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Flood Protection and Management for the Lower Illinois River System

Phase III: Real-time Simulation of Floods with Managed LDD Storage Options

by

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Office of Water Resources
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Illinois State Water Survey
Watershed Science Section
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A Division of the Illinois Department of Natural Resources

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ABSTRACT

This report documents the structure and the use of an improved version of the Windows-based interface of the unsteady flow model, UNET. This interface was developed by the Illinois State Water Survey for the Office of Water Resources, Illinois Department of Natural Resources. The current version of the interface program can download historic, real-time, and forecasted stage and flow data from U.S. Geological Survey, U.S. Army Corps of Engineers, and National Weather Service Web sites interactively. These data can be used to update an existing Data Storage System (DSS) database or to create new ones.

The interface allows the user to create or update gaging station information in a Microsoft Access database. The user can create project files to run the UNET model for historic, design, real-time, and forecasted flood events. The graphing function allows plotting of single and multiple hydrographs, or stage profiles of a single reach and multiple reaches. The utility tools include screen captures, document editing, and DSS file editing. This interface program uses the original UNET geometry and boundary condition files to maintain the same level of accuracy as the UNET model.

Real-time simulation of a flood event simulates flood stage profiles using real-time stage and flow data downloaded from related Web sites. Locations and magnitudes of levee overtopping will be displayed for the lower Illinois River should these occur. The interface program lets the user modify parameters to simulate simple levee failure or two types of complicated embankment failures, overtopping and piping. Simulations also can be performed using the modified levee information, such as breaches or revised crest elevations. The change of water surface elevation induced by modifying levees can be compared with another simulation graphically and also in table format. Stage profiles from all simulations can be plotted together with levee heights on both sides of the channel along the Lower Illinois River to visually show the impacts of particular floods.

INTRODUCTION

Floodplains of the Lower Illinois River from Peoria to Grafton have been claimed for agricultural purposes through the construction of Levee Drainage Districts (LDDs) between 1879 and 1916 (Thompson, 1989). Levee heights have been a concern because levees can increase river stages and also the frequency of levee overtopping. Current heights reportedly provide protection at flood magnitudes of 20- to 50-year return intervals (Singh, 1996; USACOE, 1994) for different LDDs.

These levees were built along the main channel. Evidence has shown that levee alignment can affect the flood elevations (Hall, 1991); therefore, the actual level of protection the levee system can provide is unclear. In addition, observations also indicate a trend of increased flood heights since 1970 (Singh, 1996), further compromising the protection levels provided by the levees. During the 1985 flood, for example, the stage exceeded top elevations of levees at Globe, Coal Creek, Lost Creek, and South Beardstown LDDs between Kingston Mines and Meredosia; during the 1993 flood, levees at Nutwood, Eldred, Hillview, Hartwell, and Spankey were overtopped/breached (USACOE, 1994). Because floods have produced devastating damages and trauma, there is an urgent need to develop improved management plans and flood protection strategies for the Lower Illinois River.

Since 1995, the Illinois State Water Survey (ISWS) has conducted several projects related to unsteady flow modeling of the Lower Illinois River, as sponsored by the Office of Water Resources, Illinois Department of Natural Resources. Singh (1996) examined stage and flood frequencies and the Mississippi backwater effects; Akanbi and Singh (1997) validated the one-dimensional unsteady state flow UNET model for the La Grange and Alton Pools of the Lower Illinois River for large flood events; Akanbi et al. (1999) evaluated managed flood storage options using the Lower Illinois River UNET model constructed by Akanbi and Singh (1997); and Soong and Lian (2001) extended the Lower Illinois River UNET model to include Pool 26 of the Mississippi River and calibrated the model with real flood events. Studies of managed LDD options for flood reduction showed that peak stages near Meredosia could be reduced by more than a foot using a combination of LDDs converted to flood storage areas. If the Lacey, Langellier, W. Matanzas & Kerton Valley, and McGee Creek LDDs were converted to provide managed storage areas, the additional area protected against a 100-year flood could reach 65,262 acres upstream of River Mile (RM) 43.2. Levees downstream of this section would have to be raised 1-3 feet to protect them against a 100-year flood caused by backwater from the Upper Mississippi River. Note these results were derived according to design floods. Lian et al. (2001) developed a Windows-based interface that downloads real-time stage and discharge data from the U.S. Geological Survey (USGS), U.S. Army Corps of Engineers (USACOE), and National Weather Service (NWS) Web sites; creates or updates the Data Storage Database (DSS); executes the UNET model; and post-processes model outputs.

The UNET program (Barkau, 1995) is appropriate for the proposed work because it solves the full dynamic wave equation and has adopted many routings for the levee system and other complex channel-floodplain geometries. The new version of HEC-RAS 3.0 has incorporated many UNET model functions, and it is easy for visualization and editing of geometry data. However, the program cannot simulate levee breaching in the real-time mode and does not have the full capabilities of the generic UNET program. Therefore, the UNET model will continue to be used for this study.

The new version of the Windows-based interface uses a project file to hold required input and output files for the UNET program. It allows the user to create or update gaging station information within a Microsoft Access database, download historic, real-time, and forecasted stage and flow data from USGS, USACOE, and NWS Web sites, and to save data into a DSS database. Forecasted stages can be entered manually if not downloaded correctly at critical stations. The user can execute the UNET program with the project file or use this program to just run the UNET model. The input and output DSS data, such as stage and discharge hydrographs and water surface elevation profile along a reach and along the Lower Illinois River, can be visualized selectively. With existing levee profiles plotted, together with the simulated water surface elevation profile, the model can identify potential locations of levee overtopping and magnitudes of overtopping. This program has utility tools for screen captures, document editing, and DSS database editing. It also allows the user to access other Web sites for current weather conditions, real-time stage and discharge hydrographs, and forecasted stages. This report documents the structure of the Windows-based interface and instructs users in model use.

Acknowledgments

This study was supported by the Office of Water Resources (OWR), Illinois Department of Natural Resources (IDNR). Mr. Gary Clark and Mr. Robert Dalton, both of OWR, provided information and many helpful suggestions during the project. Mr. Clark also served as the project manager. Ms. Karla Andrew programmed some components of the interface program. Ms. Eva Kingston edited the report, and Ms. Linda Hascall prepared final graphs for the report. Ms. Cathy Truong, a junior from the Department of Mathematics at the University of Illinois at Urbana-Champaign, checked and updated the DSS database for the UNET model. The authors also would like to thank Dr. David T. Soong, U.S. Geological Survey in Urbana, for his comments on the project.

The views expressed in this report are those of the authors and do not necessarily reflect the views of the sponsor or the Illinois State Water Survey.

STARTING THE PROGRAM

After successful installation of the Windows-based interface program (Appendix A), the real-time icon will appear in the startup program menu. Click on ***Real-Time*** to start the program. Figure 1 shows the startup screen with empty file boxes.

The current version uses project files, which are text files with a “prj” extension. It holds the project title, file names of input DSS database, cross-sectional data (CS) files, boundary condition (BC) files, output DSS file, a CS log file, and a BC log file for the UNET simulation. The user can choose to open a pre-constructed project file (Figure 2) or start a new project. A new user is advised to start a new project and then use the browse buttons beside the file boxes to select appropriate files or to type in the file names from the working directory. The user also is advised to type in the project title, although it is not required. The user then can select “**Save As**” under “**File**” and choose a name to save the project. This project file can be opened for use later. The window will look like Figure 3 when an existing project file is opened or a new project file is created. The working directory name also is shown at the bottom of the window.

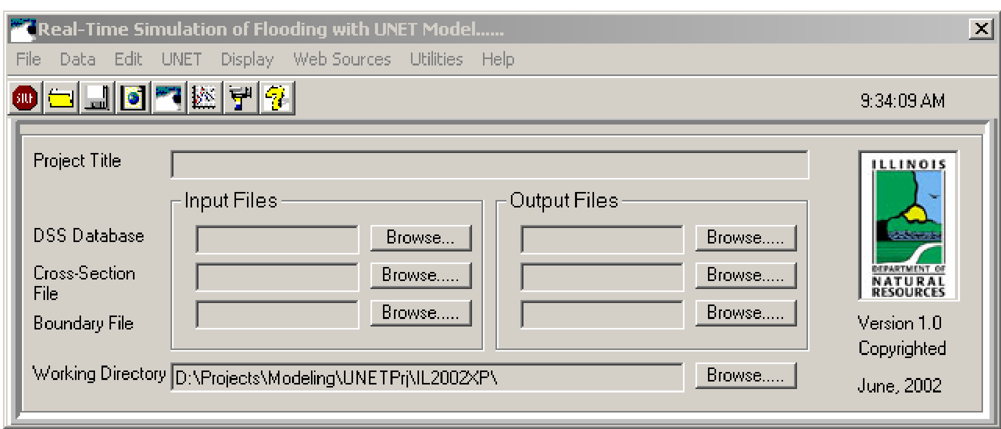


Figure 1. The opening screen of the Windows-based interface

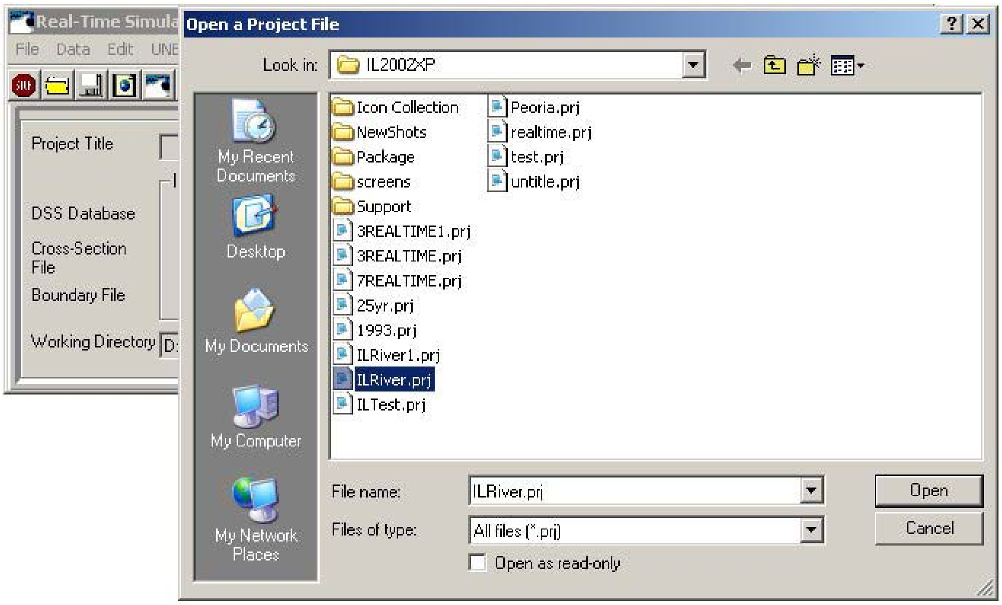


Figure 2. The opening screen for a project file

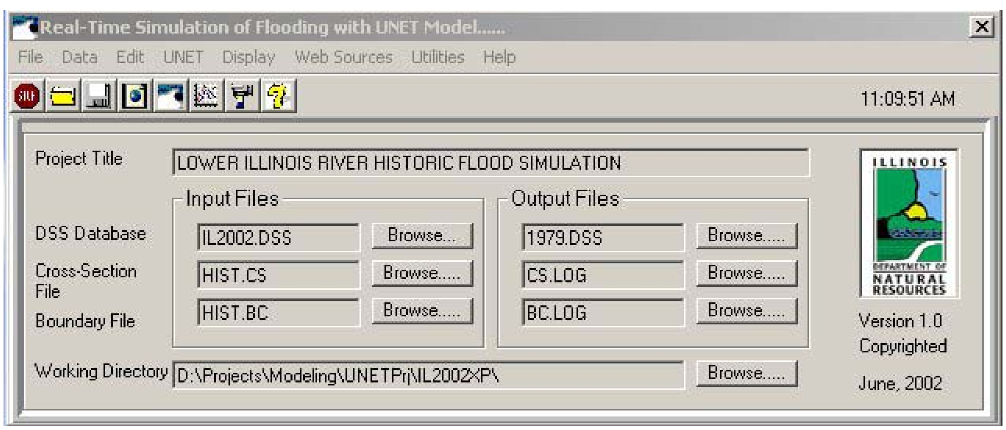


Figure 3. The opening screen for an existing project

PREPARING DATA

Downloading Data

Historic, real-time, and forecasted stage and discharge data can be downloaded from several Web sites. These data can be used to update an existing DSS database (for example, historic data of stage and discharge gaging stations on the Lower Illinois River and its tributaries, and Pool 26 of the Mississippi River and its tributaries) or to create a new DSS database. Gaging station information is stored in a Microsoft Access database named “Real-Time.mbs”.

The user can update or modify that information through Microsoft Access or by opening the database file as shown in Figure 4.

Downloading Historic Data

The window shown in Figure 5 was set up to download the stage and discharge from USGS and USACOE Web sites. Most USGS gaging stations measure discharges while most USACOE stations measure stages. **Note**: historic data for the USACOE St. Louis District are not available online.

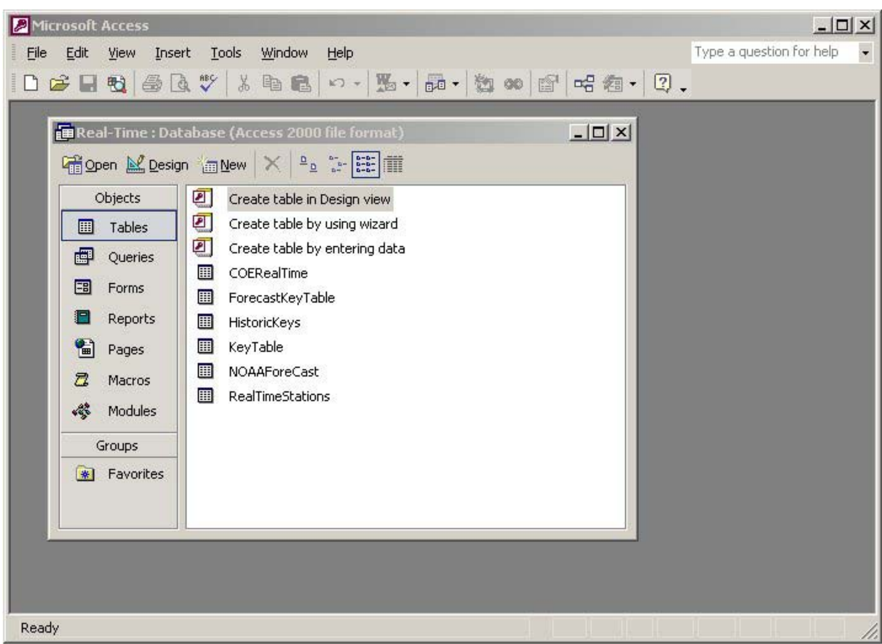


Figure 4. Modifying the gaging station information database

The user selects ***Data***, ***Download Stage and Flow Data***, and then ***Historic Data*** in the main window. A sub-window (Figure 5) will appear with a list of gaging stations (Appendix B). The user presses the ***Select All*** button or manually selects one or more stations in the list (moving the scroll bar to see more stations). The default end date is the current date, and the start date is three days earlier. The user can change both the start date and end date for downloading. (**Note**: USGS historic data are recorded for the water year). In most cases, data for active stations only date back to the previous September.

After stations have been selected and dates are set, clicking on ***Download*** starts downloading. A progress bar will appear, and the panel at the bottom of the window will show the gaging station for which data are being downloaded. Error messages will appear in the fourth box of that panel if data are not available. The error also will be written to a warning file that can be viewed in any text editor or through the ***View Errors*** button that will appear if errors are present.

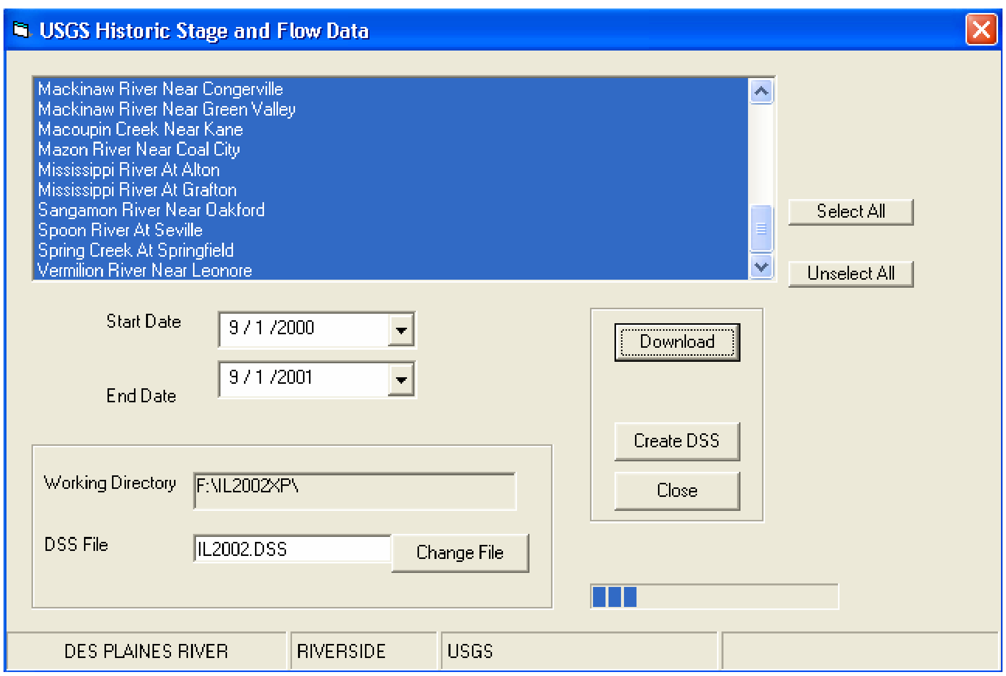


Figure 5. Downloading historic stage and flow data

Downloaded data are saved in an ASCII file that can be used to update or create a new DSS database. The DSS file named on the screen will be written to the update file. The user can name a new DSS database so the program creates a new DSS database from the downloaded data or update a database if the file already exists. The user must close the window after completing all tasks.

