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Hydrologic Engineering Center

Hydrologic Modeling System HEC-HMS

Release Notes

Version 3.0.0
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Introduction

Version 2.2.2 of the Hydrologic Modeling System (HEC-HMS) was completed in May 2003 and released for general use shortly thereafter. For a number of reasons, it was necessary to completely replace the program interface. While designing the replacement, we took the opportunity to improve accessibility, incorporate workflow efficiencies, and improve the ability of the program to adapt to the user. A number of simulation capabilities were also added. The result is this new version with a brand new interface. It is currently available for the Microsoft Windows® operating system and will soon also be available for the Sun Microsystems Solaris™ operating system.

The *Technical Reference Manual* for Version 2.0 continues to accurately describe the mathematical models included in the program. New simulation capabilities described later in this document have been added to the program and are not included in the manual. The manual is currently undergoing a major revision to expand documentation of existing mathematical models and fully describe the newly added models. The *Applications Guide* also continues to accurately describe how to apply the program to various engineering problems. However, the guide is undergoing revision to add guidance on how to use new features of the program to more efficiently solve problems.

The program has been designed to be easy to use. However, an understanding of how the program works is critical to producing accurate results. It is suggested that a new user read the *Quick Start Guide*. The guide briefly describes the basic features of the program in enough detail to begin using it. The guide also includes a step-by-step tutorial.

Installation

The installation program and all documentation are available on the HEC website at http://www.hec.usace.army.mil/. The 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. If the software was provided to you on a CD-ROM or other media, insert it in the appropriate drive.

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.

Instructions for installing the program on the Sun Microsystems Solaris™ operating system can be found in Chapter 2 of the User's Manual.

Changes in Capability

The deficit and constant loss method in the subbasin has been made more flexible in the definition of the recovery rate. Previous versions of the program included monthly recovery rates in the loss method. The loss method now retrieves the recovery rate for each time step from the meteorologic model. Necessary recovery rates can be calculated by the monthly constant or Priestley-

Taylor evapotranspiration methods. Old recovery rate data in the loss method is automatically converted to monthly constant evapotranspiration data in the meteorologic model when the old project is opened with the new version.

The gridded SCS curve number loss method in the subbasin has changed how parameters are specified. Previous versions of the program required the curve number for each grid cell to be included in the ModClark file. The curve numbers must now be stored as a parameter grid in the grid manager. There is no automatic conversion of the old data to the new format. A utility is available that can create a parameter grid in DSS from a GIS grid layer.

The soil moisture accounting loss method in the subbasin no longer uses soil moisture units. The units were originally designed to reduce repetition of work but were found to be more difficult to use than anticipated. All parameter data for the soil moisture accounting loss method is now stored separately in each subbasin. Old soil moisture unit data is automatically loaded into the subbasins when the old project is opened with the new version.

The gridded soil moisture accounting loss method in the subbasin has changed how parameters are specified. Previous versions of the program required the soil moisture unit name to be specified for each grid cell in the ModClark file. Then corresponding soil moisture units had to be configured in the soil moisture unit manager for each name used in the ModClark file. Now, all parameters must be stored as parameter grids in the grid manager. There is no automatic conversion of the old data to the new format. A utility is available that can create a parameter grid in DSS from a GIS grid layer.

The Muskingum-Cunge standard section and Muskingum-Cunge 8-point routing methods in the reach element have been combined. There is now only one Muskingum-Cunge routing method with cross section options of rectangle, trapezoid, triangle, circle, or 8-point. Old routing data is automatically converted to the new routing method when the old project is opened with the new version.

The specification of tailwater submergence calculations for the reservoir now allows greater control by the user. An option is provided for unrestricted outflow from the reservoir by specifying no tailwater calculations. An option is provided for specification of an elevation-discharge curve that is used to determine the depth of flow at the reservoir tailwater based only on reservoir discharge, and reduction of outflow as appropriate. An option is provided for specification of an elevation-discharge curve that is used to determine the depth of flow based on total flow at the element downstream of the reservoir, and reduction of outflow as appropriate. Finally, there is an option for specified stage that is used to determine the reduction of outflow as appropriate.

