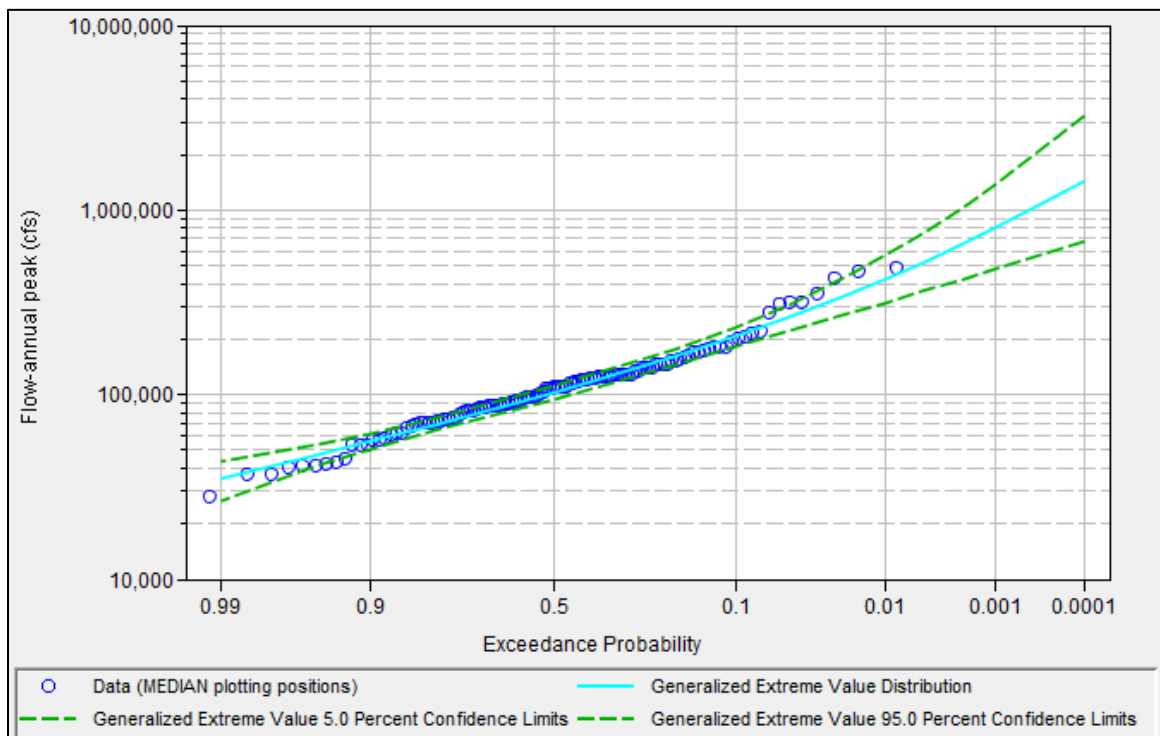




**US Army Corps
of Engineers**
Hydrologic Engineering Center

HEC-SSP

Statistical Software Package



Release Notes

Version 2.2

June 2019

Approved for Public Release. Distribution Unlimited.

Introduction

Version 2.2 of the Statistical Software Package (HEC-SSP) is now available. This version supersedes version 2.1.1 and all previous versions. The new version, released in June 2019, includes improvements to nearly all previously-released analyses, two new analyses (Distribution Fitting and Mixed Population), a redesigned Curve Combination analysis, and enhanced data usage and manipulation. These new features and options are discussed in the User's Manual for Version 2.2.

New Capabilities

The following paragraphs list the new capabilities that were added to HEC-SSP for version 2.2. A list of the bugs fixed between versions 2.1.1 and 2.2 can be found within the "Problems Repaired" section of this document.

General – Numerous enhancements to the user interface have been made in an attempt to improve the user experience when performing statistical analyses.

HEC Data Storage System (DSS) – The DSS library used by HEC-SSP has been upgraded to version 7. This upgrade allows HEC-SSP to read/write time series and paired data faster in addition to enhanced functionality within HEC-DSSVue, which is distributed with HEC-SSP. Users can access the built-in instance of HEC-DSSVue in addition to the study DSS file by clicking **Tools | HEC-DSSVue**.

Safemode – A safemode flag can be used during startup that will turn off the ***Load Last Project at Startup, Restore Layout, Automatic Saving at Defined Intervals, and Load Plugin*** options. To enable the safe mode start up, first ensure all instances of HEC-SSP are closed. Then, include the following line within the "**HEC-SSP.config**" file and restart HEC-SSP:

-safemode

Frames – In lieu of nested windows that cannot be moved independent of the main window, the Data Importer, editors for each analysis, and plotted or tabulated data have been converted to independent frames which can be moved, hidden, minimized, or maximized independently of the main window, as shown in Figure 1.

