
		RRE	603	902	1,110	1,380	1,580	1,790	2,000	2,280
		Weighted	844	1,220	1,450	1,740	1,950	2,150	2,340	2,590
07286047	Tippo Bayou trib at Phillip, Miss.	EMA	18	23	25	29	32	34	37	40
		RRE	19	24	28	32	34	37	40	44
		Weighted	18	23	26	29	32	34	37	40
07287165	Mosquito Lake trib #1 at Itta Bena, Miss.	EMA	57	73	84	98	109	120	131	146
		RRE	34	45	52	61	68	75	81	90
		Weighted	56	72	82	95	104	114	124	137

Table 3. Annual exceedance probability flows for 58 U.S. Geological Survey streamgages used in regional regression analysis based on data through the 2017 water year.—Continued

[Flows are in cubic feet per second. USGS, U.S. Geological Survey; %, percent; Miss., Mississippi; Mo., Missouri; La., Louisiana; Ark., Arkansas; no., number; trib., tributary; St., State; Hw, highway; nr, near; Rs, research; Pd, pond; Byu, Bayou; COE, U.S. Army Corps of Engineers; EMA, Expected Moments Algorithm; RRE, regional regression equation; weighted, weighted estimate computed using equation 2; @, at; %, percent]

USGS streamgage number	USGS streamgage name	Method	Annual exceedance probability flow							
			50%	20%	10%	4%	2%	1%	0.5%	0.2%
07287170	Mosquito Lake trib no 2 at Itta Bena, Miss.	EMA	70	84	93	104	111	118	125	135
		RRE	47	58	66	75	81	87	93	101
		Weighted	70	84	92	102	110	117	123	132
07288280	Big Sunflower River nr Merigold, Miss.	EMA	5,620	7,400	8,470	9,750	10,600	11,500	12,300	13,300
		RRE	6,030	8,410	9,950	11,800	13,200	14,500	15,800	17,500
		Weighted	5,680	7,480	8,640	10,100	11,200	12,300	13,300	14,700
07288500	Big Sunflower River at Sunflower, Miss.	EMA	6,120	8,180	9,480	11,100	12,200	13,300	14,500	15,900
		RRE	6,280	8,870	10,600	12,700	14,200	15,700	17,200	19,100
		Weighted	6,130	8,190	9,500	11,100	12,300	13,400	14,600	16,100
07288570	Quiver River nr Doddsville, Miss.	EMA	2,700	4,030	4,990	6,300	7,330	8,410	9,570	11,200
		RRE	3,120	4,020	4,570	5,240	5,700	6,140	6,560	7,080
		Weighted	2,720	4,030	4,960	6,210	7,160	8,120	9,090	10,400
07288650	Bogue Phalia nr Leland, Miss.	EMA	7,100	8,670	9,590	10,700	11,400	12,100	12,800	13,600
		RRE	5,370	7,100	8,150	9,420	10,300	11,100	11,900	13,000
		Weighted	7,080	8,650	9,570	10,600	11,400	12,000	12,700	13,600
07288680	Big Sunflower River at Little Callao Landing, Miss.	EMA	15,800	19,900	22,400	25,400	27,600	29,800	31,900	34,700
		RRE	13,700	18,400	21,300	24,700	27,000	29,300	31,500	34,300
		Weighted	15,700	19,800	22,300	25,400	27,600	29,700	31,900	34,600
07364110	Nevins Creek Tributary near Pine Bluff, Ark.	EMA	134	254	352	493	612	743	883	1,090
		RRE	182	342	474	668	830	1,000	1,190	1,470
		Weighted	137	260	363	512	636	776	931	1,150
07364120	Bayou Bartholomew near Star City	EMA	1,700	2,420	2,880	3,420	3,810	4,180	4,540	5,000
		RRE	2,100	3,150	3,890	4,850	5,600	6,320	7,060	8,040
		Weighted	1,710	2,440	2,910	3,480	3,900	4,300	4,700	5,230
07364128	Deep Bayou near Grady	EMA	1,510	1,700	1,810	1,920	2,000	2,070	2,140	2,220
		RRE	2,290	3,210	3,820	4,570	5,120	5,650	6,180	6,870
		Weighted	1,520	1,710	1,830	1,950	2,040	2,120	2,200	2,300
07364140	Ables Creek near Tyro, Ark.	EMA	4,140	6,710	8,650	11,300	13,400	15,700	18,000	21,400
		RRE	2,030	3,640	4,910	6,680	8,090	9,590	11,200	13,500

Table 3. Annual exceedance probability flows for 58 U.S. Geological Survey streamgages used in regional regression analysis based on data through the 2017 water year.—Continued

[Flows are in cubic feet per second. USGS, U.S. Geological Survey; %, percent; Miss., Mississippi; Mo., Missouri; La., Louisiana; Ark., Arkansas; no., number; trib., tributary; St., State; Hw, highway; nr, near; Rs, research; Pd, pond; Byu, Bayou; COE, U.S. Army Corps of Engineers; EMA, Expected Moments Algorithm; RRE, regional regression equation; weighted, weighted estimate computed using equation 2; @, at; %, percent]