The specification of paired data for use in the basin model has been moved to a paired data manager. Previous versions of the program required the data to be specified at the element where it was used. For example, an inflow-diversion function for a diversion was specified along with the other parameter data for the element. Paired data is now entered once in the paired data manager and then used by reference wherever it is needed in the program, similar to the way unit hydrographs and s-graphs were handled in the previous version. Old paired data is automatically loaded into the paired data manager and connected to the element where it was used when the old project is opened with the new version.

The name of the s-graph paired data has changed; it is now called a percentage curve. This reflects the fact that it specifies the percentage of unit depth for the percentage of the time lag. Other paired data in the future will also use this same

specification. Existing manually entered s-graphs are automatically converted. External s-graphs are also converted but may have units problems. Previous versions of the program did not consider the units specified in the data header for external s-graphs. The program now requires units of "%" using the percent symbol.

The global editors are more flexible than in previous versions. When a global editor is opened it will only show the elements selected in the basin map at the time the editor is requested. For example, presume a basin model that contains a total of 10 subbasins all with the Clark unit hydrograph transform method. If only four subbasins are selected and the global editor is requested, only those four selected subbasins will appear in the editor. If no elements are selected, then the global editor will open and show all elements for the requested method. If elements were selected, then the global editor will include an option to switch to viewing all elements.

The reservoir element provides five different options for specifying storage characteristics. Routing is computed using the storage indication method when the storage-outflow, elevation-storage-outflow, or elevation-area-outflow options are selected. A direct solution of the mass conservation equation is used when the elevation-area or elevation-storage options are selected. Previously the routing method was determined automatically based on the selected option for specifying the storage characteristics. It is now required to select the routing method.

New Simulation Capabilities

Several types of time-series data have been added to support new simulation capabilities. These include temperature, solar radiation, and crop coefficient. Stage gages have also been added. All basin model elements now include the option of observed stage, using the new stage gages.

The Priestley-Taylor evapotranspiration method has been added to the meteorologic model. It is implemented with a crop coefficient to account for changes in the plant's ability to match the potential demand. The coefficient is specified as a time-series so that intra-annual and inter-annual changes can be taken into account.

The gridded Priestley-Taylor evapotranspiration method has been added to the meteorologic model. It is essentially the same as the standard Priestley-Taylor method except that all calculations are performed on a grid cell basis. This allows for separate evapotranspiration potentials in each grid cell based on changes in temperature, solar radiation, and crop coefficient in each cell.

The temperature index snowmelt method has been added to the meteorologic model. It uses a variety of data to compute a meltrate per degree above freezing, but does it separately for each time step. The computed meltrate depends on the temperature of the accumulated snow pack, amount of precipitation, temperature above or below freezing, and the antecedent conditions. Ground melt from below the snow pack can also be included. It can be applied by breaking the subbasin into one or more elevation bands.

The gridded temperature index snowmelt method has been added to the meteorologic model. It is essentially the same as the standard temperature index method except that all calculations are performed on a grid cell basis. This

allows for some key parameters to be specified separately for each grid cell while other general parameters are specified for all subbasins.

The exponential loss method has been added to the subbasin. It is implemented using the same algorithm found in the legacy HEC-1 program. It is suitable for event simulation but parameter estimation usually requires calibration data.

The gridded deficit and constant loss has been added to the subbasin. It implements the deficit and constant loss method on a grid cell basis with separate parameters and boundary conditions for each cell. The parameters are stored as parameter grids in the grid manager, including a grid of impervious area in each grid cell. A utility is available that can create a parameter grid in DSS from a GIS grid layer.

The number of spillways, over flows, and outlets for a reservoir has been increased. Previously, only one of each outflow type was allowed for the elevation-storage or elevation-area options. Now up to 10 different spillways, 10 over flows, and 10 outlets may be used.

A new culvert outlet is now available for reservoirs using the elevation-storage or elevation-area options. The culvert allows simulation of inlet or outlet control situations. The user may specify which assumption to use or allow the program to automatically determine the controlling condition for each time step. Nine different culvert shapes are provided.

Pumps may now be included for reservoirs using the elevation-storage or elevation-area options. They are a main category like spillways, over flows, outlets, and dam break. Initially only one pump option is provided; head-discharge pump.

A depth-area analysis tool has been added to assist in developing frequency-based flow estimates at many locations in a watershed. The tool works by selecting a simulation run that uses a meteorologic model with the frequency precipitation method. Elements in the basin model can be selected and appropriate storms will automatically be generated using the correct depth-area reductions at each selected element.