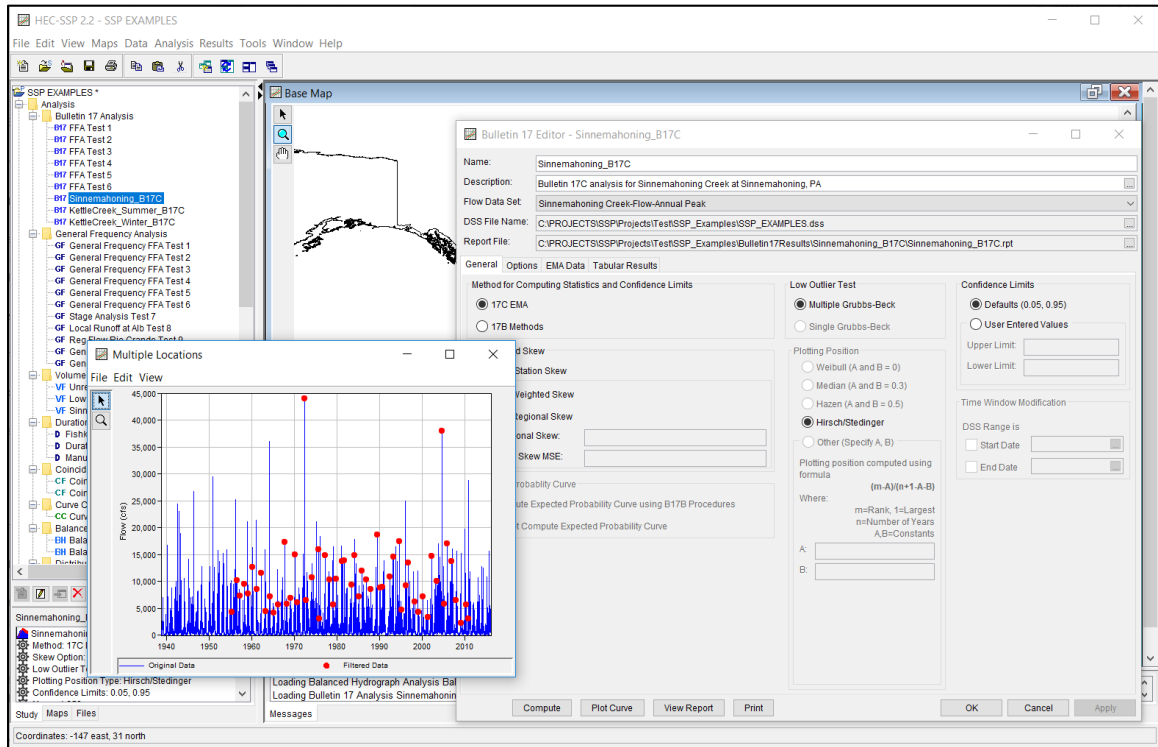


Figure 1. Independent Frames.

Data Import – The Data Importer has been enhanced to reduce unnecessary scrolling by users. Buttons, windows, and dialogs have been reformatted and moved to enhance the user experience when importing data.

Note: Use care when entering the A-, B-, C-, E-, and F-parts for a DSS record. These fields are meant to provide the user with a means to differentiate individual data sets. If more than one data set is created with a non-unique combination of A-, B-, C-, E-, and F-parts (i.e. they are all left blank), data may be overwritten/lost. This is analogous to using the Save As command and specifying a file name that is equivalent to an already-existing file.

Data Visualization – After data has been added to the study, it can be plotted, tabulated, and/or edited. Multiple data sets can now be selected and plotted together. For instance, if multiple streamflow annual maximum series for different locations are downloaded from the USGS website, they can both be selected and plotted in a single window/viewport with common x- and y-axes. Also, if the data sets utilize different dependent variables but share a common independent variable, they will be plotted in the same frame using a common x-axis but different viewports using different y-axes. For instance, if two annual maximum series and corresponding peak flow codes were downloaded from the USGS website, they can all be selected and plotted in a single window. This window will contain a single x-axis corresponding to the dates of the time

series. However, two viewports will be used: one containing the annual maximum series and another containing the peak flow codes, as shown in Figure 2.