USGS streamgage number	USGS streamgage name	Method	Annual exceedance probability flow							
			50%	20%	10%	4%	2%	1%	0.5%	0.2%
		Weighted	3,750	6,050	7,680	9,950	11,900	13,700	15,600	18,500
07364150	Bayou Bartholomew near McGehee, Ark.	EMA	3,330	4,550	5,300	6,180	6,810	7,410	8,000	8,730
		RRE	3,330	4,780	5,750	7,010	7,960	8,910	9,820	11,000
		Weighted	3,330	4,550	5,300	6,190	6,830	7,450	8,050	8,800
07364165	Upper Cutoff Creek near Monticello, Ark.	EMA	897	1,630	2,240	3,130	3,900	4,740	5,680	7,050
		RRE	1,280	2,210	2,940	3,930	4,720	5,530	6,410	7,640
		Weighted	934	1,710	2,350	3,290	4,100	4,960	5,900	7,250
07364260	Hanks Creek near Hamburg, Ark..	EMA	671	1,240	1,680	2,300	2,810	3,330	3,900	4,690
		RRE	1,150	1,870	2,390	3,090	3,630	4,190	4,760	5,560
		Weighted	719	1,310	1,790	2,450	2,990	3,540	4,140	4,960
07364300	Chemin-A-Haut Bayou near Beekman, La.	EMA	5,130	11,500	17,300	26,200	34,000	43,000	52,800	67,600
		RRE	4,740	7,180	8,850	11,000	12,600	14,200	15,800	17,900
		Weighted	5,060	10,600	15,000	21,200	26,600	31,600	36,000	42,800
07364500	(COE) Bayou Bartholomew near Beekman, La.	EMA	7,050	9,140	10,400	11,900	12,900	13,900	14,900	16,000
		RRE	5,510	7,600	8,990	10,700	12,000	13,200	14,500	15,900
		Weighted	7,030	9,120	10,400	11,900	12,900	13,900	14,800	16,000
07367658	Cypress Creek Canal no. 19 trib nr Dumas, Ark.	EMA	156	207	240	281	310	340	368	406
		RRE	187	284	353	445	515	586	659	759
		Weighted	157	210	244	288	321	354	388	434
07368500	Big Colewa Byu nr Oak Grove, La.	EMA	1,060	1,400	1,600	1,850	2,030	2,200	2,360	2,570
		RRE	1,000	1,320	1,520	1,760	1,940	2,100	2,260	2,470
		Weighted	1,060	1,390	1,600	1,850	2,020	2,190	2,350	2,560
07369250	Turkey Cr trib at Potato Rs Pd at Chase, La.	EMA	89	134	166	210	244	279	316	368
		RRE	89	133	165	207	240	272	306	352
		Weighted	89	134	166	209	243	278	314	363
07386000	Byu Carencro nr Sunset La.	EMA	2,360	3,240	3,820	4,530	5,060	5,580	6,110	6,790
		RRE	1,730	2,460	2,940	3,550	3,980	4,410	4,830	5,400
		Weighted	2,330	3,200	3,760	4,450	4,960	5,460	5,950	6,600

Table 3. Annual exceedance probability flows for 58 U.S. Geological Survey streamgages used in regional regression analysis based on data through the 2017 water year.—Continued

[Flows are in cubic feet per second. USGS, U.S. Geological Survey; %, percent; Miss., Mississippi; Mo., Missouri; La., Louisiana; Ark., Arkansas; no., number; trib., tributary; St., State; Hw, highway; nr, near; Rs, research; Pd, pond; Byu, Bayou; COE, U.S. Army Corps of Engineers; EMA, Expected Moments Algorithm; RRE, regional regression equation; weighted, weighted estimate computed using equation 2; @, at; %, percent]

USGS streamgage number	USGS streamgage name	Method	Annual exceedance probability flow							
			50%	20%	10%	4%	2%	1%	0.5%	0.2%
07386500	Byu Bourbeau @ Shuteston, La.	EMA	1,160	1,620	1,910	2,270	2,530	2,790	3,040	3,370
		RRE	793	1,110	1,320	1,590	1,790	1,990	2,180	2,430
		Weighted	1,150	1,600	1,880	2,220	2,470	2,710	2,950	3,250
0728875070	Deer Creek east of Leland, Miss.	EMA	490	619	698	789	851	912	968	1,040
		RRE	977	1,230	1,390	1,590	1,730	1,870	2,000	2,150
		Weighted	503	637	723	826	900	971	1,040	1,130

A separate GLS analysis was conducted with drainage area as the only explanatory variable to produce the exponents of drainage area to be used in equation 3. The exponent (b) values are 0.572, 0.564, 0.559, 0.553, 0.549, 0.546, 0.543, and 0.537 and should be used to transfer AEPs of 0.5, 0.2, 0.1, 0.04, 0.02, 0.01, 0.005, and 0.002, respectively.