Downloading Real-time and Forecasted Stage or Discharge Data

The second option for data downloading is the real-time or the forecasted data (Figure 6). Most functions are the same as in the historic data download window (Figure 5), but the user can select locations (Appendix C) to download. Checking boxes provides a list of stations in the window. These stations will change depending on the location selected. Stations are listed only if data are available from that location for that station. The user then can select all stations with the ***Select All*** button or manually select or deselect a particular station. It is recommended that real-time and forecasted data be saved to a new DSS database file that will be used for real-time simulation of forecasted floods. **Note:** Discharges from some tributaries are extrapolated for five more days by assuming the discharges remain the same as those for the current day.

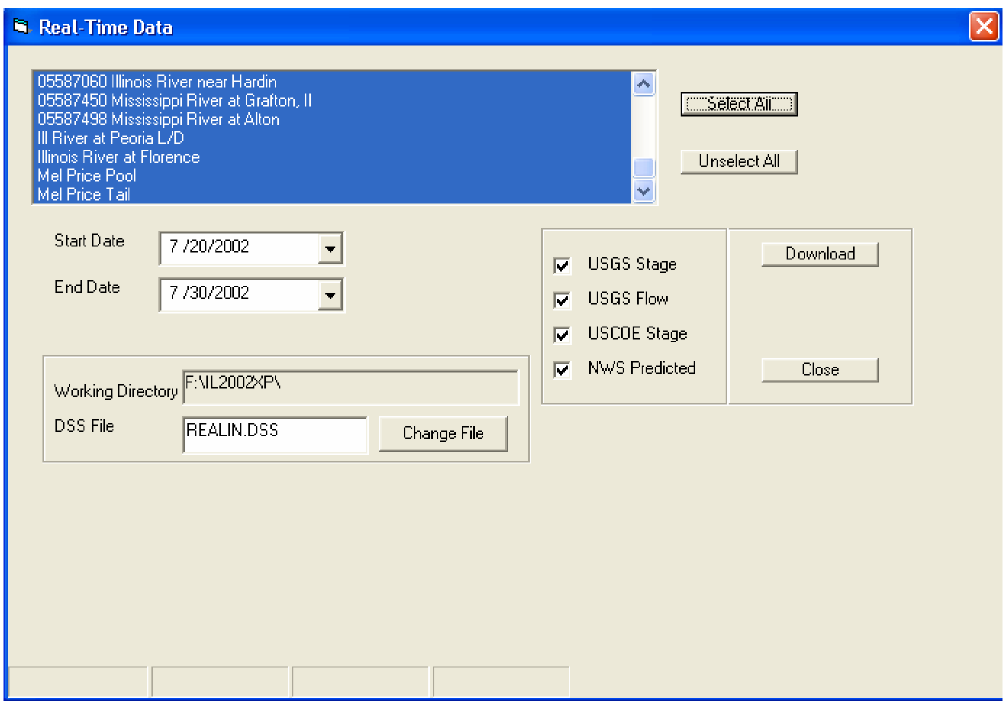


Figure 6. Downloading real-time stage and flow, and forecasted stage data

Editing Geometry and Boundary Condition

The UNET program requires the geometry cross-section (CS) file and the boundary condition (BC) file together with the DSS database file. Two modules have been developed to modify existing files or to create new CS and BC files. Both are still in preliminary stages, however. Shown in Figure 7 is an opened existing CS file with two selection boxes on the top left of the window. The user can select a reach from the top box and then the cross section, which is indicated by river mile. The ground elevation (GR) and other information such as Manning roughness (NH or NC card), X1 card will be displayed in the grid boxes. Cross-sectional GR data are plotted in the top right corner. The user can change the number in any grid cell by double clicking on the cell of interest, typing in the number, and then clicking anywhere but the cell to make the change effective. The user then can click **Update and Exit** to confirm changes or simply click on **Close** to quit without making any change to the CS file.

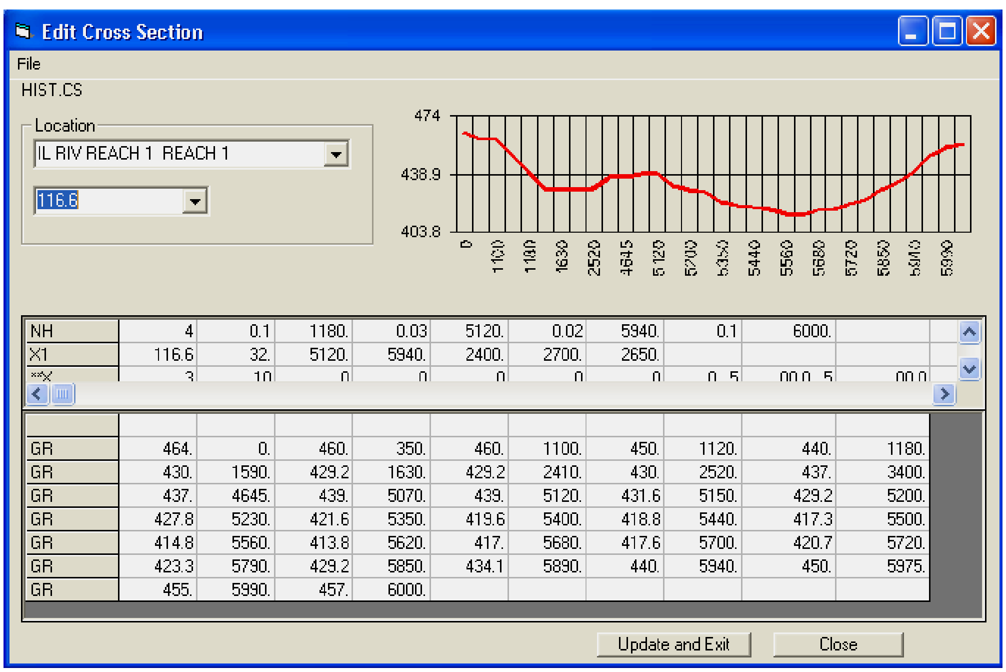


Figure 7. Modifying a cross-sectional file

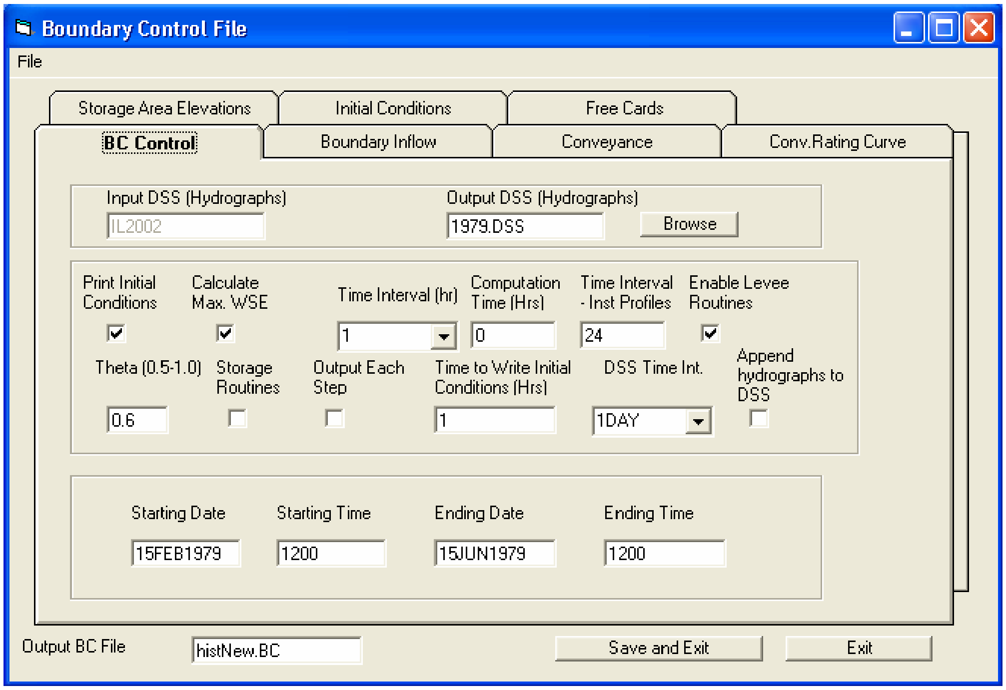


Figure 8. Modifying a boundary condition file

Figure 8 displays data for an existing BC file with seven tabs for BC control, boundary inflow, conveyance, conveyance rating curve, free cards, storage area elevations, and initial flow condition. The user may change the number in the grid cell or text boxes by typing in desired information.

MODELING WITH UNET

The UNET program was designed to simulate historic, design, and real-time flood events. Simulations can be performed under existing or modified levee conditions for management purposes or scenario studies. The interface is designed to execute the generic UNET program without any change to UNET model structure and functionalities. Thus, the results preserve model credibility and accuracy.

Levee Options

The UNET model can simulate levee breaching by simple failure and by embankment failure. Simple failure applies to the simple spillway concept in which the available storage area receives the flow from the channel by a linear routing factor. Embankment failure simulates failure by overtopping or by piping.

Simple Levee Failure

The UNET model simulates simple embankment failure on a simple spillway similar to the illustration in Figure 9. A levee is viewed as an offline area. Initially, the storage is dry. Levee storage starts to fill when the river stage exceeds a preset elevation at the breach. The rate of flow, $Q(t)$, into the storage area at a specified time t is determined by the total available storage and a simple routing factor with the unit of time^{-1} (hour^{-1}) as follows:

$$Q(t) = k\Delta V(t)$$

where ΔV is the levee storage available to be filled and k is a linear routing factor, defined as the fraction of the total available storage volume per hour. The user can define an elevation-volume rating for the storage areas. The current UNET model allows up to 20 incremental elevation-volume points for levee storage.

If the river stage still overtops the embankment after levee storage is full, then the overflow is distributed along the length of the embankment and the breach is ignored. When the

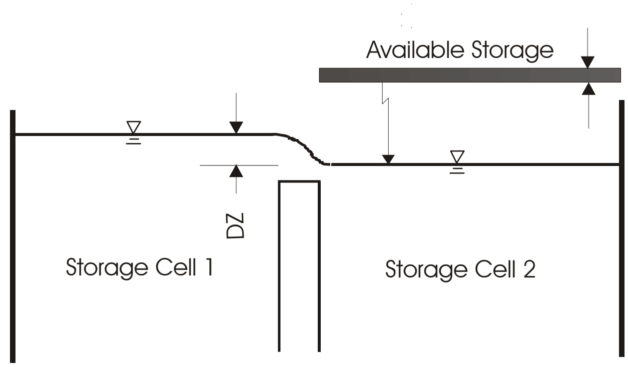


Figure 9. Schematic of levee breach through a simple spillway

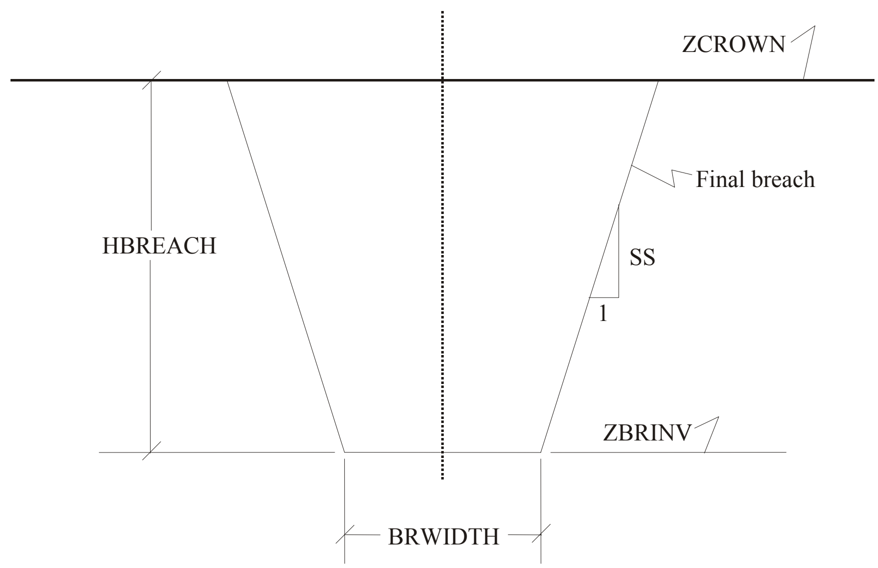


Figure 10. Schematic of a trapezoidal breach by overtopping

river stage drops below the embankment, the flow in the levee storage will drain back into the river through the breach. A modeler needs to determine the routing factor k through experience or by calibration with observed stage data when available. Note that modeling a simple levee failure does not assume any failure of the embankment, and the levee breach is preset by the modeler.

Embankment Failure

The UNET model simulates two types of embankment failures, overtopping and piping. It does not simulate the erosion of the breaching for both failures. It is assumed that the final shape of breaching is trapezoidal with a side slope of 1:1 (Figure 10).

Embankment Failure with Overtopping

Overtopping failure of an embankment begins when the water level in the channel exceeds a specified water surface elevation. The water surface elevation at which the embankment fails is ZFAIL. If ZFAIL is higher than the top of an embankment (ZCROWN), flow overtopping the embankment initially is simulated by a weir without embankment failure. Breaching starts from the top of the embankment and increases linearly in width and depth until a defined final width (BRWIDTH) and depth (HBREACH) are reached (Figure 10).

These parameters for embankment failure are entered in the UNET model by an embankment failure (EF) record. It defines the overtopping breach by setting the starting elevation of the pipe through the embankment (ZBREACH) as zero or blank.

Embankment Failure with Piping

Piping failure assumes greater seepage through the embankment that creates a conduit or pipe (Figure 11) that will consume the embankment and form a trapezoidal breach (HEC, 1997). Piping failure starts when water levels exceed ZFAIL. If ZFAIL is higher than the top of the embankment (ZCROWN), and the water level is higher than ZCROWN but below ZFAIL, overtopping is assumed and the program simulates weir flow.

For piping failure, the pipe cross section is assumed to be a hexagon. The cross-sectional area starts from zero when failure begins at a defined elevation, ZBREACH. The breach enlarges around the axis of the centroid to its final trapezoidal shape during an assumed time period, DTFAIL (hour). Side slopes remain constant. The breach stops when it reaches the final breaching width (BRWIDTH), and invert elevation (ZBRINV), as shown in Figure 12. After DTFAIL, the breach is treated as a spillway.