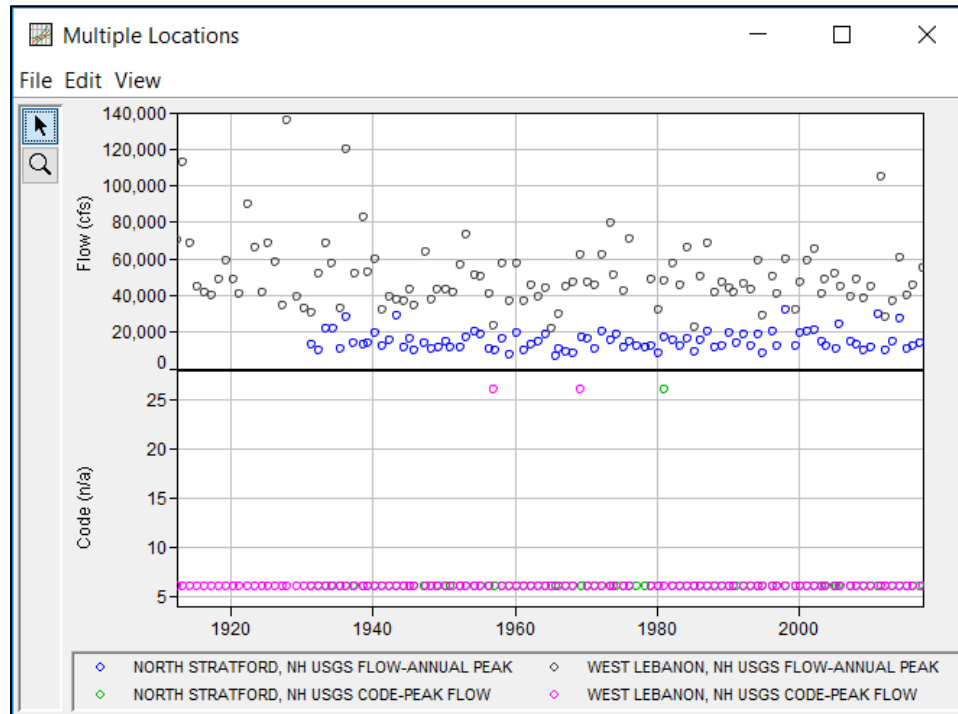


Figure 2. Visualizing Multiple Data Sets.

Data Filtering – After data has been imported into the study, the user can filter the original data set to another data set using one or more filters which can be “nested”. For instance, if the user has already imported a daily flow time series from the United States Geological Survey (USGS) website and wishes to extract an annual maximum series for the time period between 1955 and 2010 using a season spanning 01Apr – 30Nov, the ***Filter to Annual Maxima*** option can be used. The resulting annual maximum series will be comprised of peaks that occurred between 01Apr and 30Nov in each year between 1955 and 2010, as shown in Figure 3. Absolute time window, season, min/max threshold, annual maximum series, partial duration/peaks over threshold, and starting pool stage/elevation filters are available for use within the current version. For more information, see Chapter 4 within the ***HEC-SSP version 2.2 User’s Manual***.

