ESTIMATING MAGNITUDE AND FREQUENCY OF FLOODS USING THE PeakFQ PROGRAM

FLOOD-FREQUENCY ANALYSIS

Flood-frequency analysis provides information about the magnitude and frequency of selected flood discharges. Frequency commonly is expressed in terms of exceedance probability (a dimensionless number ranging from 0 to 1.0) or as a recurrence interval (the reciprocal of exceedance probability) in years (table 1). Flood-frequency information is important for defining flood-hazard areas; for managing floodplains; and for designing bridges, culverts, dams, levees, and other structures.

Flood-frequency analysis commonly is performed on records of annual maximum instantaneous peak discharges collected systematically at streamflow gaging stations. Bulletin 17B of the Hydrology Subcommittee of the Interagency Advisory Committee on Water Data (1982) defines procedures recommended to provide a consistent approach for determining flood-flow frequency from peak-flow records. The procedures include methods for improving skew estimates using regional skew information, tests for high and low outliers, adjustments for low outliers and zero flows,

and incorporating historic peak-flow information. Historic peaks are noteworthy events occurring before, after, or between periods of record collection.

PROGRAM PeakFQ

The Peak flow FreQuency analysis program (PeakFQ, Flynn and others, 2006) implements the Bulletin 17B recommended procedures for flood frequency analysis of streamflow records (Kirby, 1981). PKFQWin provides an interactive Windows interface to PeakFQ. PKFQBat provides a command-line interface to PeakFQ for batch-style processing on DOS, UNIX, and Linux operating systems.

PeakFQ INPUT OPTIONS

Three types of input files are supported by PeakFQ. The annual peaks may be in standard WATSTORE text format or in a Watershed Data Management (WDM) file (Flynn and others, 1995). An optional program specification file (.psf) can be used to identify the file containing the peaks and to specify processing options.

Table 1. Exceedance probabilities and associated recurrence intervals.

Annual exceedance probability	Recurrence interval (n-year flood)
0.6667	1.50
0.50	2.00
0.4292	2.33
0.20	5.00
0.10	10.00
0.04	25.00
0.02	50.00
0.01	100.00
0.005	200.00
0.002	500.00

PeakFQ OUTPUT OPTIONS

Program PeakFQ provides estimates of flood magnitude for ten annual exceedance probabilities and their corresponding recurrence intervals (table 1.) The output file also provides the logarithmic mean standard deviation, and skew for both the annual peaks and the Bulletin 17B estimate.

PeakFQ can provide a graph with the Bulletin 17B and systematic frequency curves, the systematic peaks, and confidence limits (fig. 1.) *See Bulletin 17B for a detailed explanation of the graph components.*

Bulletin 17B guidelines:

- Fit logarithms of annual peak discharges to a Pearson Type III distribution using the method of moments to compute mean, standard deviation, and skew of the log-transformed data.
- Improve skew estimate by averaging it with a regional skew estimate obtained from Bulletin 17B or other source. Weight station and generalized skew to reflect relative accuracy.
- Test to identify high and low outlier limits and screen data against them.
- Adjust for low outliers, zero flows, and below gage base peaks based on conditional probability techniques.
- Incorporate historic or paleoflood information using historically weighted moments approach.
- Compute confidence limits.
- Graph frequency curves.
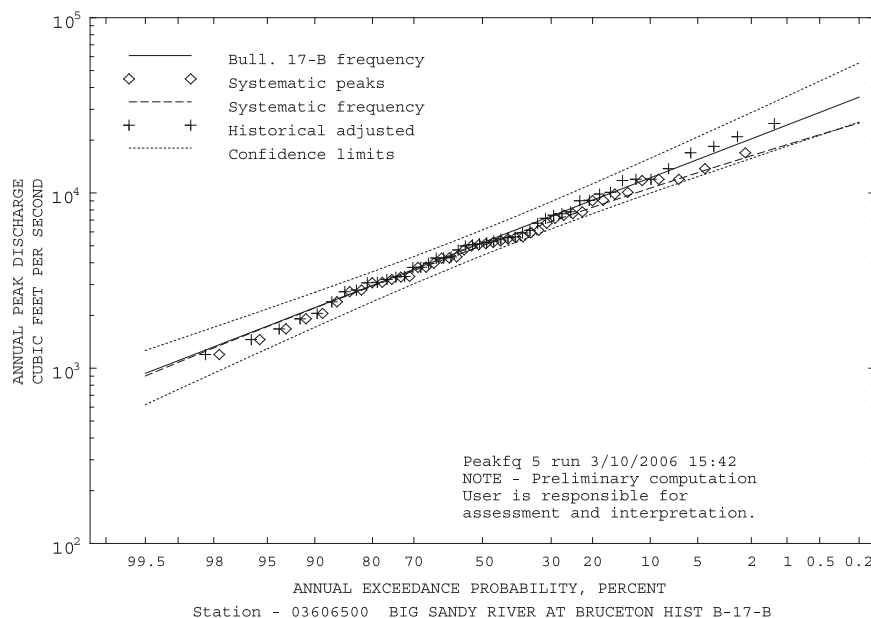- Use other approaches as appropriate and justified.

Figure 1. Example of PeakFQ probability graph of annual peaks, frequency curves, and confidence limits.