The method just presented, however, does not weight the area-weighted flows at the ungaged locations with the flows computed using the regression equations. The AEP flows from the streamgage can be transferred and weighted with flows computed with the regression equations for the ungaged location using the following equation:

$$Q_{P(u)w} = \left(\frac{2|\Delta A|}{A_g}\right) Q_{P(u)r} + \left(1 - \frac{2|\Delta A|}{A_g}\right) Q_{P(u)}, \quad (4)$$

where

$Q_{P(u)w}$ is the weighted flow estimate at the ungaged location, in cubic feet per second;

$|\Delta A|$ is the absolute difference in drainage areas between the ungaged location and the streamgage, in square miles;

A_g is the drainage area at the streamgage, in square miles;

$Q_{P(u)r}$ is the flow estimate at the ungaged location for the selected AEP, computed using the regression equations, in cubic feet per second; and

$Q_{P(u)}$ is the area-weighted estimate of flood flow, corresponding to the selected P-percent AEP, at the ungaged location, u, in cubic feet per second computed using equation 3.

If the drainage area at an ungaged location differs by more than ±50 percent from that of the selected streamgage, the regression equations should be used to estimate AEP flows. If an ungaged location is between two streamgages on the same stream, the streamgage with the drainage area nearest in size to that at the ungaged location and the longest period of record should be used to compute area-weighted estimates of AEP flows (Sauer, 1974).

Locations on Ungaged Streams

For locations on ungaged streams, the drainage area, slope, and basin shape ratio should be determined using StreamStats (USGS, 2017a). StreamStats delineates the drainage basin for the selected location, computes basin characteristics, and estimates flows for a range of AEPs. The standard error of prediction (SEP) is a measure of the accuracy of AEP flow estimates computed using the regression equations. The equations also apply to ungaged locations on gaged streams that are outside the range of 0.5 to 1.5 times the drainage area of the streamgage.

Accuracy and Limitations of Regression Equations

The regression equations are applicable at locations on streams that have basin characteristics within the range of those used to develop the equations. The methods described in this report do not apply to locations on streams that are substantially affected by regulation from upstream impoundments or other man-made structures. The regression equations are not applicable at locations on streams where more than 10 percent of the drainage area of the basin upstream of the location of interest is covered by impervious surfaces. The accuracy of the regression equations is not known for locations that have basin characteristics outside the following ranges used to develop the equations: drainage areas from 0.03 to 2,370 mi^2; channel slopes from 0.36 to 31.74 feet per mile; and basin shape ratios from 1.24 to 75.97. The equations are valid for the MAP region in the States of Mississippi, Arkansas, Louisiana, and Missouri represented by streamgages used in the study (fig. 1; table 1).

The accuracy of a flood-frequency estimate traditionally has been expressed in two ways—as the mean standard error of the model or as the mean SEP. The mean standard error of the model is a measure of how well the regression model fits the streamgage data and represents the standard deviation of the differences between streamgage data and predictions from the regression equation. The SEP is a measure of how well the regression model estimates AEP flows for ungaged basins. The SEP is the square root of the mean square error of prediction. The mean square error of prediction is the sum of two components—the MSE resulting from the model and the sampling MSE resulting from estimating the model parameters from samples of the population. The MSE range (43–57 percent) and the SEP range (45–61 percent) for the GLS regression were within acceptable limits for AEP analysis (England and others, 2019).

Summary and Conclusions

Flood-frequency estimates for rural Mississippi Alluvial Plain streams in Mississippi were last updated in 1985; since that time, estimation techniques have improved, and additional annual peak streamflow data are available to improve the accuracy of such estimates. Thus, the U.S. Geological Survey, in cooperation with the Mississippi Department of Transportation, performed flood-frequency analyses to estimate annual exceedance probability (AEP) flows at streamgages and related the AEP flows to selected basin characteristics to develop a suite of generalized least-squares regression equations to estimate AEPs at ungaged locations in the Mississippi Alluvial Plain. Many basin characteristics were analyzed, but drainage area, slope, and a basin shape ratio yielded the best model and were used as explanatory variables in the regression equations. Standard error of prediction of the generalized least-squares models ranged from 45 to 61 percent. Pseudo-R^2 of the models ranged from 90 to 94 percent. Standard model error ranged from 43 to 57 percent.

Floods have the potential to create devastating impacts to the economy, infrastructure, and the landscape. Keeping both the flood-frequency analyses at streamgages and the regression equations used to compute flood-frequency at ungaged locations updated on a publicly accessible web interface such as StreamStats (https://water.usgs.gov/osw/streamstats/) provides water-resource managers with critical information for flood-response planning. By broadening the regional approach from parts of States to larger regions that cross State lines, flood-frequency estimates have the potential to be more accurate than previously possible and are applicable to a larger study area. Lastly, providing the tools to delineate drainage basins, compute basin characteristics, and compute AEP flows on StreamStats allows a user to select a site of interest and obtain flood information for the site at any time.

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