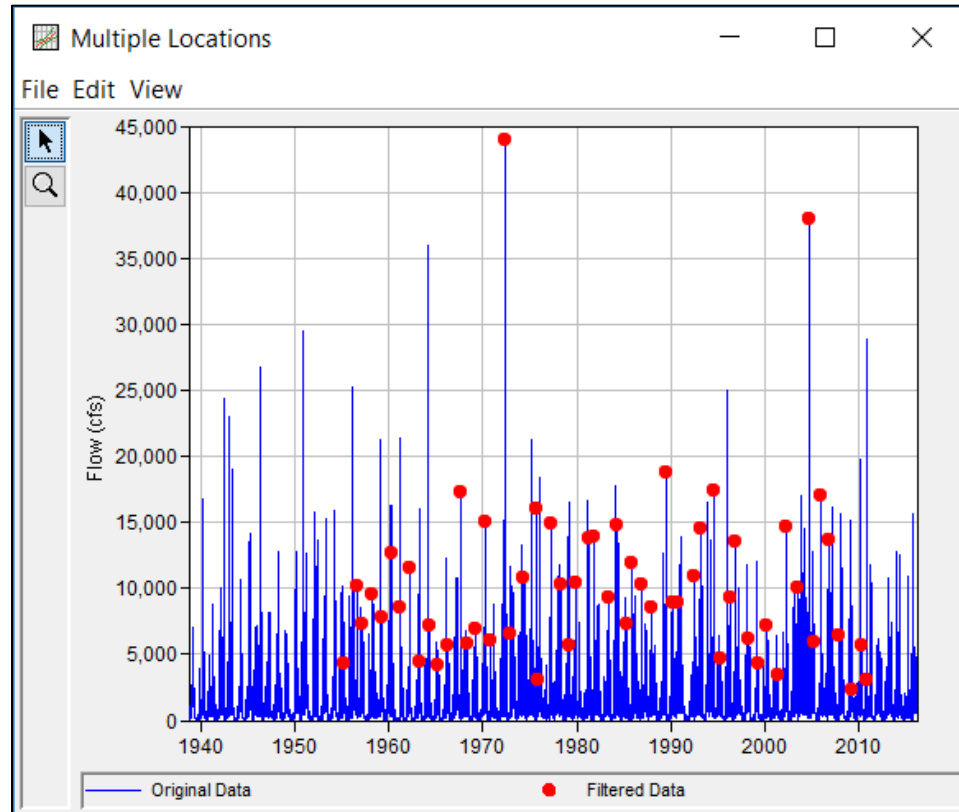


Figure 3. Original and Filtered Data.

Map Window – The Map Window has been enhanced to allow for a more intuitive experience. For instance, if imported data contains georeferenced coordinates, points corresponding to the X-Y locations will be immediately shown in the **Map Window**. The data can then be plotted and/or tabulated using right-click options. Additionally, various internet maps can be used to visualize the surrounding areas. Available maps include Google® Street Map, Satellite Map, and Terrain Map, Bing® Satellite Map, and Open Street Map, as shown in Figure 4. These maps can be accessed through the **Maps | Add Internet Map** option.

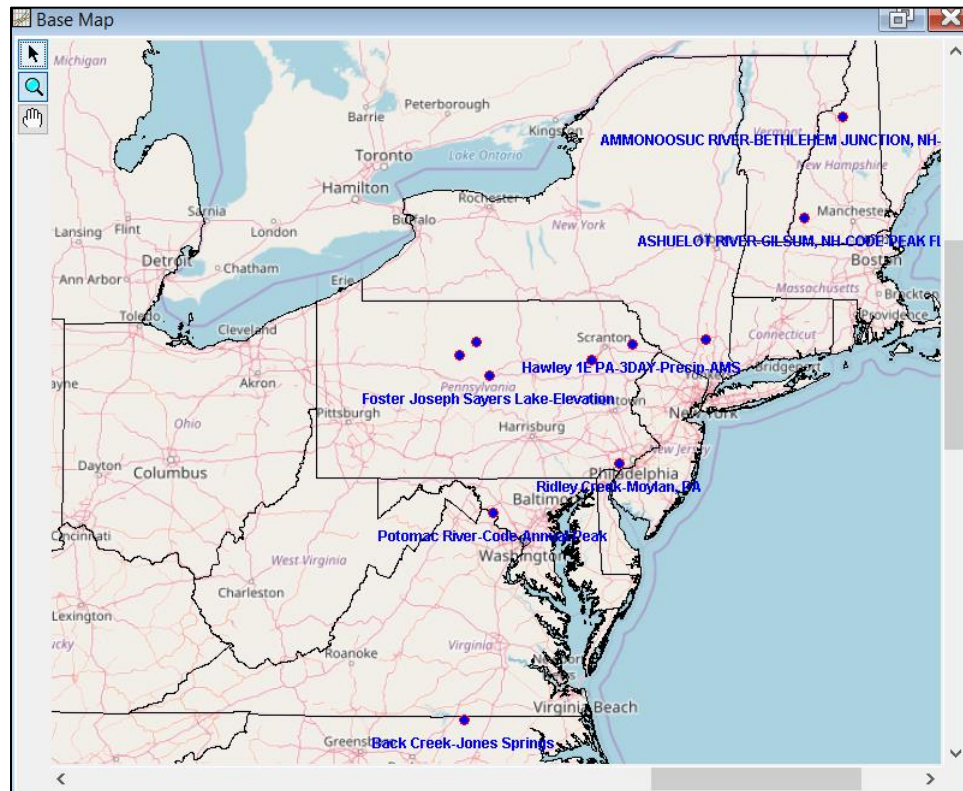


Figure 4. Georeferenced Data Sets and a Background Internet Map.

Bulletin 17 Analysis – This component of the software allows the user to perform an annual peak flow frequency analysis using the Log Pearson Type III (LPIII) analytical distribution. The current version of HEC-SSP allows the user to utilize two algorithms for fitting the LPIII distribution and computing annual peak flow frequencies. The first is contained within Bulletin 17B, which was published by the Interagency Advisory Committee on Water Data in 1982. The second algorithm is contained within Bulletin 17C, which was officially published by the USGS in March 2018.