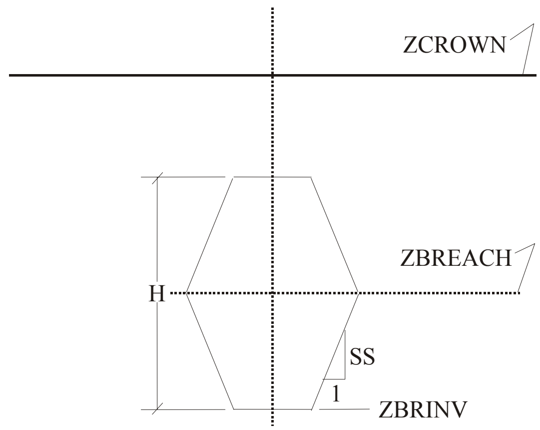


Figure 11. Schematic of a hexagonal breach by piping

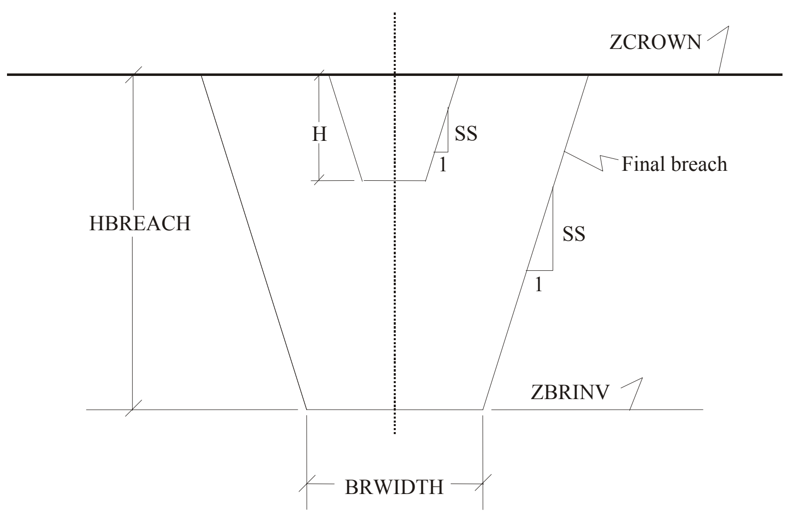
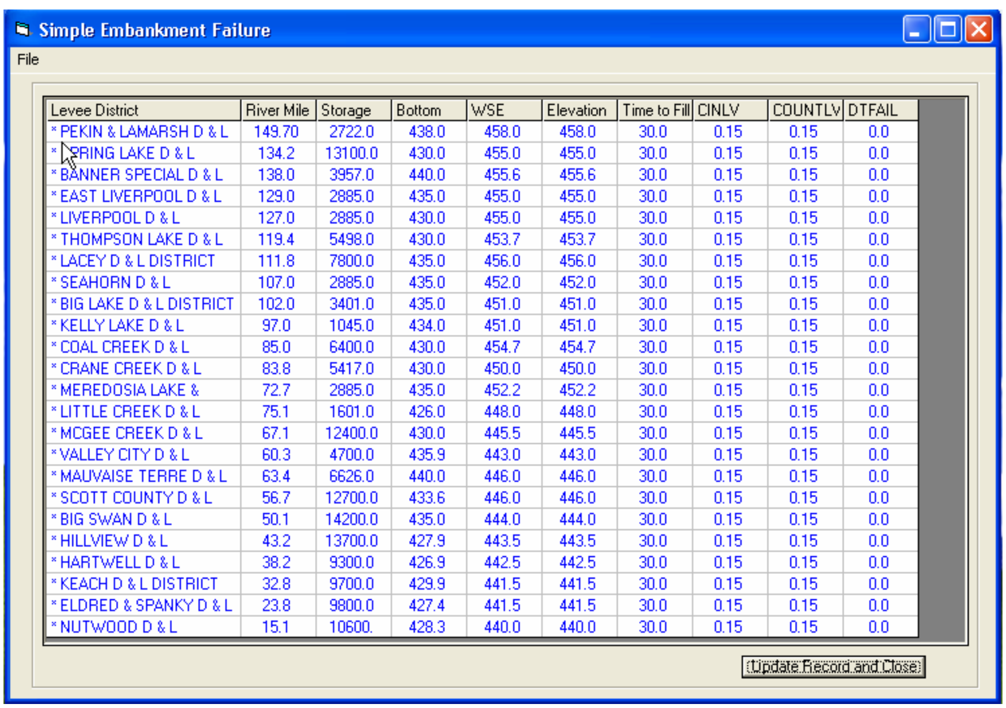


Figure 12. Final trapezoidal breach through the top of the embankment

The computational mechanism being explained allows the user to change variable values in the window and save the modified information for UNET simulation. See Figure 13 for the simple levee failure option for each LDD.

Default levee system information displayed in Figure 13 is for existing conditions without any modifications to the levees. Each window shows the name of the LDD, river mile, storage area, and the bottom elevation of the LDD. These parameters must not be changed unless the LDD geometry also is modified. Modifying ZFAIL, the elevation at which the embankment fails, allows simulation of the rising or lowering of the levee crown elevation. Levee breaching stops at the invert elevation, ZBRINV. The time required for the LDD to fill can be changed to any reasonable value. Double clicking on the grid cell allows the user to change the value and then clicking anywhere except the selected cell makes the change effective (Figure 14). Clicking on ***Save and Exit*** saves the file containing the LDD information for later use in the UNET model. Note that the current version cannot have LDD storage input as the elevation-volume rating relation.

Figure 15 provides information for the complicated levee failure option for each LDD under existing conditions.



Levee District	River Mile	Storage	Bottom	WSE	Elevation	Time to Fill	CINLV	COUNTLV	DTFAIL
* PEKIN & LAMARSH D & L	149.70	2722.0	438.0	458.0	458.0	30.0	0.15	0.15	0.0
* SPRING LAKE D & L	134.2	13100.0	430.0	455.0	455.0	30.0	0.15	0.15	0.0
* BANNER SPECIAL D & L	138.0	3957.0	440.0	455.6	455.6	30.0	0.15	0.15	0.0
* EAST LIVERPOOL D & L	129.0	2885.0	435.0	455.0	455.0	30.0	0.15	0.15	0.0
* LIVERPOOL D & L	127.0	2885.0	430.0	455.0	455.0	30.0	0.15	0.15	0.0
* THOMPSON LAKE D & L	119.4	5498.0	430.0	453.7	453.7	30.0	0.15	0.15	0.0
* LACEY D & L DISTRICT	111.8	7800.0	435.0	456.0	456.0	30.0	0.15	0.15	0.0
* SEAHORN D & L	107.0	2885.0	435.0	452.0	452.0	30.0	0.15	0.15	0.0
* BIG LAKE D & L DISTRICT	102.0	3401.0	435.0	451.0	451.0	30.0	0.15	0.15	0.0
* KELLY LAKE D & L	97.0	1045.0	434.0	451.0	451.0	30.0	0.15	0.15	0.0
* COAL CREEK D & L	85.0	6400.0	430.0	454.7	454.7	30.0	0.15	0.15	0.0
* CRANE CREEK D & L	83.8	5417.0	430.0	450.0	450.0	30.0	0.15	0.15	0.0
* MEREDOSIA LAKE &	72.7	2885.0	435.0	452.2	452.2	30.0	0.15	0.15	0.0
* LITTLE CREEK D & L	75.1	1601.0	426.0	448.0	448.0	30.0	0.15	0.15	0.0
* MCGEE CREEK D & L	67.1	12400.0	430.0	445.5	445.5	30.0	0.15	0.15	0.0
* VALLEY CITY D & L	60.3	4700.0	435.9	443.0	443.0	30.0	0.15	0.15	0.0
* MAUVAISE TERRE D & L	63.4	6626.0	440.0	446.0	446.0	30.0	0.15	0.15	0.0
* SCOTT COUNTY D & L	56.7	12700.0	433.6	446.0	446.0	30.0	0.15	0.15	0.0
* BIG SWAN D & L	50.1	14200.0	435.0	444.0	444.0	30.0	0.15	0.15	0.0
* HILLVIEW D & L	43.2	13700.0	427.9	443.5	443.5	30.0	0.15	0.15	0.0
* HARTWELL D & L	38.2	9300.0	426.9	442.5	442.5	30.0	0.15	0.15	0.0
* KEACH D & L DISTRICT	32.8	9700.0	429.9	441.5	441.5	30.0	0.15	0.15	0.0
* ELDRED & SPANKY D & L	23.8	9800.0	427.4	441.5	441.5	30.0	0.15	0.15	0.0
* NUTWOOD D & L	15.1	10600.	428.3	440.0	440.0	30.0	0.15	0.15	0.0

Figure 13. Parameters for the simple levee failure option

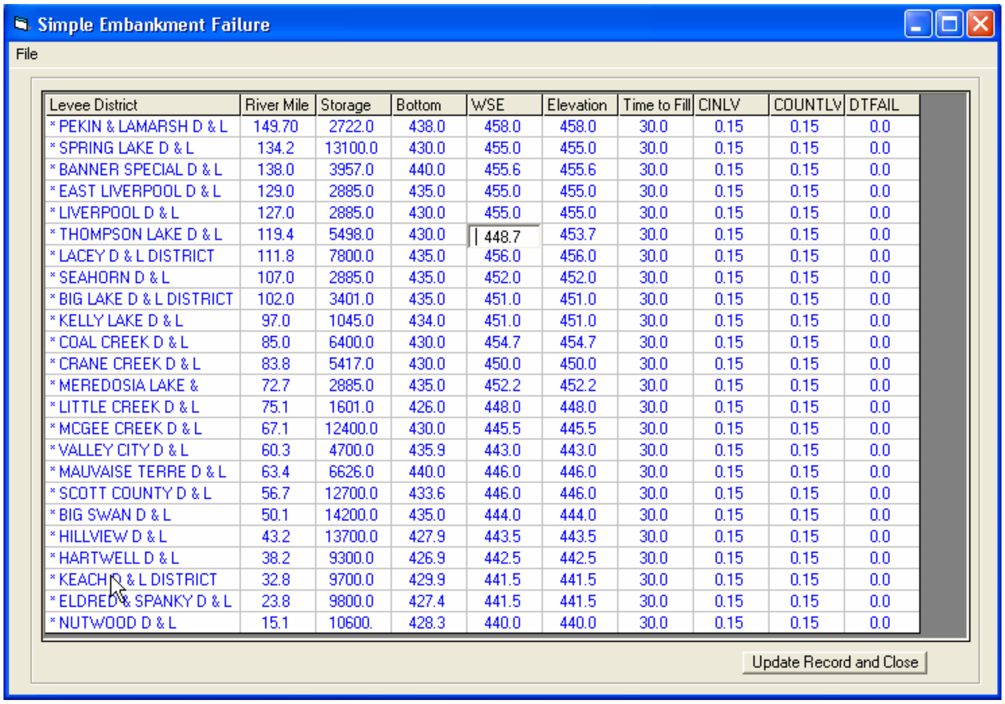


Figure 14. Changing parameters for the simple levee failure option

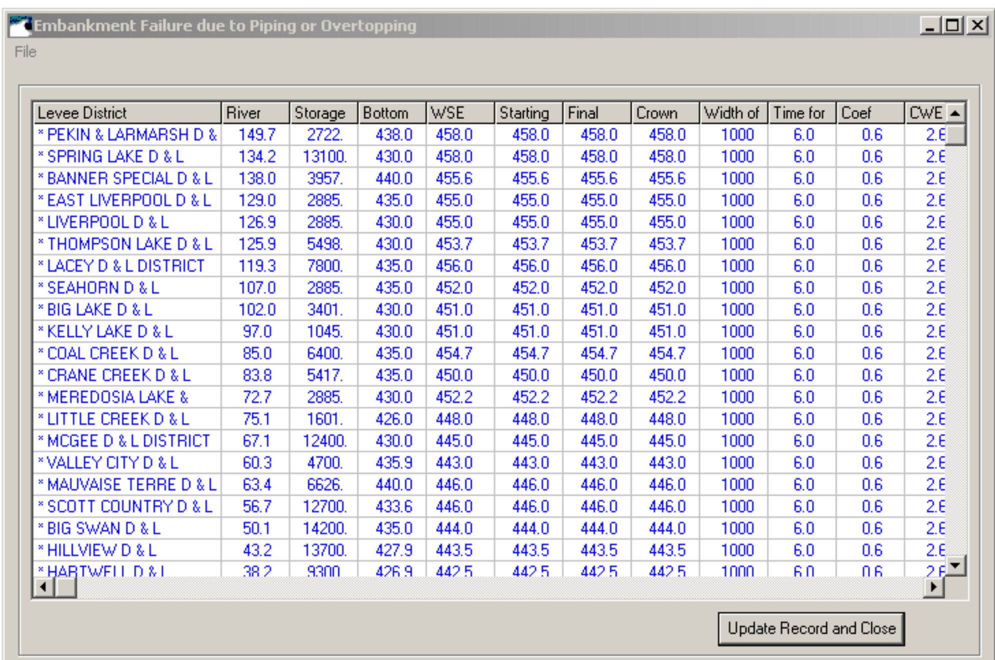


Figure 15. Parameters for the complicated levee failure option

UNET Model Setup

Figure 16 is the schematic of the seven-reach UNET model. The model contains three reaches on the Lower Illinois River and four reaches on Pool 26 of the Mississippi River:

- Reach 1: the segment of the Illinois River from just downstream of Peoria Lock and Dam to just upstream of the confluence of the Sangamon River and the Illinois River.
- Reach 2: a portion of the Sangamon River from Oakford to its mouth at the Illinois River.
- Reach 3: the segment of the Illinois River from just downstream of the confluence of the Sangamon River and the Illinois River to the mouth of the Illinois River at Grafton.
- Reach 4: the segment of the Mississippi River from just downstream of Lock and Dam 25 to the junction of the Cuivre River and the Mississippi River.
- Reach 5: a portion of the Cuivre River from Troy to the confluence of the Cuivre River and the Mississippi River.
- Reach 6: a portion of the Mississippi River from just downstream of the junction of the Cuivre River and the Mississippi River to just upstream of the junction of the Illinois River and the Mississippi River.
- Reach 7: a portion of the Mississippi River from just downstream of the confluence of the Illinois River and the Mississippi River at Grafton to Pool 26 at the Melvin Price Lock and Dam.

A three-reach UNET model as shown in Figure 17 was used to simulate a design flood in the 1998 project (Akanbi et al., 1999).

- Reach 1: the segment of the Illinois River from just downstream of Peoria Lock and Dam to just upstream of the confluence of the Sangamon River and the Illinois River.
- Reach 2: a portion of the Sangamon River from Oakford to its mouth at the Illinois River.

- Reach 3: the segment of the Illinois River from just downstream of the confluence of the Sangamon River and the Illinois River to the mouth of the Illinois River at Grafton.

The tributaries are simulated as lateral inflows, and watersheds near the river are considered as uniform lateral inflow sources.

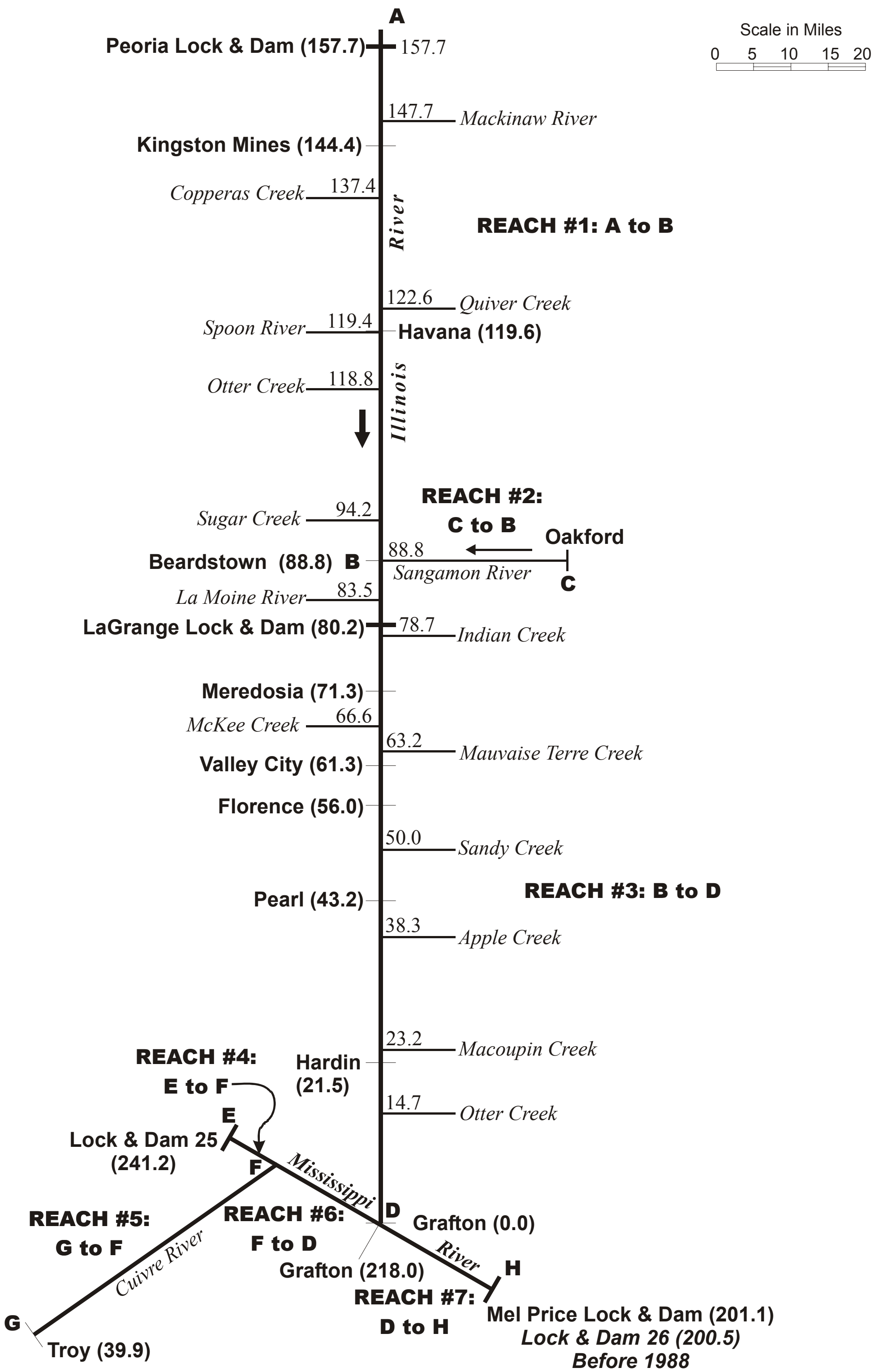


Figure 16. Schematic of the Lower Illinois River - Pool 26 of the Mississippi River UNET model (river miles)