Using PKFQWin

PKFQWin is launched by double-clicking on the PKFQWin icon on the desktop or by selecting USGS and then PKFQWin under Programs in the Windows Start menu. The File pull-down menu at the top of the window (fig. 2) contains options to *Open* an input file, *Save Specs* to a .psf file, or *Exit* the program. The main window contains three tabs. The *Stations Specification* tab and the *Output Options* tab become active once an input file has been identified and read. The *Results* tab becomes active after the *Run PeakFQ* button has been selected.

The *Station Specifications* tab is populated with data read from the file of peak flows and, if used, the .psf file. Default values are used for parameters not specified in the input files. The shaded columns are informational and cannot be modified. Values in the white columns can be modified as appropriate for the analysis.

The *Output Options* tab is used to specify file and graphics output choices and to name the text output files. The *Run PeakFQ* button runs the analysis.

The *Results* tab becomes active after the analysis has been completed and provides access to the text output file and the plots generated by the analysis.

The *Save Specs* button at the bottom of the window is used to save the specifications and output options to a program specification file (.psf). A .psf file can be edited and used as an input file to rerun the analysis, facilitating evaluation of different parameters.

The Help pull down menu at the top of the window contains three options: *About* returns the program version number, *Send Feedback* captures the program and system state and e-mails this information to the developers to help identify problems, and *PKFQWin Help* opens the user's guide as a Windows help document.

Using PKFQBat

PKFQBat provides a batch-style interface to PeakFQ and accommodates the analysis of a single station or many stations. The program is launched from the command line and includes all of the analysis and output options found in the PKFQWin version.

Software, Data Sources, and Additional Information

The PeakFQ program and documentation and other hydrologic analysis software is available at: *http://water.usgs.gov/software/* .

USGS peak flow data can be retrieved in the WATSTORE text format at: *http://nwis.waterdata.usgs.gov/usa/nwis/peak* .

For information on local USGS flood frequency studies and research, contact the USGS Water Science Center Director for the area of interest; a list is available at: *http://water.usgs.gov/district_chief.html* .

References:

Flynn, K.M., Hummel, P.R., Lumb, A.M., and Kittle, J.L., Jr., 1995, Users manual for ANNIE, version 2, a computer program for interactive hydrologic data management: U.S. Geological Survey Water-Resources Investigations Report 95-4085, 211 p.

Flynn, K.M., Kirby, W.H., and Hummel, P.R., 2006, Users manual for PeakFQ, annual flood frequency analysis using Bulletin 17B Guidelines: U.S. Geological Survey Techniques and Methods Report Book 4, Chap. B4, 42 p.

Interagency Advisory Committee on Water Data, 1982, Guidelines for determining flood flow frequency: Bulletin 17B of the Hydrology Subcommittee, Office of Water Data Coordination, U.S. Geological Survey, Reston, VA., 183 p.

Kirby, W.H., 1981, Annual flood frequency analysis using U.S. Water Resources Council guidelines (program J407): U.S. Geological Survey Open-File Report 79-1336-I, WATSTORE User's Guide, v. 4, chap. I, sec. C, 56 p.

PKFQWin

File   Help

Use File menu to Open PEAKFQ data or PKFQWin spec file.   **PEAKFQ Data File: TEST2.INP**
Update Station and Output specifications as desired.
Click Run PEAKFQ button to generate results.   **PKFQWin Spec File:**

Station ID	Include in Analysis?	Beginning Year	Ending Year	Historic Period	Skew Option	Generalized Skew	Gen Skew Std Error	Mean Sqr Err	Low Hist Peak	Lo-Outlier Threshold	High Sys Peak	Hi-Outlier Threshold	Gage Base Discharge	Urban/Reg Peaks	Latitude	Longitude	Plot Name
03606500	Yes	1897	1973	0	Weighted	-0.5	0.55	0.3025	18500	0	17000	0	0	No	36.0386	88.2283	03606500
03606500	Yes	1897	1973	77	Generalized	-0.5	0.55	0.3025	18500	0	17000	0	0	No	36.0385	88.2283	03606500-1
01373500	Yes	1882	1968	0	Weighted	0.6	0.55	0.3025	4400	0	8800	0	0	No	41.5111	73.9486	01373500
06600500	Yes	1935	1973	0	Weighted	-0.2	0.55	0.3025	0	0	71500	0	0	No	42.5767	96.3119	06600500
06600500	Yes	1935	1973	82	Weighted	-0.2	0.55	0.3025	0	0	71500	70000	0	No	42.5767	96.3119	06600500-1
01614000	Yes	1929	1973	0	Weighted	0.2	0.55	0.3025	0	0	22400	0	0	No	39.5119	78.0375	01614000
11274500	Yes	1932	1973	0	Weighted	0.2	0.55	0.3025	0	0	10200	0	0	No	37.3169	121.128	11274500
11274500	Yes	1932	1973	0	Generalized	0.2	0.55	0.3025	0	0	10200	0	0	No	37.3169	121.128	11274500-1

Tabs: Station Specifications | Output Options | Results

Buttons: Run PEAKFQ   Save Specs   Exit

Figure 2. Station Specifications tab in main window of PKFQWin.