Previously, the Bulletin 17C mathematical processes used within HEC-SSP were contained in a Fortran dynamic-link library (.dll) which was shared with the United States Geological Survey. Within HEC-SSP version 2.2, all of these processes have been converted to utilize the Java object-oriented language, upon which HEC-SSP is based. This allows for much greater flexibility in their usage, such as integrating these processes within the General Frequency and Volume Frequency analyses where the Log Pearson Type III distribution parameters can be overridden by the user. Enhanced graphical and tabular output are also possible due to this conversion.

While these changes have greatly improved the usability and tractability of the software, Bulletin 17 analyses created within previous versions, especially those created for paleoflood applications that spanned an extremely long durations (i.e. hundreds or thousands of years) may not function appropriately in the current version of HEC-SSP without adhering to certain steps. Please see the document titled

“How_to_update_your_old_B17C_analyses” for these steps. This document can be found on the HEC web site. We apologize for any inconvenience this may have caused. Also, due to slight dissimilarities in number formatting between the two languages, trivial differences in confidence limits computed using the new Java code may be experienced when compared against the results against older versions. These differences have been found to be on the order of 0.1%.

Finally, if USGS peak flow codes were imported to a study, they will no longer be selectable within Bulletin 17 and/or General Frequency analyses. This change was meant to prevent inadvertent selections of peak flow codes in lieu of the actual flow data that was intended. For more information, see Chapter 5 within the *HEC-SSP version 2.2 User's Manual*.

General Frequency Analysis – This component of the software allows the user to perform a generalized frequency analysis of hydrologic data including, but not limited to, flow, stage, and precipitation data. The user can choose between different analytical distributions or perform a graphical fit to the data.

Due to the previously mentioned Java conversion of the Bulletin 17C processes, users can now access all functionality within those processes in a generalized fashion. For instance, users can fit an LPIII analytical distribution to an annual maximum series using the Expected Moments Algorithm but then manually override the mean, standard deviation, or skew and recompute new confidence limits, variances, and flow rates for given probabilities.

Additionally, many different analytical distributions can now be fit to hydrologic data including Normal/log-Normal, PearsonIII/LPIII, Logistic/log-Logistic, Gamma, Gumbel, Exponential, 4-parameter Beta, Generalized Extreme Value, Generalized Pareto, and Generalized Logistic. Both the method of moments and linear moments (in addition to EMA for LPIII) can be used to fit the aforementioned analytical distributions. For more information, see Chapter 6 within the *HEC-SSP version 2.2 User's Manual*.

Volume Frequency Analysis – This component of the software allows the user to perform a volume frequency analysis of flow data across multiple durations. Both low and high flow analyses are possible in addition to analytically or graphically fitting a frequency distribution.

Due to the previously mentioned Java conversion of the Bulletin 17C processes, users can now access all functionality within those processes to systematically assess flow-frequency across different durations. For instance, users can fit an LPIII analytical distribution using the Expected Moments Algorithm to 1-, 3-, 5-, and 10-day duration annual maximum series that were extracted from a daily duration time series. Then, the mean, standard deviation, or skew parameters can be smoothed across all durations of interest and used to recompute new confidence limits, variances, and flow rates for given probabilities for all durations of interest. For more information, see Chapter 7 within the *HEC-SSP version 2.2 User's Manual*.

Curve Combination Analysis – This component of the software allows the user to combine and estimate a best-fit frequency distribution. Within version 2.0, user-defined weights for each input frequency curve were used to compute a best-fit distribution. Subsequently, this analysis was removed from HEC-SSP due to a change in recommended curve combination techniques. Within the current version, users can only utilize graphical techniques to define this best-fit distribution. For instance, users can input and visualize annual maximum series of reservoir stages in addition to peak reservoir stages realized when routing hypothetical frequency precipitation events for the upstream drainage area, balanced hydrographs constructed from peak flow- and/or volume-frequency curves. Then, a best-fit stage-frequency curve can be estimated using graphical techniques and the multi-point edit tool. For more information, see Chapter 10 within the *HEC-SSP version 2.2 User's Manual*.