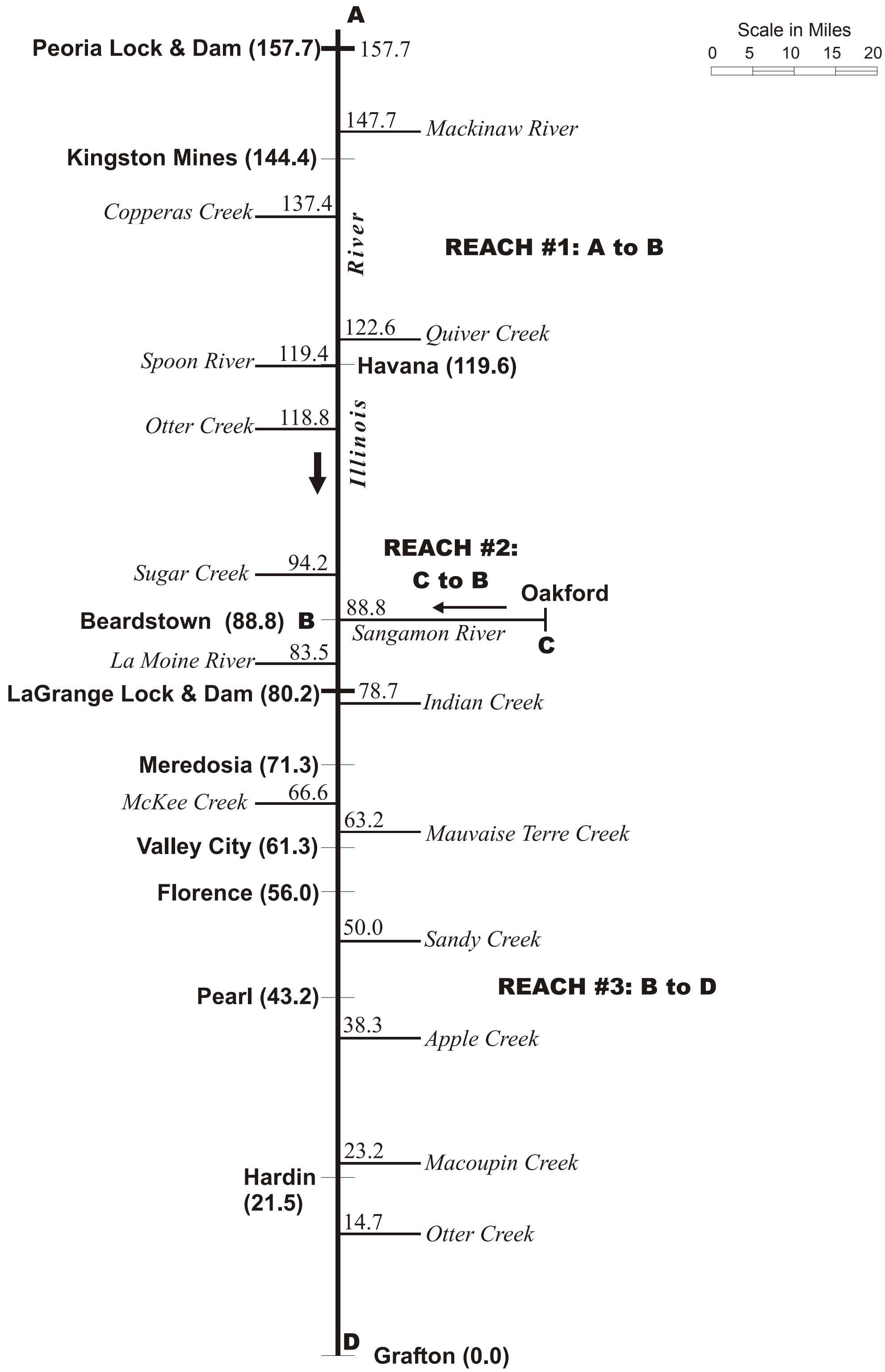


Figure 17. Schematic of the Lower Illinois River UNET model (river miles)

Simulation with UNET

Design floods for 2-, 10-, 25-, 50-, and 100-year periods and historic flood events are simulated with the extended Lower Illinois River UNET model that includes Pool 26 of the Mississippi River, the seven-reach model. Real-time simulation of floods is based on the three-reach UNET model.

To run the program, the user selects **UNET** in the main window, and then ***Run UNET*** in the pulldown menu to open the window shown in Figure 18. The top of the window will show the input BC file and the DSS file to be used for the input hydrograph. Also shown at the top is the name of the output BC file, which is named by adding "new" to the input BC file as in the figure and adding a normal output DSS file. The user can choose to use any name for both files.

The user also can modify parameters in the BC file for the UNET model. *Time Interval* and *Theta* are allowed to change for numerical stability of the model. A smaller time interval and greater theta value achieve better stability, but a larger time interval, which means less time steps, will take less time to simulate. A theta value between 0.5 and 1.0 is allowed; however, a value of 0.6 to 0.7 is suggested for better accuracy. The user also can change the starting and ending times within the window for the selected simulation period of interest. After all modifications are completed, clicking on ***Save*** and then ***Run*** executes the UNET program. The user must wait until the simulation is over to **Exit.**

The UNET program also can be executed with existing CS and BC files by entering file names into the appropriate boxes and then following the steps in this section.

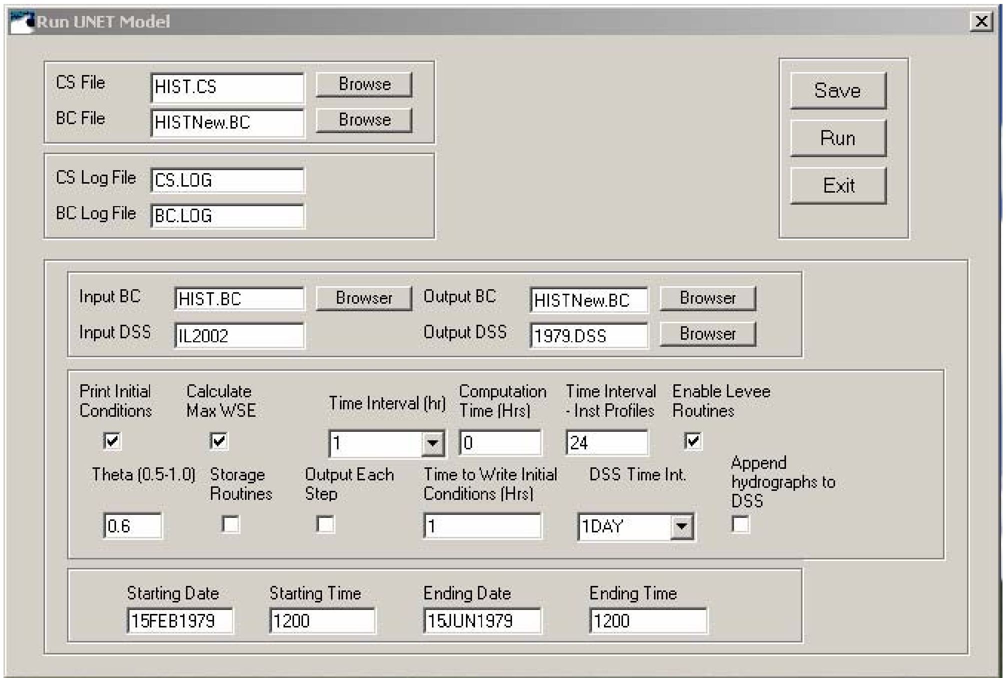


Figure 18. Executing the UNET program

PLOTTING HYDROGRAPHS AND STAGE PROFILES

The pathname used in the HEC-DSS database consists of up to 80 characters in six parts referenced by A, B, C, D, E, and F, respectively. All parts are delimited by a slash symbol. For example, a typical pathname in the input DSS database for the Lower Illinois River UNET model is: /ILLINOIS RIVER/LA GRANGE POOL/STAGE/01JAN1979/1DAY/OBS/

where:

A=ILLINOIS RIVER, river basin or project name

B=LA GRANGE POOL, location or gage identifier

C=STAGE, data variable

D=01JAN1979, starting date for block of data

E=1DAY, time interval

F=OBS, a user-defined description to further define the data

The graphical display of DSS databases in the current version has been improved greatly over previous versions (Lian et al., 2001). The user can open the plot module by selecting **Display** and then **Plot from DSS File** in the pull-down menu. Clicking on the **Browser** allows selection of a DSS file for plotting (Figure 19). All paths will be placed in the six columns for all six parts in the DSS file (Figure 20), and unique path names will appear in the six selection boxes. The user can select a path from the selection boxes from left to right; thus, only selected paths will be displayed (Figure 21). The user can select any path to plot by clicking on the data row of interest, and the selected path will appear in the lower data grid for plotting.

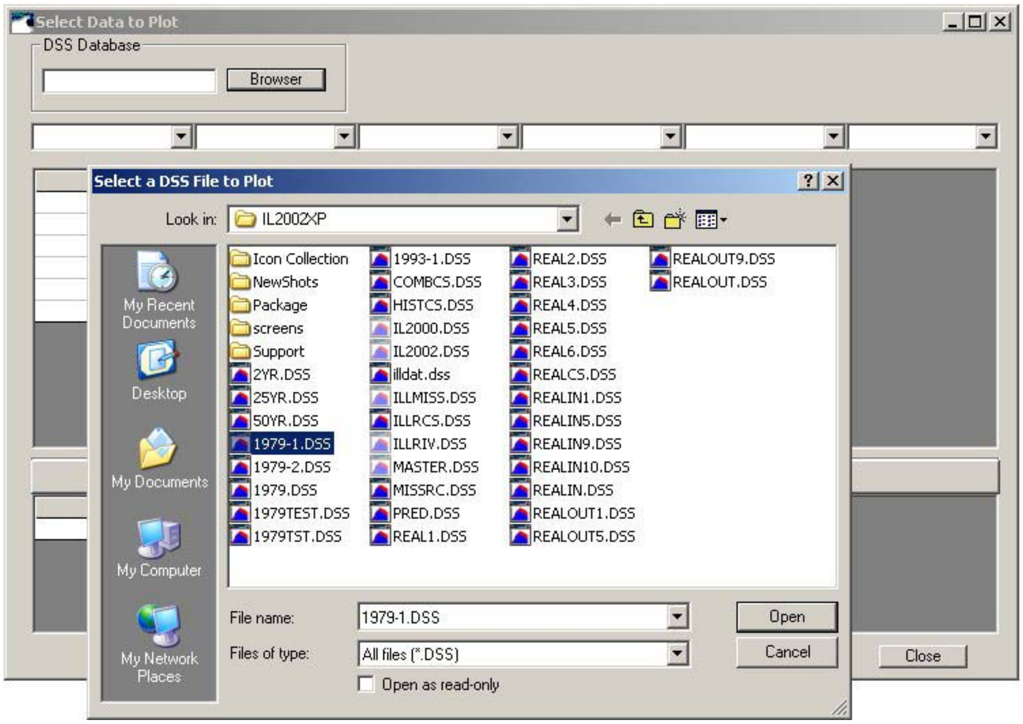


Figure 19. Selecting a DSS file to plot

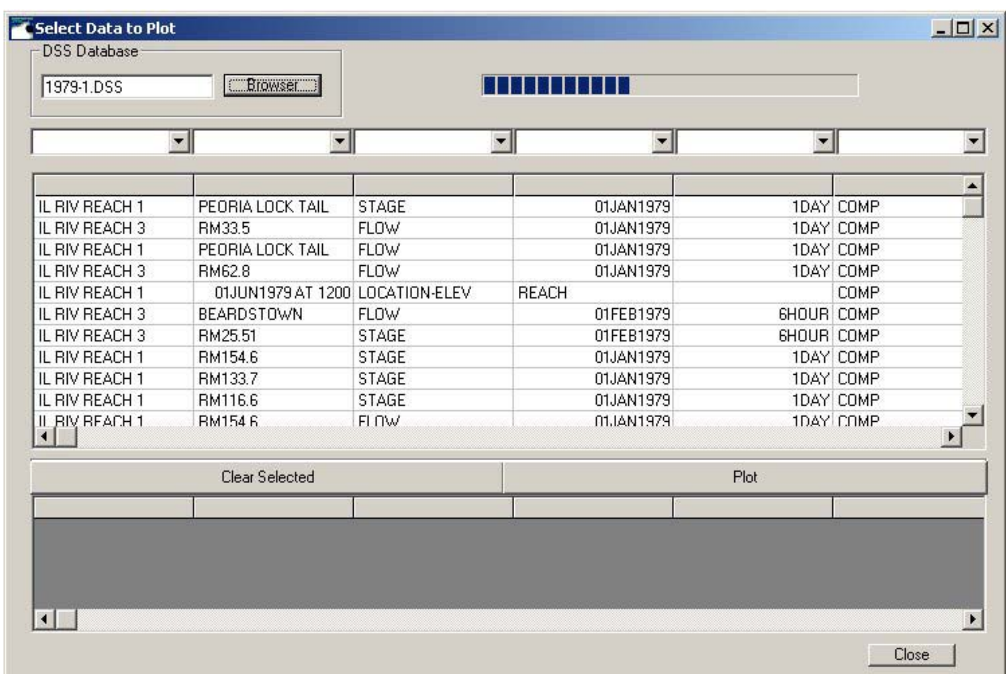


Figure 20. Displaying DSS file path strings

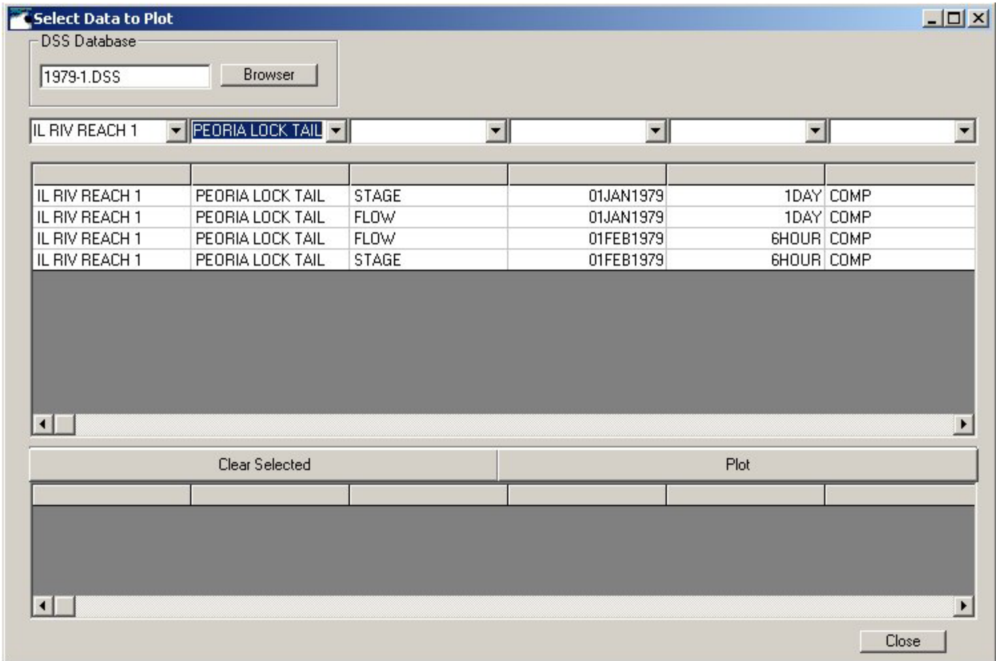


Figure 21. Selecting DSS file path strings

Hydrographs

Figure 22 shows a hydrograph plotted from the data path of the window underneath.

The user also can select up to 10 paths of the same type of data to plot; for example, stage or flow as shown in Figure 23. **Note**: the user must make sure that the time periods for multiple hydrographs are the same.

To zoom in on hydrograph shown in Figure 23, the user needs to hold down the shift key, press the left mouse button to drag a rectangular zoom window, and then release the mouse button. To get the value of any point on the curve or anywhere in the window, the user needs to move the cursor to the point and click the right mouse button (Figure 24).