Known Issues

The new snowmelt capabilities in the meteorologic model have been carefully tested. Nevertheless, the large scope of the capability means that new issues are likely to be discovered as the development team continues testing. Testing is an ongoing process for the entire program. Continued aggressive testing of the snowmelt capabilities is expected to rapidly mature it to the same level as the remainder of the program.

Future Plans

A new baseflow method is under development based on the nonlinear Boussinesq flow assumptions. It is similar to the existing recession method except that the parameters are physically measurable in the watershed. The new method will make it much easier to develop baseflow estimates in ungaged watersheds.

New reservoir spillway options are under development. Control gates will be added to both ogee and broad-crested spillways. Options will be provided for

vertical lift gates (sluice gates) and also radial gates (tainter gates). Controls will be provided so that gate operations can be simulated.

Land surface erosion and channel sediment transport is under development. Initially one simple method will be provided for simulating land surface erosion as part of subbasin calculations. Eventually more complex methods will be added to the subbasin. A simplified channel transport capability will be added to reach elements. It will handle erosion and deposition within the channel in addition to transport down the channel, all in a simplified approach appropriate for hydrologic simulation. It is not anticipated to include a movable bed.

A frequency curve analysis tool will be added to assist in developing curves from a family of events. The tool assumes that events have been developed for specific exceedance probabilities using the frequency storm. The user will be able to select the simulation run or depth-area analysis that represents each exceedance probability. By also selecting analysis locations, frequency curves will be automatically developed for those locations using the peak flow data.

Several features for the basin map are already under development. An alignment will be added for specifying the location and stationing of streams. Using it will be optional, but it will facilitate laying out reach elements and integrating with other HEC software. Tools will also be added for controlling the drawing properties of background maps. Finally, display of gridded input (such as precipitation) and gridded parameters (such as SCS curve numbers) will be added to the map.

Results visualization will also be improved. Drawing properties for graphs will be customizable. Access to the line styles, background patterns, axis scales, titles, and other components of a graph will all be customizable. Furthermore, where results are currently not available if they need to be recomputed, it will be possible to view old results but they will be labeled as out-of-date. Finally, additional results for the depth-area analysis will be added.

A flexible report generation tool is underdevelopment. It will be able to produce reports of basin model and meteorologic model input data, as well as simulation run results. The reports will be based on a generalized format that can be easily customized both in the data displayed and the formatting used to display it.

Documentation

The *Hydrologic Modeling System HEC-HMS: Quick Start Guide* provides a brief description of the program for new users. It describes the different parts of the interface and the basic steps necessary to obtain simulation results. A tutorial takes the user through the creation of a new project and shows how to obtain results.

The *Hydrologic Modeling System HEC-HMS: User's Manual* contains extensive information on installing and using the program. Details on the use of each of the features and capabilities in the program are included.

Support Policy

Technical support for program users within the Corps of Engineers is provided through an annual subscription service. Subscribing offices can expect full support from HEC staff in the routine application of the program. Users are strongly urged to consult with HEC staff on the technical feasibility of using the

program before beginning a project with unique requirements such as grid cell hydrology, snow melt, or continuous simulation. Extended support for large or complex projects can be arranged under a separate reimbursable project agreement.

Support can not be provided to users outside the Corps of Engineers. Domestic and foreign vendors are available that provide fee-for-service support similar to the support provided to subscribing Corps offices. Such service agreements are between the user and the vendor and do not include HEC staff. Vendors do contact HEC on behalf of their users when unusual problems or errors are encountered. A list of vendors can be found at http://www.hec.usace.army.mil/.

Reporting of suspected program errors is unrestricted and we will reply to all correspondence concerning such errors. We are continuously working to improve the program and possible bugs should always be reported. Reports should include a written description of the steps that lead to the problem and the effects that result from it. If we cannot reproduce the reported problem, we may ask you to send a copy of your project.

Request support or report program errors through the following channels:

- Call 530.756.1104, 7:30 am to 4:30 pm PT Monday through Friday.

- Fax 530.756.8250 any time.

- Write to U.S. Army Corps of Engineers, Institute for Water Resources, Hydrologic Engineering Center, 609 Second Street, Davis, CA 95616-4620 USA.

- Send email to *hec.hms@usace.army.mil* on the internet.

- Visit our web site at http://www.hec.usace.army.mil.