Balanced Hydrograph Analysis – This component of the software allows the user to create hypothetical hydrographs that “balance” flow rates and/or volumes across either a single or multiple durations. Within previous versions of HEC-SSP, the user was required to either manually define the flow- or volume-frequency curve for a specified duration or choose and parameterize one of three analytical distributions (log-Normal, LPIII, or Generalized Extreme Value). Within the current version, the user can link to a Bulletin 17, General Frequency, or Volume Frequency analysis and import the results (once computed). For instance, users can define a balanced hydrograph using the 1-hour, 1-day, 3-day, and 10-day durations, link a Bulletin 17 analysis to the 1-hour duration and a Volume Frequency analysis to the 1-, 3-, and 10-day durations and import the results. As long as the Volume Frequency analysis was set up to compute a frequency curve for the appropriate durations, the correct results for each duration will automatically be imported. This modification was made in an attempt to decrease the amount of time necessary to set up a Balanced Hydrograph analysis in addition to reducing possible errors when transcribing results from one analysis to another. For more information, see Chapter 11 within the *HEC-SSP version 2.2 User's Manual*.

Distribution Fitting Analysis – This brand new component of the software allows the user to analyze time series or paired data in an extremely open and free environment. Any type of data stored in a DSS format (i.e. flow, stage, elevation, precipitation, wind speed, wind direction, etc) can be analyzed. Data can be filtered using one or many of the aforementioned filtering options, viewed using cumulative distribution, probability density, or time series plots, and statistics computed. Nineteen analytical distributions using two fitting methods can then be fit to the aforementioned data and visualized using cumulative distribution function (CDF), probability density function (PDF), probability-probability, quantile-quantile, or CDF-plotting position plots. The goodness of fit of each of the analytical distributions | fitting methods can also be assessed using one of two tests. Once a distribution is selected, confidence limits and expected probability curves can be computed, as shown in Figure 5. For more information, see Chapter 12 within the *HEC-SSP version 2.2 User's Manual*.

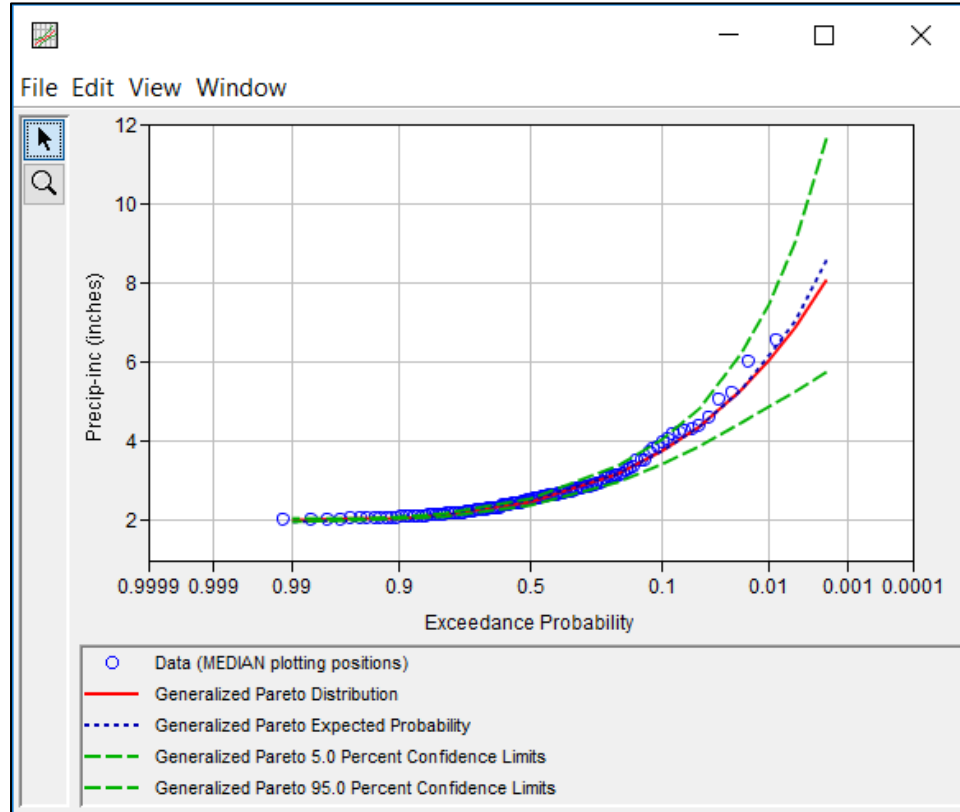


Figure 5. Plot of Data and Selected Distribution.