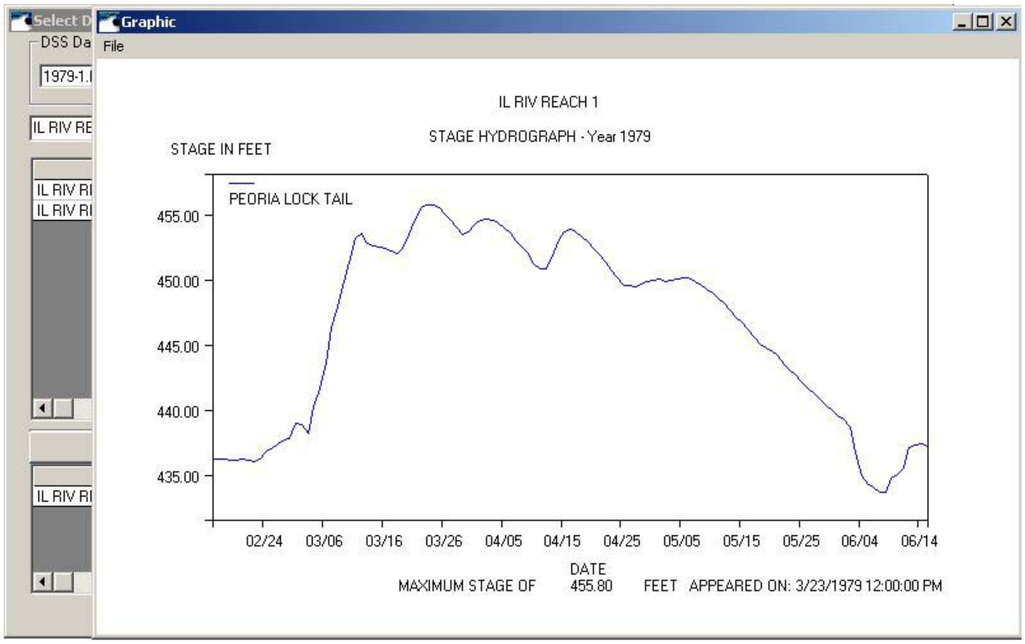


Figure 22. Plotting a selected stage hydrograph

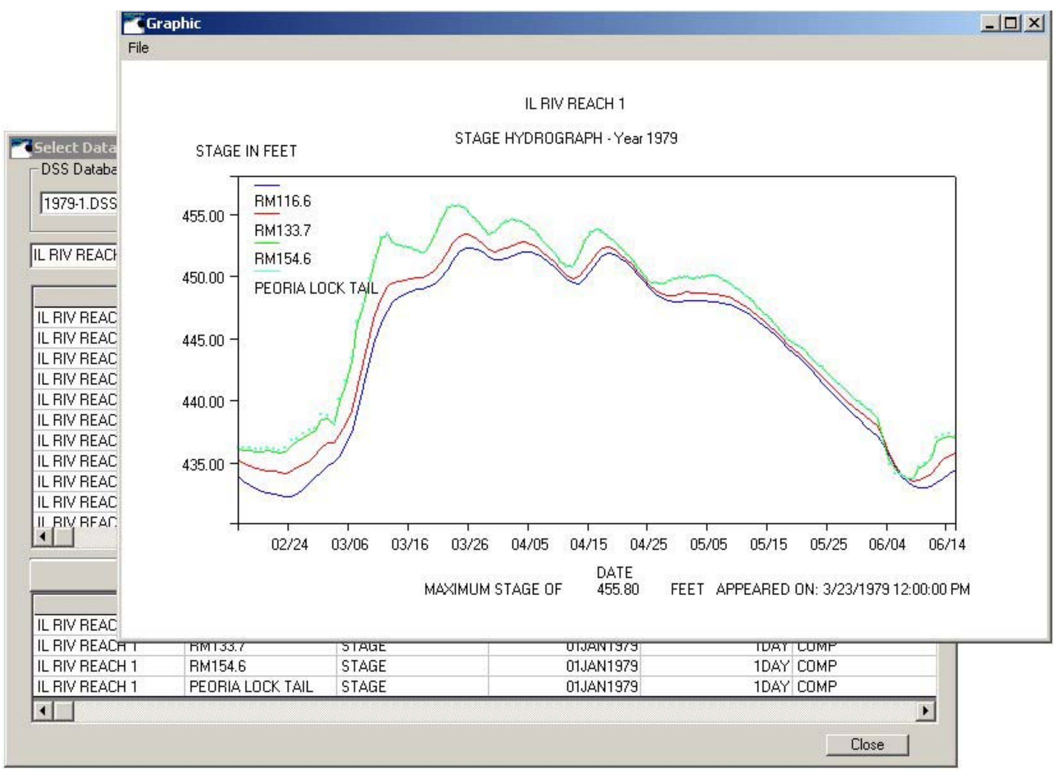


Figure 23. Plotting selected multiple stage hydrographs

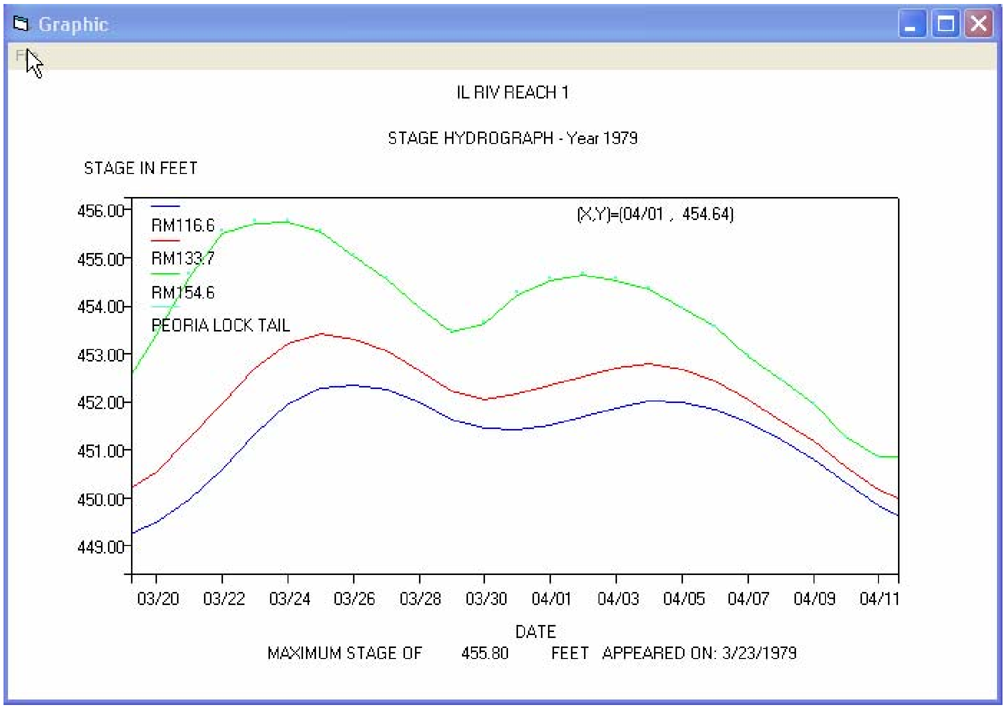


Figure 24. A zoom view of multiple stage hydrographs

The user also can plot multiple flow hydrographs (Figure 25) and zoom in or out the graph (Figure 26). Notice that the maximum stage or discharge for the simulation period is displayed at the bottom of the plot.

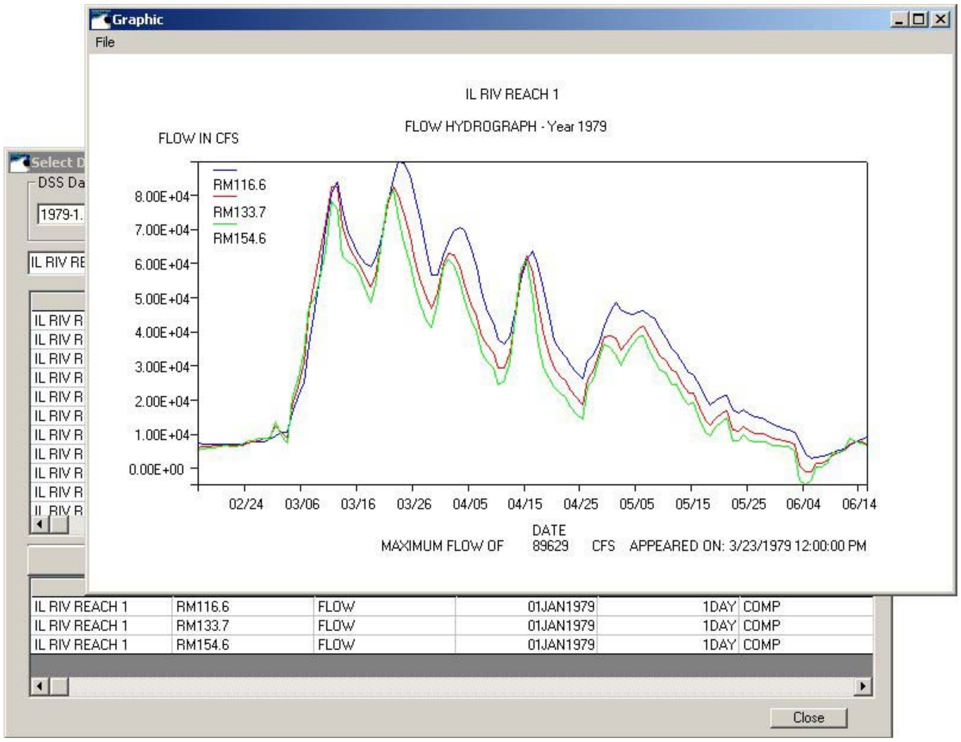


Figure 25. Plotting selected multiple flow hydrographs

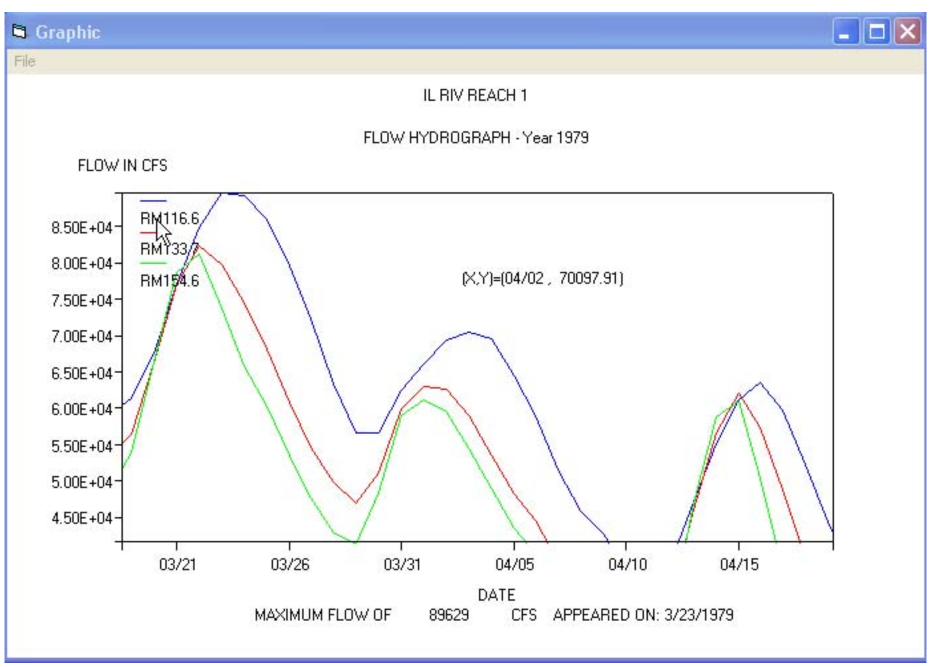


Figure 26. A zoom view of multiple flow hydrographs

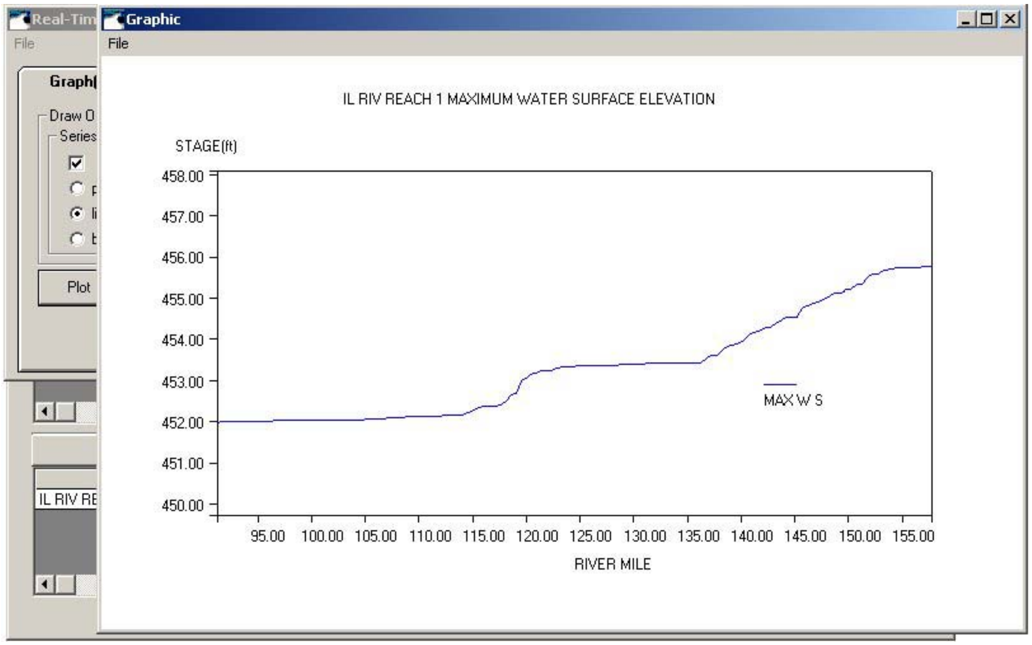


Figure 27. Plotting a selected stage profile for a single reach

Stage Profiles

The UNET program can plot a stage profile of a single reach (Figure 27) and multiple reaches on the same stream. When multiple reaches are selected, the program will sort data based on river miles. The user needs to make sure the reaches selected are continuous for the same river system even though they don't have to be in the correct sequence.

By dragging a box with the mouse and then releasing the mouse button, the user can zoom in on the reach stage profile (Figure 28).

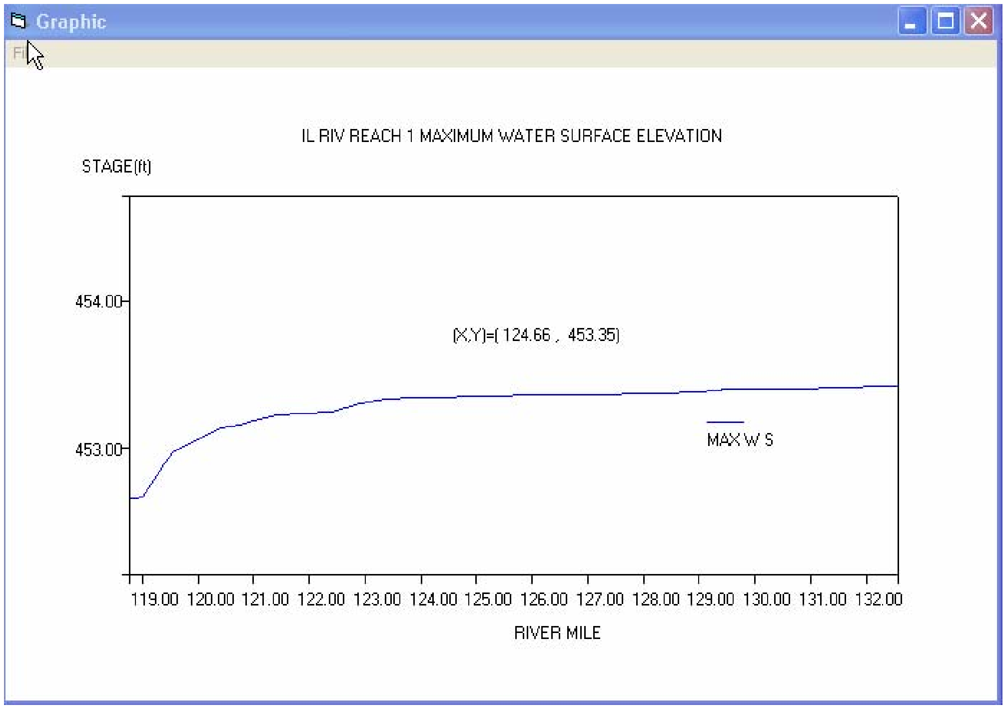


Figure 28. A zoom view of a stage profile

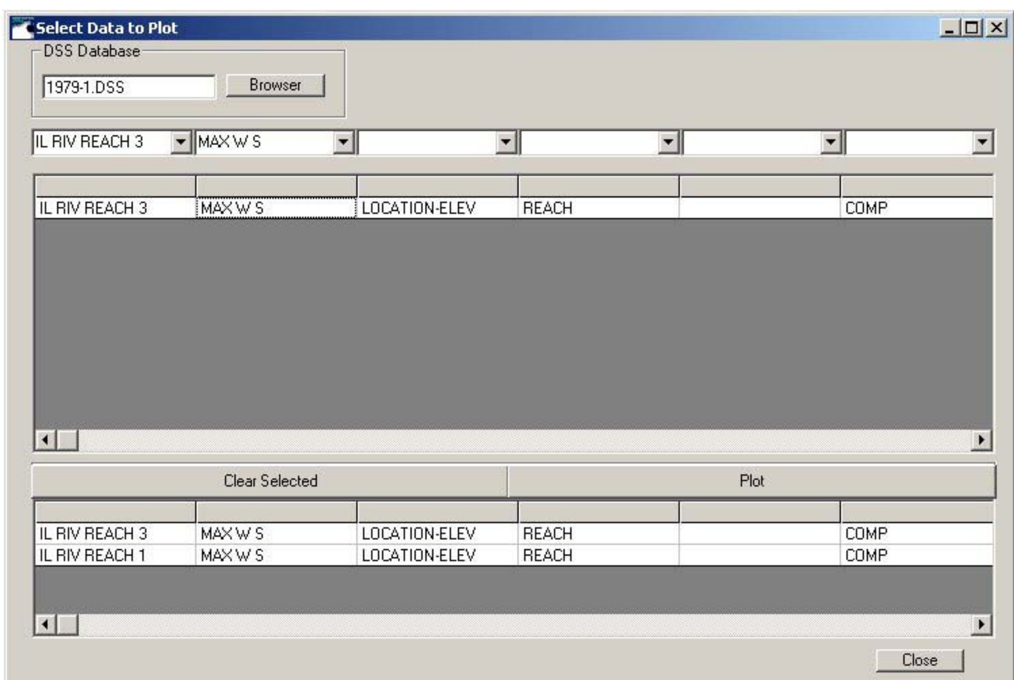


Figure 29. Selecting data to plot a stage profile for multiple reaches

Figure 29 shows data selected for reaches 1 and 3 to plot the stage profile for the Lower Illinois River.