Mixed Population Analysis – This brand new component of the software allows the user to combine multiple frequency curves (that are representative of different causal mechanisms) using the probability of union concept to compute a frequency curve that reflects the occurrence of more than one type of flood in a year. For instance, users can combine rainfall-only, rain-on-snow, and snowmelt-only flow-frequency curves into a single flow-frequency curve, as shown in Figure 6. Treating multiple flood types as separate, independent, identically distributed samples of floods of a particular cause allows for examination of the frequency of floods per type of flood. For more information, see Chapter 13 within the *HEC-SSP version 2.2 User’s Manual*.

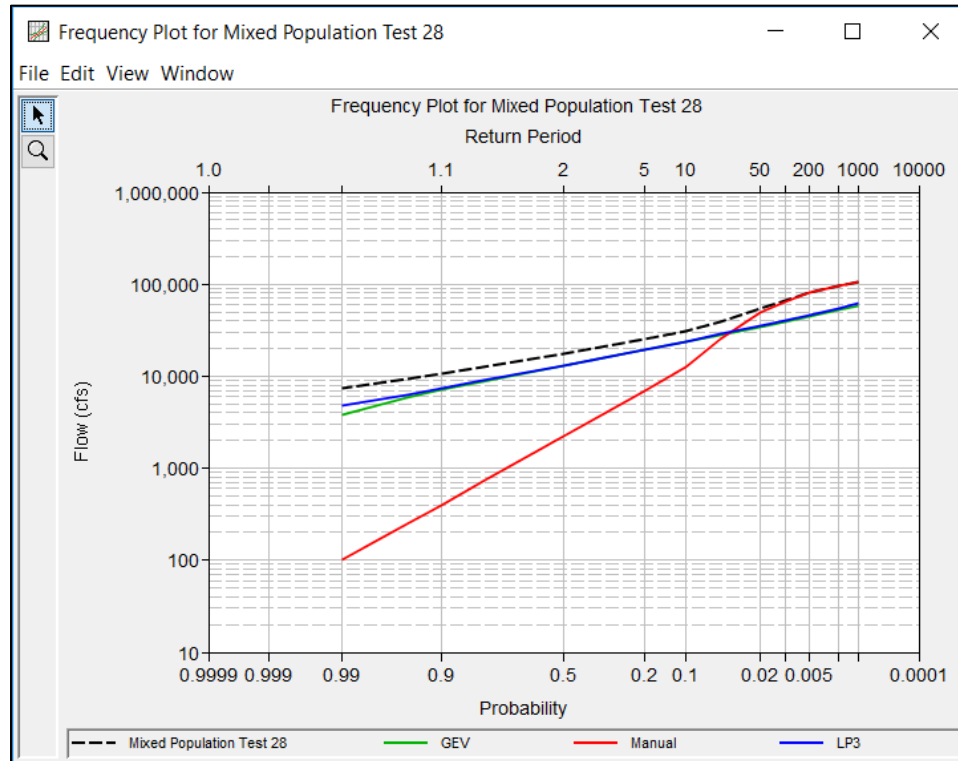


Figure 6. Mixed Population Results.

Installation

The installation program and all documentation are available on the HEC web site at <http://www.hec.usace.army.mil/>. This new release is installed independently of any previous versions of the program so you will need to remove Version 1.0, 1.1, 2.0, or 2.1 if you do not want to use these versions anymore. However, you may keep different versions of the program installed for parallel use or testing if you choose to do so. This new version will automatically open projects developed with any previous version of the program. However, once a project has been opened in Version 2.2, **it may not be possible to open it with older versions of the program.**

The new installation package is designed to be easy to use. It will take you through the steps of selecting a directory for the program files and making other settings. Use the following steps to install the program on the Microsoft Windows® operating system:

1. Download the installation package from the HEC website to a temporary folder on the computer.
2. Run the installation program. In Windows Explorer, double-click the icon for the installation program. You must have administrator privileges to run the installer.
3. Follow the on-screen prompts to install the program.

Documentation

The Statistical Software Package HEC-SSP: User's Manual contains extensive information on installing and using the program. Details on the use of each feature and capabilities in the program are included. The manual was updated with information describing new features added to the program for the Version 2.2 release.