The program includes levee information for the Lower Illinois River (Peoria Lock and Dam to Grafton) as a text file and can be updated easily.

Figure 30 shows a stage profile for the lower Illinois River with levees, and Figure 31 is a zoomed view of a portion of that figure.

Figure 30. Plotting a stage profile for the Lower Illinois River with levees

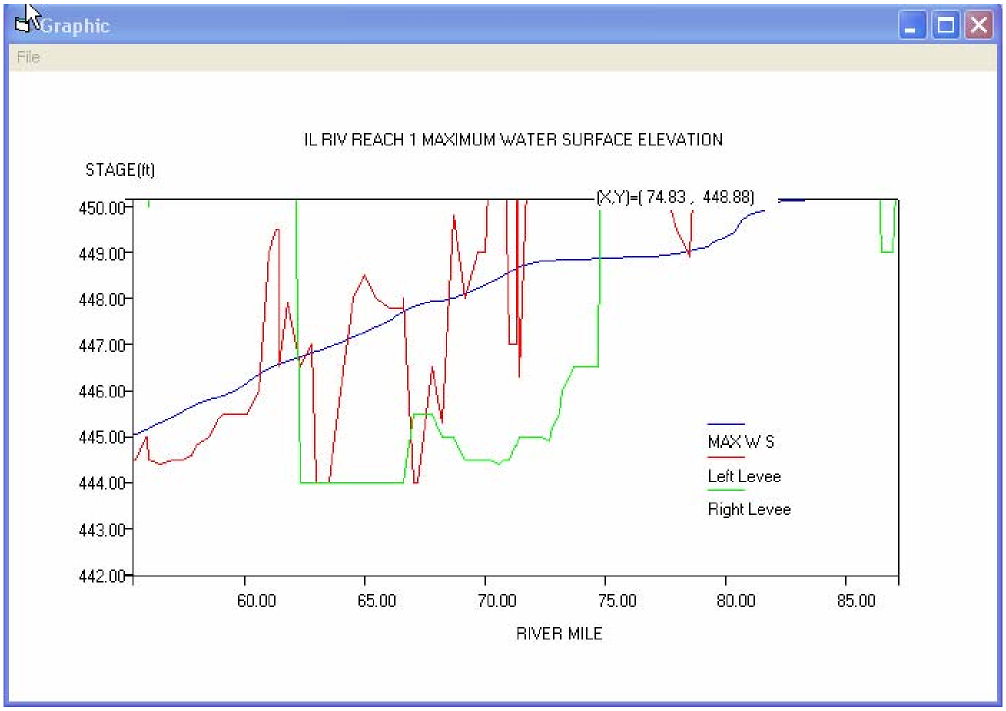


Figure 31. A zoom view of a stage profile with levees

Displayed in the grid table (Figure 32) are locations and magnitudes of left and right levee overtopping should any levee overtopping occur. The user can click **Save Stage Profile** to save stage profile data, which can be used for comparison later. A small window will pop up, and the user can enter a file name, browse for a file to save, or quit without saving any file.

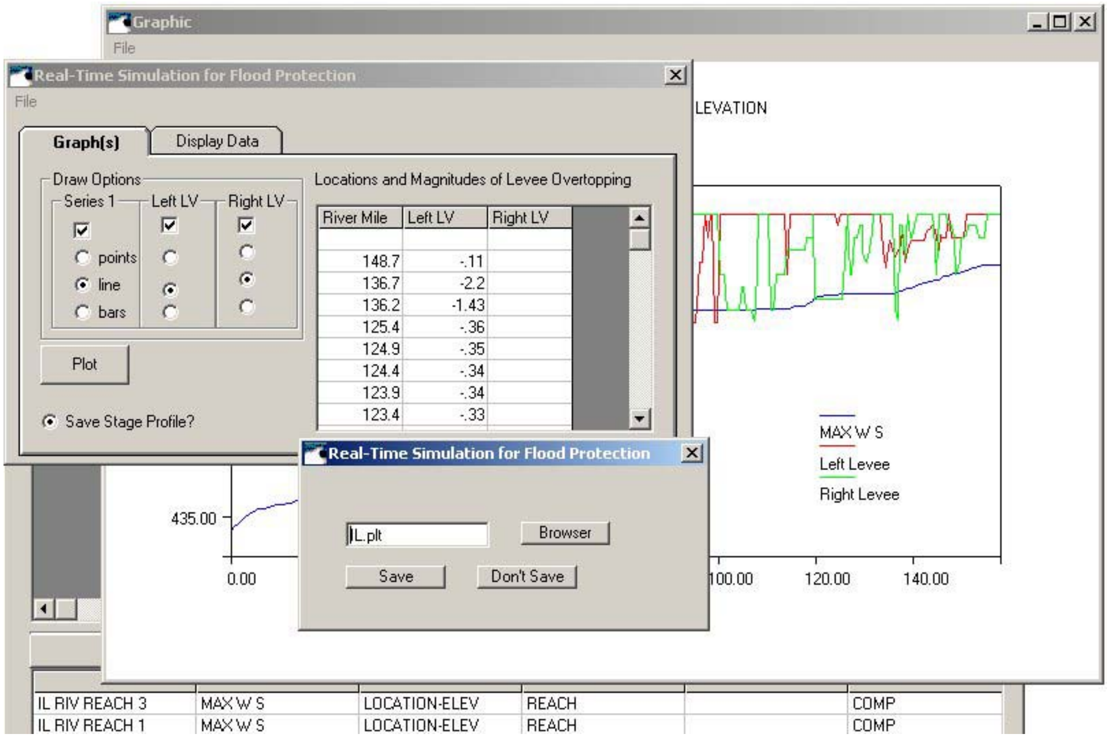


Figure 32. Displaying levee overtopping information and prompt to save data

Clicking the **Display Data** tab (Figure 32) results in Figure 33, a table of river mile, stage, left levee, right levee, left levee overtopping, and right levee overtopping.

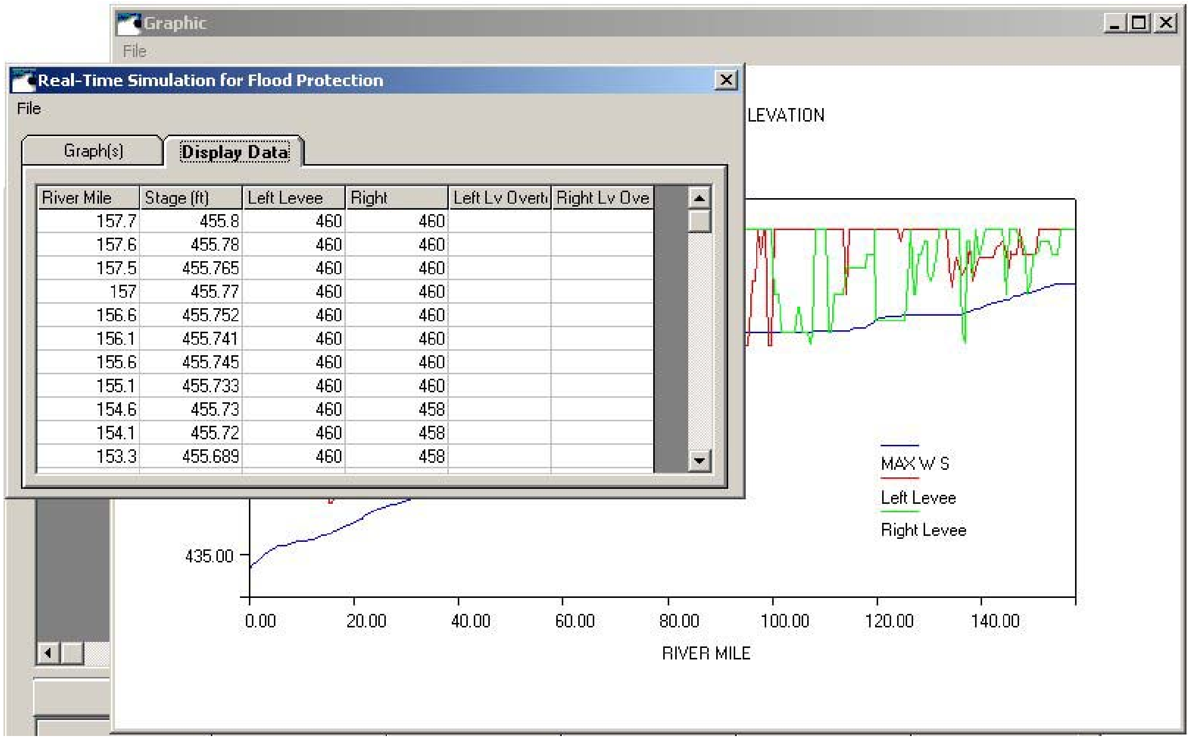


Figure 33. Displaying stage and levee overtopping information

Comparison of Stage Profiles

Comparison of stage profiles can be used to see stage reduction/increase with managed LDD options. The user can select data files for two chosen profiles (Figure 34): for example, “Illinois79-1.plt” and “Illinois79-2.plt”. There are four drawing options: Profile 1, Profile 2, Left levee, and Right levee. The user can select all options or just one option to draw.

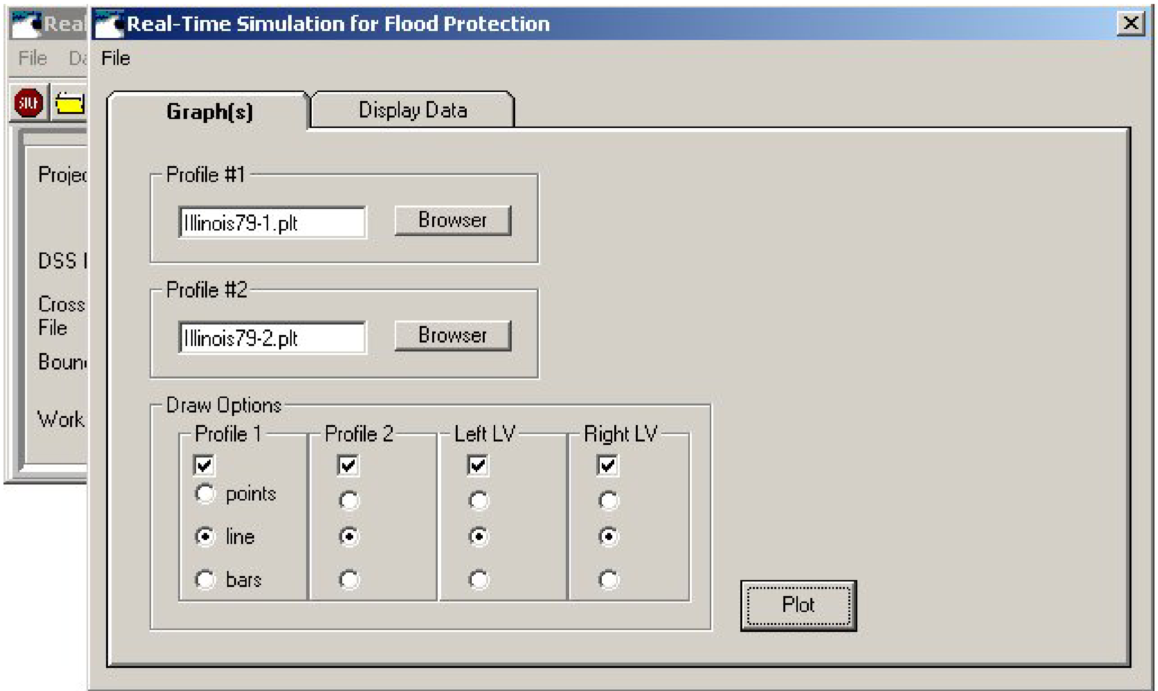


Figure 34. Comparing two stage profiles for the Lower Illinois River

Figure 35 is a comparison of two simulations for a 1979 flood. The user can zoom in a specified area to see more detail and click on any point to see the stage value (Figure 36). Information for two profiles is displayed in the **Display Data** table (Figure 37).

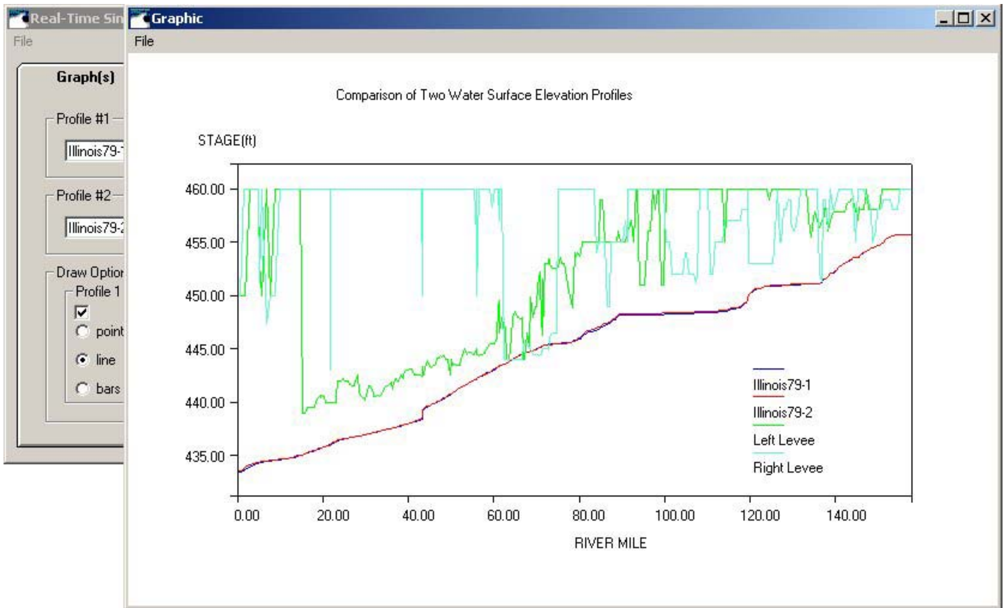


Figure 35. Plotting stage profiles and levees

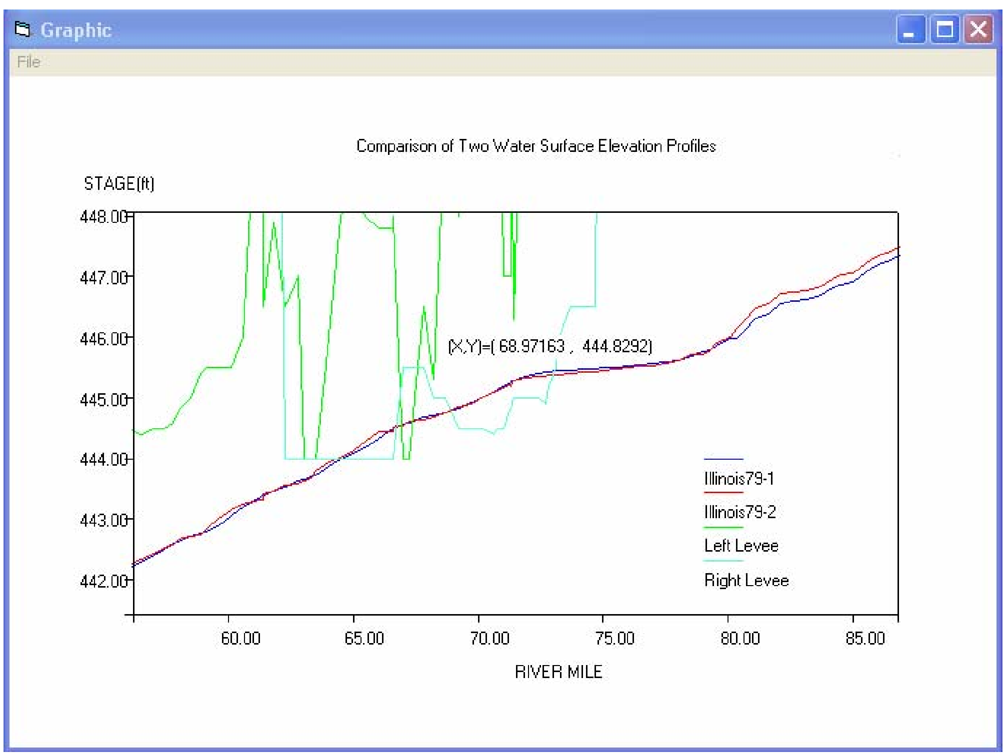
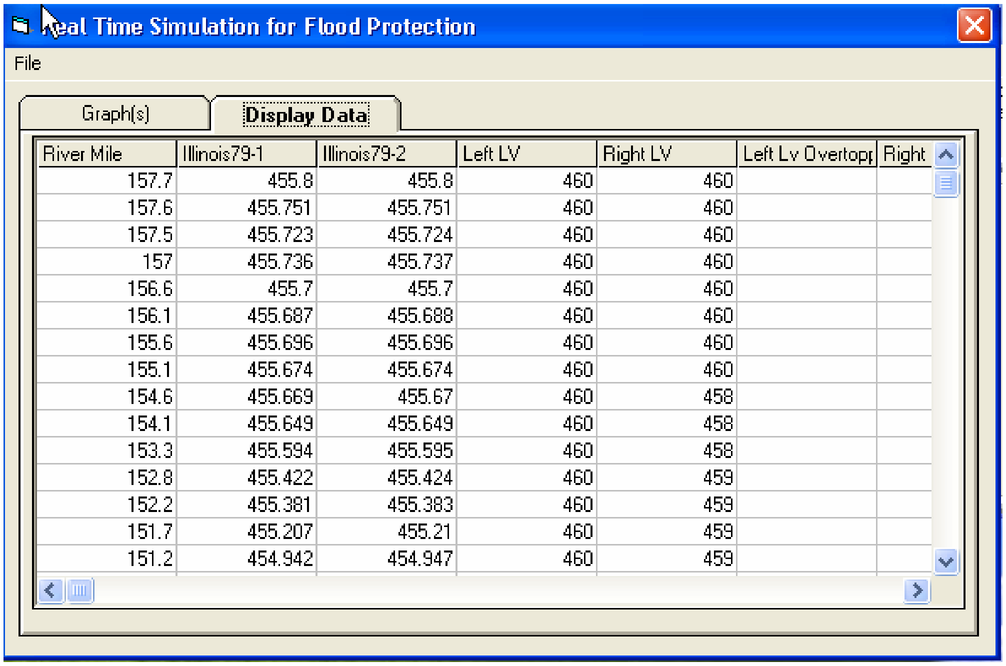


Figure 36. A zoom view of comparison stage profiles



River Mile	Illinois79-1	Illinois79-2	Left LV	Right LV	Left Lv Overtopp	Right
157.7	455.8	455.8	460	460		
157.6	455.751	455.751	460	460		
157.5	455.723	455.724	460	460		
157	455.736	455.737	460	460		
156.6	455.7	455.7	460	460		
156.1	455.687	455.688	460	460		
155.6	455.696	455.696	460	460		
155.1	455.674	455.674	460	460		
154.6	455.669	455.67	460	458		
154.1	455.649	455.649	460	458		
153.3	455.594	455.595	460	458		
152.8	455.422	455.424	460	459		
152.2	455.381	455.383	460	459		
151.7	455.207	455.21	460	459		
151.2	454.942	454.947	460	459		

Figure 37. Displaying stages of two comparison profiles

UTILITY TOOLS

The interface program includes four utility tools. The **Snap Shot** tool can capture any part of an active window (Figure 38). The image captured can be saved as a bmp file or printed directly. **Document Editor** is a very functional program for text file editing (Figure 39).

Figure 38. **Snap Shot**, a tool for screen capture

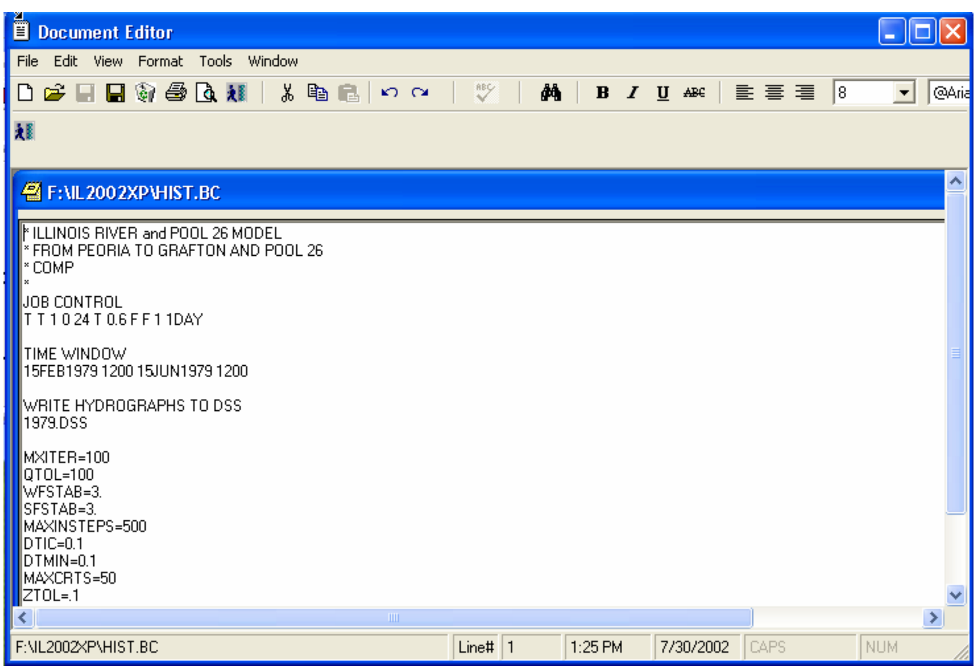


Figure 39. **Document Editor**, a text file editor

The **HEC DSSUTL** program is for DSS database editing (Figure 40). The HEC-RAS 3.0 program also is included should the user want to use it (Figure 41). These can be accessed through the *Tools* menu on the main screen of the program.

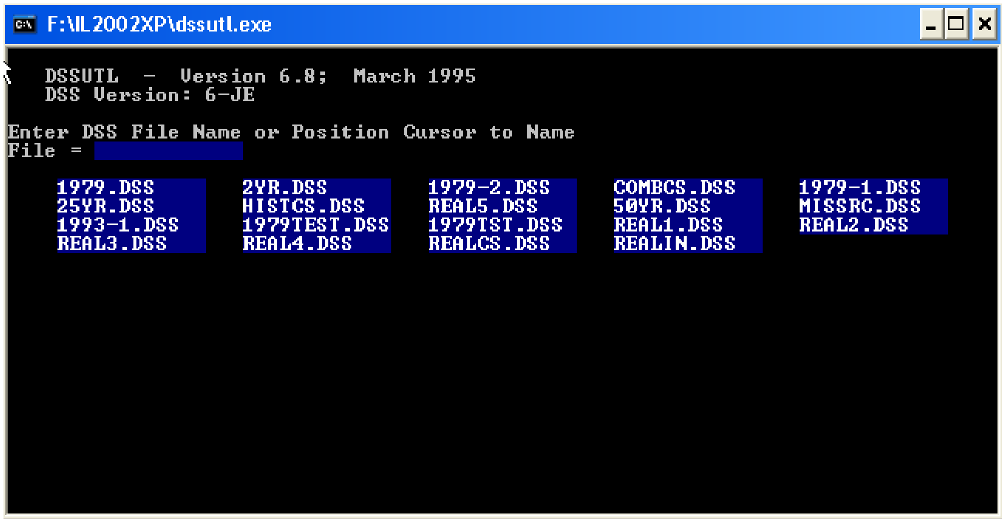


Figure 40. **HEC DSSUTL**, a DSS utility

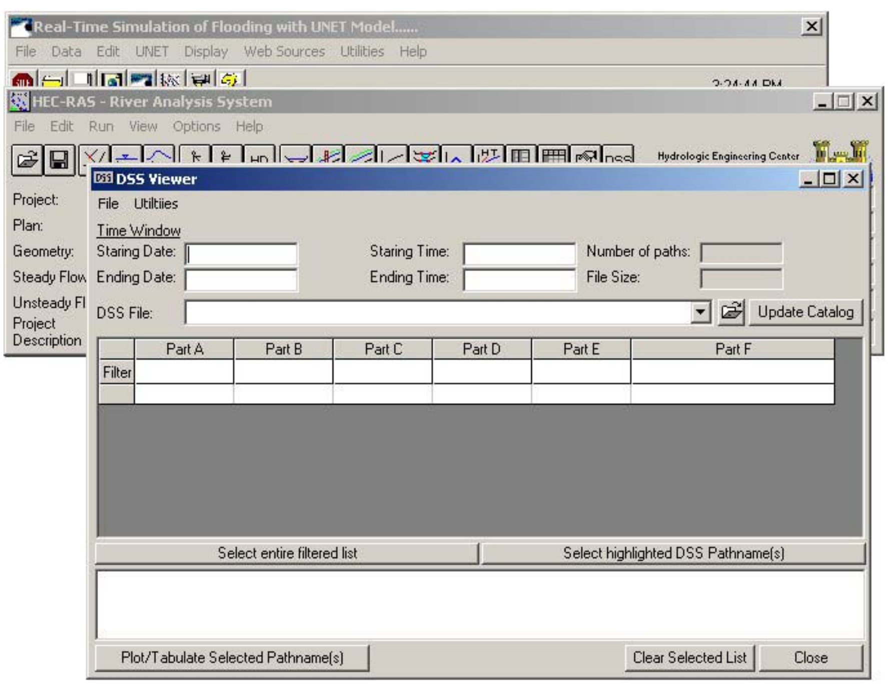


Figure 41. The HEC-RAS 3.0 program

WEB RESOURCES

This program includes four real-time Web resources for easy access: current and next 10-day weather forecast, USGS real-time stage and flow, USACOE real-time stage, and NWS forecasted stage, which will help to check on real-time and forecasted data downloaded from those sites through this interface program.

The user can check the current weather and weather forecast by entering an area zip code and clicking on **Check Weather** (Figure 42). Clicking on **Close** allows the user to exit the program.

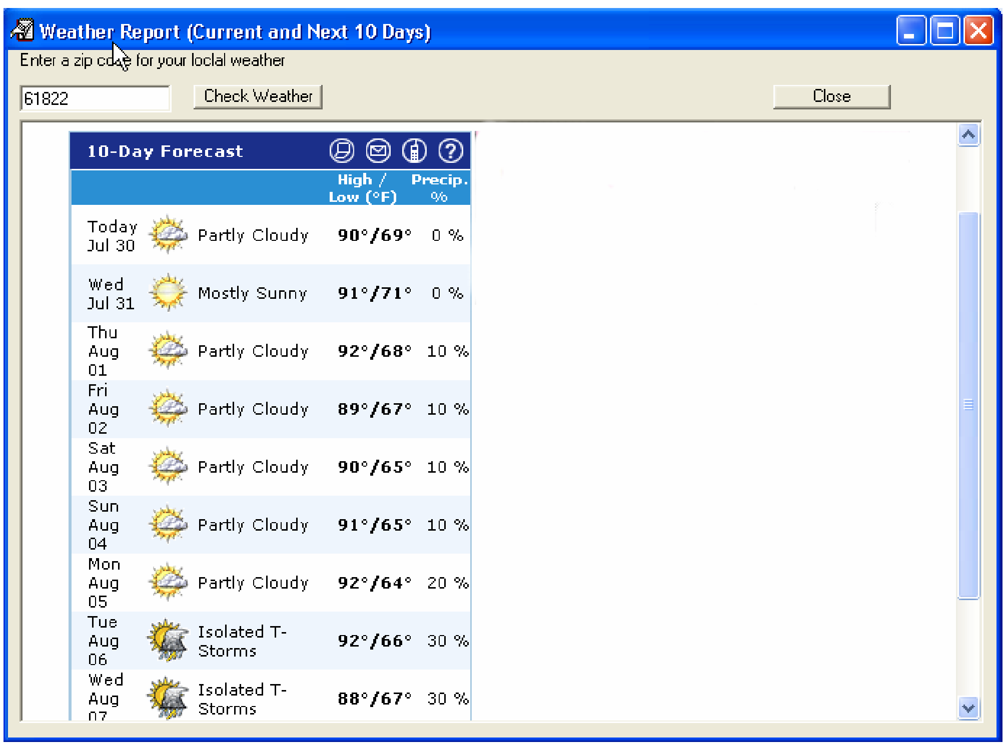


Figure 42. Checking current weather from the weather.com Web site

Real-time stage (Figure 43) and flow (Figure 44) hydrographs also can be viewed by entering a number between 1 and 31 (days) and then selecting a station to retrieve the hydrograph. The default is 7 days. Only stations included in the Microsoft Access database (Figure 4) can be viewed. However, the user can update the database to view more stations or stations at different locations.

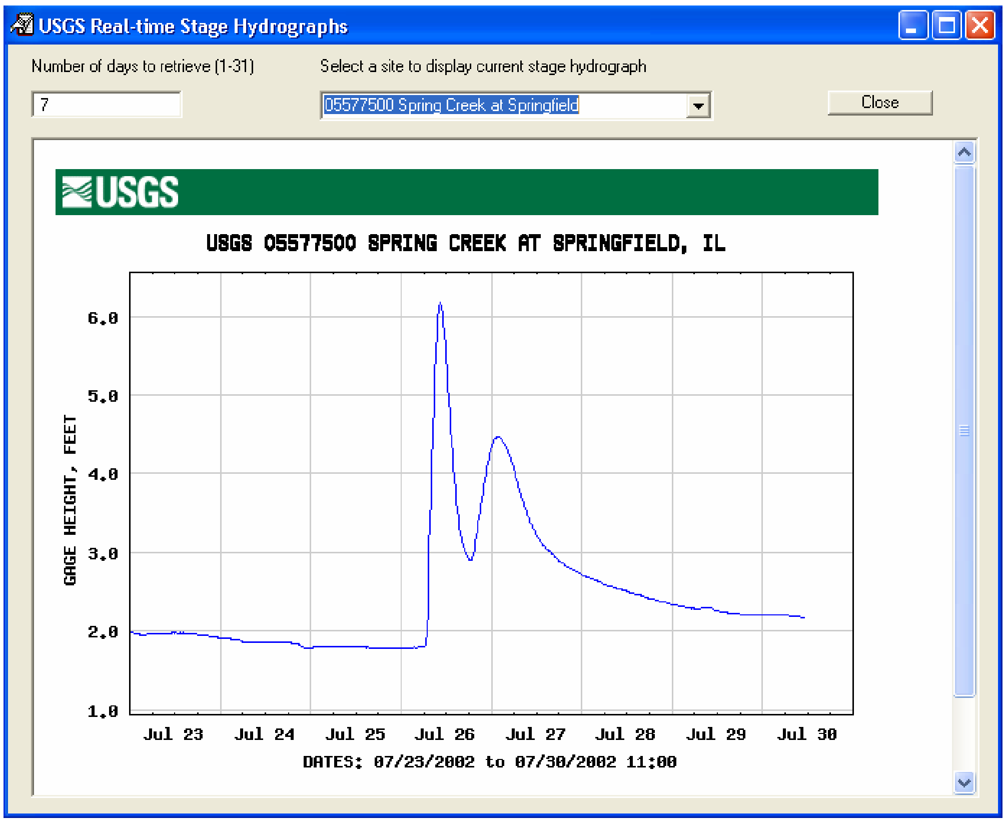


Figure 43. Displaying a real-time stage hydrograph from the USGS Web site

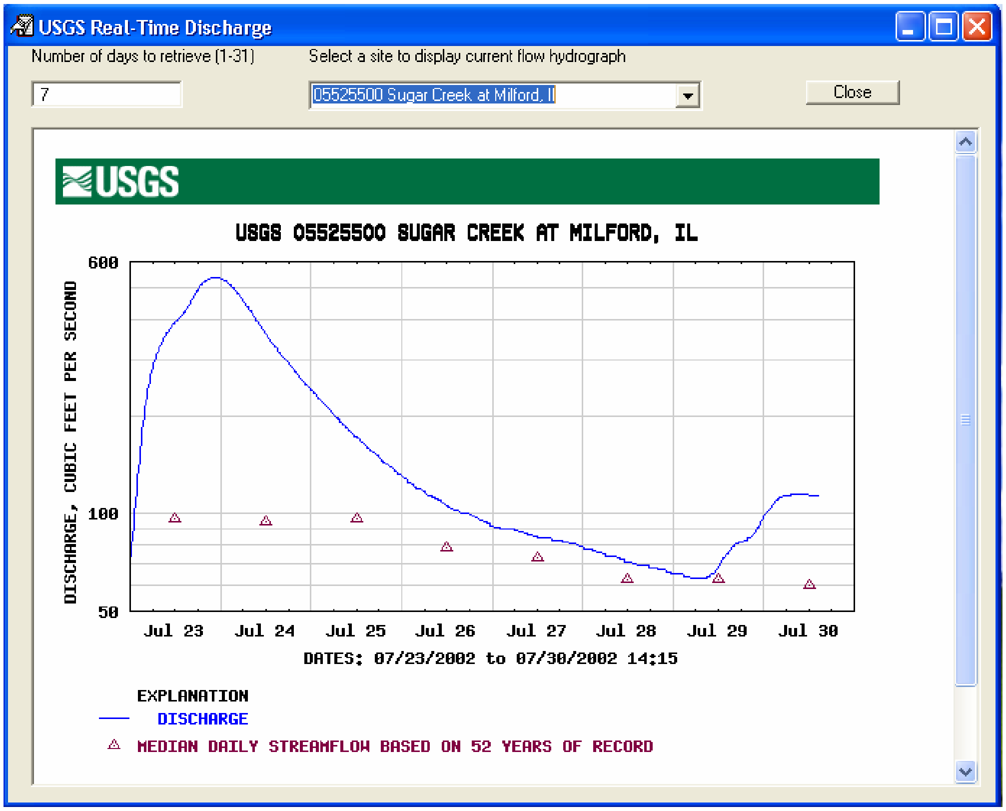


Figure 44. Displaying a real-time flow hydrograph from the USGS Web site

The USACOE's real-time stage hydrographs also can be viewed (Figure 45). Gaging station information must be included in the Microsoft Access database (Figure 4).