Problems Repaired

The development team continues to test the software and respond to program errors even after a new release is made. The following is a list of major bugs that were found in HEC-SSP version 2.1.1 and earlier that were fixed for version 2.2. Numerous other small bugs have been found and fixed but are not listed here:

1. Summary Reports (accessed through the Results | Summary Report menu option) were sometimes displaying different statistics and quantile information than what was shown within the Tabular Results tab of the analysis in question. This has been fixed within version 2.2.
2. Modifications to the analysis order within the study tree were not being maintained through study close and open. This has been rectified within version 2.2.
3. In previous versions, the minimum number of events needed to compute an analytical frequency analysis was 3. Within version 2.2, at least 10 systematic/historical events are needed to compute a Bulletin 17, General Frequency, or Volume Frequency analysis.
4. Within a Bulletin 17 Analysis, the Right-Click | Save As option did not save all manually entered data. Now, when performing a save as operation on an analysis that contains manually entered data, the data will be maintained through the Save As option.
5. Annual maximum series versus partial duration series within Bulletin 17 analyses:
 - a. When using Bulletin 17B techniques, the analysis assumed the user had screened their input to include only one value per water year. The computations treated the input as an array upon which the mean, standard deviation, and skew were computed (using Bulletin 17B techniques). Then analysis did not check if a data set with more than one value per water year was provided; it still would fit the LPIII distribution to the input values and report the results.
 - b. When using Bulletin 17C techniques, the **EMA Data** tab screened the input data set to only allow one value per year to be displayed in the **Flow**

Ranges table. However, when attempting a compute, if more than one value existed in a given water year, the second and subsequent values were not assigned a valid data type (either systematic, historical, or censored).

- c. To keep problems like this from arising, a data validation check within Bulletin 17 analysis has been instituted. If the selected data set is found to contain more than one value in any given water year (which is assumed to be from 30Sep – 01Oct), an error message will be displayed informing the user that this is not allowed within a Bulletin 17 analysis and the compute will halt. *If users wish to analyze a partial duration series or demarcate the water year as something other than 01Oct – 30 Sep, this can be accomplished within the General Frequency analysis and/or the Volume Frequency analysis.*
6. Within certain Bulletin 17 analyses that utilized Bulletin 17C techniques, especially paleoflood applications utilizing data sets that spanned extremely long durations (i.e. hundreds or thousands of years), data types were occasionally set to “SYST” (i.e. systematic) when they should have been set to “CENS” (i.e. censored). This caused erroneous results. The **EMA Data** tab has been redesigned to ensure this does not occur. However, old analyses (from v2.1 and v2.1.1) may need to be recreated to make use of these enhancements within version 2.2. Please see the document titled “How_to_update_your_old_B17C_analyses” for these steps. This document can be found on the HEC web site.
7. Within Volume Frequency analyses, users were not notified when, for a certain year, flow for duration X is greater than flow for duration Y when $X < Y$. This check has been added to version 2.2 and users will now be notified if/when this condition occurs. However, this was only a messaging bug and no changes to computations are expected.
8. Within Volume Frequency analyses that utilized data with large gaps in coverage, if the flows for a given water year for duration X were not missing but flows for the same water year for duration Y were missing, an uncaught exception was being thrown and the Volume Frequency analysis would not be accessible once closed. For example, if the 3-day duration was not missing any peaks for water years 1940 through 2010 but the 120-day duration was missing two peaks for the same time period, an uncaught exception would be thrown and not handled appropriately. Within version 2.2, this uncaught exception has been remedied and will not cause the user to lose and functionality.
9. When computing a Duration Analysis using the Bins method with user-defined bins, if the bin with the greatest value was equal to or less than the largest value in the linked data set, an error was generated with an unclear description. This error description has been improved within version 2.2.

10. Balanced Hydrograph analyses could not be placed within a folder. All analyses can now be dragged and dropped within a folder.
11. The pointer and magnifying lens tools were not present within the Balanced Hydrograph plot. These have been added within version 2.2.

We apologize for any inconvenience the aforementioned issues may have caused. While HEC does not provide technical support for this software to non-USACE users, we will respond to all documented instances of program errors. If you encounter a problem, then please take the time to send us a bug report. The report must be written and should be submitted directly to the HEC-SSP team at: hec.ssp@usace.army.mil. The bug report should include the following information:

1. Contact Information: Name, Phone, and E-mail address.
2. What version of the software are you using?
3. What operating system are you using?
4. An explanation of the problem.
5. If the problem is reproducible, please list the steps required to cause it. (Example: "1. Create a new file. 2. Insert some text ...")
6. If the problem is not reproducible (only happened once, or occasionally for no apparent reason) please describe the circumstances in which it occurred and the symptoms observed (note: it is much harder for us to diagnose and fix non-reproducible bugs).
7. If the problem causes any error messages to appear, please write down the exact text displayed.

Note: Please attach your data files if possible. This will assist in debugging the problem. If you have any suggestions or ideas for enhancing HEC-SSP, please e-mail your suggestions to hec.ssp@usace.army.mil.

Thank you for using HEC-SSP!