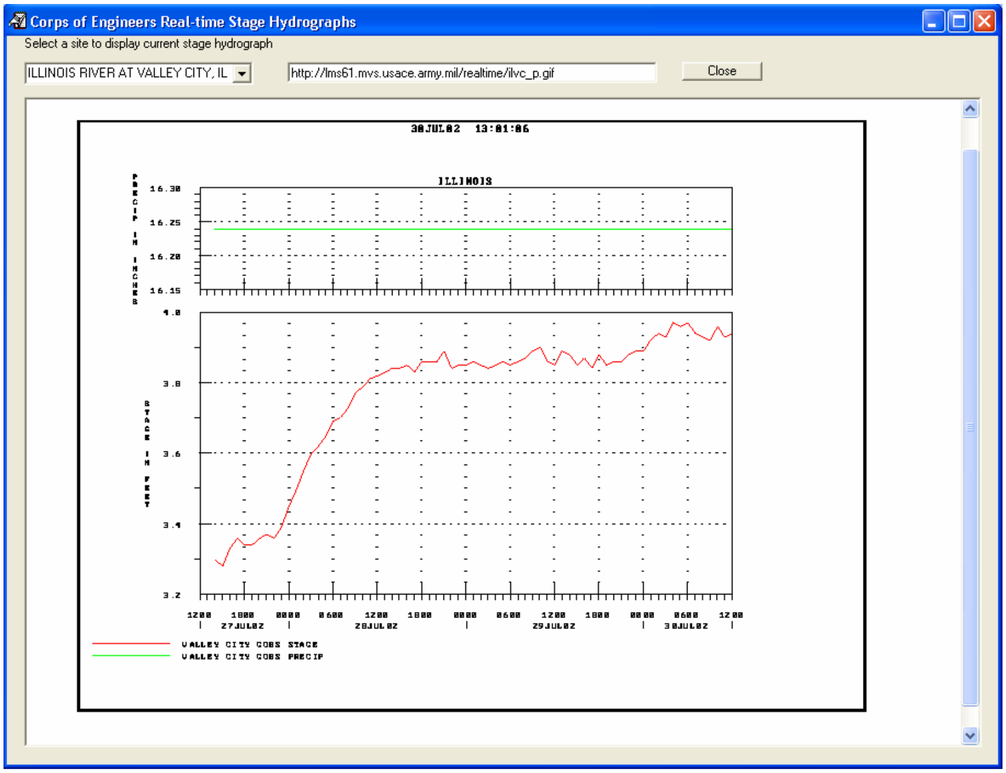


Figure 45. Displaying a real-time stage hydrograph from the USACOE Web site

Figure 46 shows NWS forecasted stage data. The report information uses either water surface elevation or gaging height above a reference gage datum.

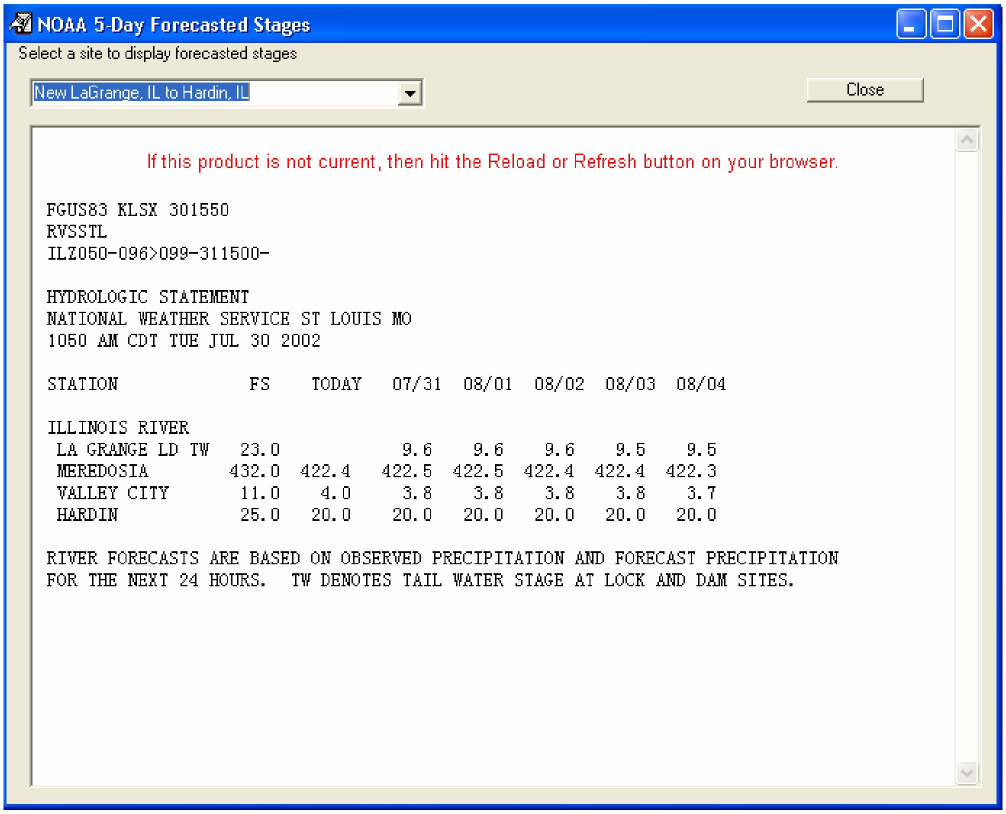


Figure 46. Displaying forecasted stages from the NWS Web site

SUMMARY

The Windows-based interface developed in this project has been improved greatly since the previous version (Lian et al., 2001). It has the capability to download real-time and historical stage and discharge data of gaging stations on the Lower Illinois River and its tributaries, and of gaging stations on Pool 26 of the Mississippi River and its tributaries from the USGS, the USACOE, and the NWS Web sites. It executes the UNET model using existing geometry and boundary condition files and post-processes the DSS database to visualize stage and discharge hydrographs and stage profiles with existing levee systems on both sides of the river from Grafton to the Peoria Lock and Dam. The real-time flooding event is simulated based on the three-reach UNET model using the real-time stage and discharge data downloading interactively from the USGS and USACOE Web sites. The interface allows the user to select the levee failure option (simple overtopping or piping failure) and modify the parameters of levee failure, thus enabling the model to simulate the management option of levee failure during a flooding event. The interface can display simulated results in graph and table formats. The user also can analyze changes by comparing the stage profiles from two separate simulations (for example, existing levee condition and levee failure options). A table associated with the simulations displays the differences at every cross section.

This interface prepares an input file for the UNET model and post-processed the output from the DSS database without changing functionality and capability of the UNET core model, thereby maintaining UNET model accuracy and reliability. This program was developed for simulations of real-time flooding on the Lower Illinois River, and the gaging station information database only includes gages related to Illinois River UNET model. However, the user can develop similar databases to use this interface. Data can be interactively downloaded for the current USGS, USACOE, and NWS Web sites and for the file formats being used when the program was developed. Any change of data format made at USGS, USACOE, and NWS Web sites may result in data downloading error. Future enhancements will include scripts for the Web files to allow the users to make changes to Web addresses and file conversion scripts.

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U.S. Army Corps of Engineers. 1994. *The Great Flood of 1993, Post-Flood Report. Upper Mississippi River and Lower Missouri River Basins*; *Appendix C.* U.S. Army Corps of Engineers, St. Louis District, St. Louis, Missouri.

APPENDIX A: INSTALLATION

To install:

Insert the CD-ROM into your CD drive. The CD will autoplay to start the installation. Select “Install” to install the program. Due to the older programs referenced within the real-time program, directories and files with names of 8 characters or less are required. There should be no space in the directory and file names. Select “Extract Data” to extract data for the UNET model to the same directory in which the program was just installed. Click “Exit” to finish the installation and remove the CD from your computer. You also may install the program though the control panel “Add/Remove programs” option in Windows. Follow the instructions given there.

Note: The interface program only can run on computers with operating systems of Windows NT, Windows 2000, or Windows XP.

APPENDIX B: DSS DATABASE OF OBSERVED HISTORIC STAGE AND FLOW DATA

Stations	*ID*	*Source*	*Type*	*Duration*
Illinois River at Peoria	5560000		Flow	1903-1906 1910-1938
Peoria L&D Tail		Rock Island COE	Stage	1988-1999
Bay Creek at Pittsfield	5512500	USGS	Stage	1993-1998
Bay Creek at Pittsfield	5512500	USGS	Flow	1939-1999
Big Bureau Creek at Princeton	5556500	USGS	Stage	1993-1998
Big Bureau Creek at Princeton	5556500	USGS	Flow	1936-1999
Illinois River at Beardstown	5584000	USGS	Flow	1920-1938
Illinois River at Florence		St Louis COE	Stage	1930-1938; 1942-2000
Illinois River at Hardin	5587060	USGS	Stage	1987-1998
Illinois River at Hardin	5587060	St Louis COE	Stage	1878-1880; 1932-2000
Illinois River at Havana	5570500	USGS	Flow	1921-1927; 1985-1989
Illinois River at Kingston Mines	5568500	USGS	Stage	1993-1998
Illinois River at Kingston Mines	5568500	USGS	Flow	1939-1999
Illinois River at Pearl		St Louis COE	Stage	1878-1881; 1885-1938; 1942-2000
Illinois River at Valley City	5586100	USGS	Flow	1938-1999
Illinois River at Valley City	5586100	St Louis COE	Stage	1883-1999
Illinois River near Copperas Creek		Rock Island COE	Stage	1988-1999
Illinois River near Havana	5570500	Rock Island COE	Stage	1988-1999
Illinois River near Kingston Mines	5568500	Rock Island COE	Stage	1988-1999
Illinois River near Meredosia	5585500	USGS	Stage	1988-1999
Illinois River near Meredosia	5585500	Rock Island COE	Flow	1989; 1991-1994
L&D 25, Tail water		St Louis COE	Stage	1938-1999
L&D 25 Pool		St Louis COE	Stage	1939-1995
L&D 26 Pool		St Louis COE	Stage	1938-1995
L&D 26 Tail		St Louis COE	Stage	1891-1990
L&D 26 Tail		St Louis COE	Stage	1992-1995
Mel Price Pool		St Louis COE	Stage	1990-1999
Mel Price Tail water		St Louis COE	Stage	1990-1995
La Moine River at Ripley	5585000	USGS	Stage	1993-1998
La Moine River at Ripley	5585000	USGS	Flow	1921-1999
Mackinaw River at Congerville	5567500	USGS	Stage	1993-1998
Mackinaw River at Congerville	5567500	USGS	Flow	1944-1999
Mackinaw River near Green Valley	5568000	USGS	Stage	1993-1998

APPENDIX B (concluded)

Stations	*ID*	*Source*	*Type*	*Duration*
Mackinaw River near Green Valley	5568000	USGS	Flow	1921-1956
Mackinaw River near Green Valley	5568000	USGS	Flow	1988-1999
Macoupin Creek near Kane	5587000	USGS	Stage	1993-1998
Macoupin Creek near Kane	5587000	USGS	Flow	1921-1999
Mississippi River at Alton	5587498	St Louis COE	Stage	1990-2000
Mississippi River at Alton	5587498	USGS	Flow	1933-1987
Mississippi River at Dixon		St Louis COE	Stage	1930-2000
Mississippi River at Grafton	5587450	St Louis COE	Stage	1879-1904; 1929-1999
Mississippi River at Grafton	5587450	USGS	Flow	1933-1998
Mississippi River at Keokuk	5474500	USGS	Flow	1878-1999
Mississippi River at St. Louis	7010000	USGS	Flow	1933-1999
Missouri River at Hermann	6934500	USGS	Flow	1928-1998
Sangamon River near Oakford	5583000	USGS	Stage	1993-1999
Sangamon River near Oakford	5583000	Rock Island, COE	Stage	1988-1999
Sangamon River near Oakford	5583000	USGS	Flow	1909-1911; 1914-1919; 1921-1922; 1928-1933; 1939-1999
Spoon River at Seville	5570000	USGS	Stage	1993-1998
Spoon River at Seville	5570000	USGS	Flow	1914-1999
Spring Creek at Springfield	5577500	USGS	Stage	1993-1998
Spring Creek at Springfield	5577500	USGS	Flow	1948-1999
Troy on Cuivre River	5514500	USGS	Flow	1922-1998
Mississippi River at Grafton	5587450	COE, St. Louis	Flow	1929-1999

APPENDIX C: GAGING STATIONS FOR REAL-TIME AND FORECASTED STAGE AND FLOW DATA

			Real-time	*Forecasted*	
Stations	*ID*	*USGS*	*COE*	*COE*	*NWS*
Mississippi River at Hannibal	05501600	Flow		Stage	
Bear Creek at Hannibal	05502000	Flow			
Mississippi River L&D Headwater	05513675	Flow, Stage	Stage	Stage	
Mississippi River L&D Tailwater	05513675	Flow, Stage	Stage	Stage	
Sugar Creek at Milford	05525500	Flow, Stage			
Illinois River at Marseilles	05543500	Flow, Stage			Stage
Bay Creek at Pittsfield	05551250	Flow, Stage			
Big Bureau Creek at Princeton	05556500	Flow, Stage			
Illinois River at Peoria	05560000	Flow, Stage		Stage	Stage
Mackinaw River near Congerville	05567500	Flow, Stage			
Mackinaw River near Green Valley	05568000	Flow, Stage			
Illinois River at Kingston Mines	05568500	Flow, Stage			
Spoon River near Seville	05570000	Flow, Stage			
Illinois River at Havana	05570500	Flow, Stage			Stage
Spring Creek at Springfield	05577500	Flow, Stage			
Illinois River at Henry	0558300	Flow, Stage			Stage
Sangamon River near Oakford	05583000	Flow, Stage			
Illinois River at Beardstown	05584000	Flow, Stage		Stage	Stage
La Moine River at Ripley	05585000	Flow, Stage			
Illinois River at Meredosia	05585500	Flow, Stage	Stage	Stage	
Illinois River at Valley City	05586100	Flow, Stage	Stage	Stage	
Macoupin Creek near Kane	05587000	Flow, Stage			
Illinois River near Hardin	05587060	Flow, Stage	Stage	Stage	
Mississippi River at Grafton	05587450	Flow, Stage	Stage	Stage	
Mississippi River at Alton	05587498	Flow, Stage	Stage		
Mississippi River at Hartford	05587750	Flow		Stage	
Mississippi River at St Louis	07010000	Flow	Stage	Stage	
Mississippi River at Chester	07020500	Flow		Stage	
Mississippi River at Cape Girardeau	07020850	Flow	Stage	Stage	Stage
Mississippi river at Thebes	07022000	Flow		Stage	
Illinois River at Peoria L & D					Stage
Illinois River at Florence			Stage		
Mel Price Pool			Stage		
Mel Price Tail			Stage		