RiverTools™

Topographic and River Network Analysis

What's New in RiverTools 2.4

March, 2001 Edition

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What's New in RiverTools 2.4

RiverTools 2.4 is a powerful and yet easy-to-use GIS application that specializes in the analysis and visualization of digital terrain, watersheds and river networks. RiverTools makes it easy to import digital elevation data in a wide variety of formats, including the SDTS Raster Profile format recently adopted by the USGS and many more. In addition to raster formats, RiverTools 2.4 now supports the import, export and display of ESRI Shapefiles, and the import and display of USGS Digital Line Graphs in SDTS format.

RiverTools includes many specialized algorithms for the analysis of DEMs and watersheds, including both D8 and D-Infinity flow algorithms, and state-of-the-art methods for dealing with pits and flats. It can quickly measure stream attributes such as length, drop, slope, curvature, upstream area, sinuosity, drainage density, longitudinal profiles, longest channel length, Horton-Strahler order and many more, for single channels or entire river networks. All of these measurements are made using the currently selected ellipsoid model of the Earth, with built-in support for over 50 different ellipsoids.

While many GIS applications have a simple scripting language for extending their functionality, RiverTools can be extended with the full power of IDL, the Interactive

Data Language, and hundreds of low-level RiverTools commands. RiverTools also runs identically on Windows, Mac, and UNIX platforms.

Overview of New Features

New File Import/Export Improvements – New file import capabilities now include the ability to read NOAA/NOS EEZ Bathymetry files and GMT raster files. Support for vector file formats has been expanded to include import, display and overlay of ESRI Shapefiles and USGS SDTS files in Topological Vector Profile format. RiverTools 2.4 also offers the ability to easily export vector data and attributes to spreadsheets and other GIS Programs. See "New File Import/Export Improvements" on page 9 for more information about these and other File menu improvements.

New Display Menu Functions – New Vector Graphic display capabilities include the ability to import and plot ESRI Shapefiles and USGS Digital Line Graphs in SDTS format. Another new Display menu feature allows you to plot a function that has been saved as a text file. See "New Display Menu Dialogs" on page 15 for more information.

New Prepare Menu Enhancements – New tools within the Prepare menu now allow you to compress and uncompress any file that has been saved with the popular GZIP algorithm. Other enhancements include improvements to the DEM mosaicking dialog and creating RTI files for a set of USGS 1-Degree DEMs. See "New Prepare Menu Enhancements" on page 17 for more information.

Enhanced Hydrologic Analysis Features – RiverTools 2.4 now supports continuous flow angles and multiple flow directions via the D-Infinity algorithm. It also supports two new options for routing flow through broad, flat valleys, more options for area-altitude plots, and a new routine for "watershed segmentation." See "Enhanced Hydrologic Analysis Features" on page 20 for details about these and other new Extract menu enhancements.

Enhanced Interactive Window Tools – All of the tool dialogs now feature an Options menu that greatly expands their functionality and makes them easier to configure. See "Enhanced Interactive Window Tools" on page 28 for more information.

Expanded Help Features – Quickly find answers to your questions using the new Windows online help feature or access help through new context-sensitive Help buttons now available on many of the dialogs. See "Ease-of-Use Improvements" on page 30 for more information on these features and enhanced Window menu features.

New Customization Features – New naming conventions for RiverTools routines and a new ability to permanently modify the User menu make it easier to extend RiverTools with user-written routines. See "New Customization Features" on page 31 for more information.

New Data CD-ROM – RiverTools 2.4 also comes with a data CD-ROM full of interesting digital terrain data in many different formats. This data is ideal for teaching a course with RiverTools and for demonstrating the raster and vector import capabilities. See "New Data CD-ROM" on page 32 for details.

New File Import/Export Improvements

RiverTools 2.4 now includes two new formats in the **File → Import DEM** dialog and expanded ability to grid irregular XYZ elevation data. New **File → Export** dialogs support exporting ENVI and ArcView grid files, and exporting vector data to ESRI Shapefiles or ASCII tables. Other File menu improvements include support for over 50 ellipsoid models of the earth and a new **Printing Options** dialog that replaces the Page Layout dialog. The File menu also allows you to control various aspects of the current RiverTools session by setting session preferences. See the following sections for details.

Improved File > Import DEM Dialog

RiverTools 2.4 can import a wide variety of DEM formats, including ArcView (.bil), ENVI, flat binary, GeoTIFF (.tif), USGS Standard (.dem), USGS SDTS (Raster Profile, .ddf), DTED (.dt0, .dt1, .dt2), gridded ASCII, NOAA/NOS EEZ Bathymetry and the GMT raster. The last two are new in this release. Note that GTOPO30, ETOPO5, Mars MOLA and NED (National Elevation Data) DEMs are also supported since they are distributed in formats listed above.

- **File → Import DEM - NOAA/NOS EEZ Bathymetry** — This new option allows you to import NOAA/NOS EEZ Bathymetry data in either the Geographic-based format (*.grd, *.prg) or the UTM-based format (*.dat, *.pru).
- **File → Import DEM - GMT Raster DEM** — This new option allows you to import DEMs in GMT's raster DEM format (*.grd), which is a special type of netCDF file.
- **File → Import DEM - Irregular XYZ** — This routine creates a regular binary grid from irregular XYZ ASCII data using two IDL routines called TRIANGULATE and TRIGRID. The input file must be in ASCII format with one XYZ triple per line.

  Make sure to specify the correct pixel x,y units. This can often be inferred from the min/max info. All x-values must be between -180 and 180, and all y-values must be between -90 and 90 in order for Degrees to be an option. The resulting size of the grid is determined by the bounding min/max values and the pixel x-size and y-size that you specify. A RiverTools info file is also created.

Other File importing improvements have been made to the **File → Import DEM → USGS Standard DEM** and the **File → Import DEM → USGS SDTS DEM**

options. Both have been improved to create "smart" default DEM filenames based on the USGS map title.

New File > Export Features

RiverTools now supports exporting data from RiverTools vector files (RTV) into ESRI Shapefiles and multi-column text files, and exporting RiverTools grid files (RTG) to four other grid formats. The **File → Export Vector → Channels, File → Export Vector → Boundaries** and **File → Export Grid** dialogs offer enhanced ability to export data and attributes and provide better integration with other GIS and spreadsheet programs.

- **File → Export Grid** — New Export Grid features add support for GeoTIFF and gridded ASCII formats. RiverTools, ENVI, and ArcView all store raster data in flat binary files in row major format. However, each has its own ASCII "header" file that contains georeferencing information. This dialog allows you to create an ENVI or ARC header file from an existing RiverTools RTI file. You can export any RiverTools grid (*.rtg).
- **File → Export Vector → Channels** — This new dialog allows you to export the spatial coordinates and attributes of channel links or Horton-Strahler streams stored in RTV files to other vector formats such as ESRI Shapefiles and multi-column text files. Exporting files as ESRI Shapefiles or as an ASCII table makes it easy to then import the data into another GIS or spreadsheet program. You can choose any subset of 19 measured channel attributes for inclusion in the output file. Listed attributes are defined in Appendix B, "RiverTools Glossary" of the *User's Guide*.

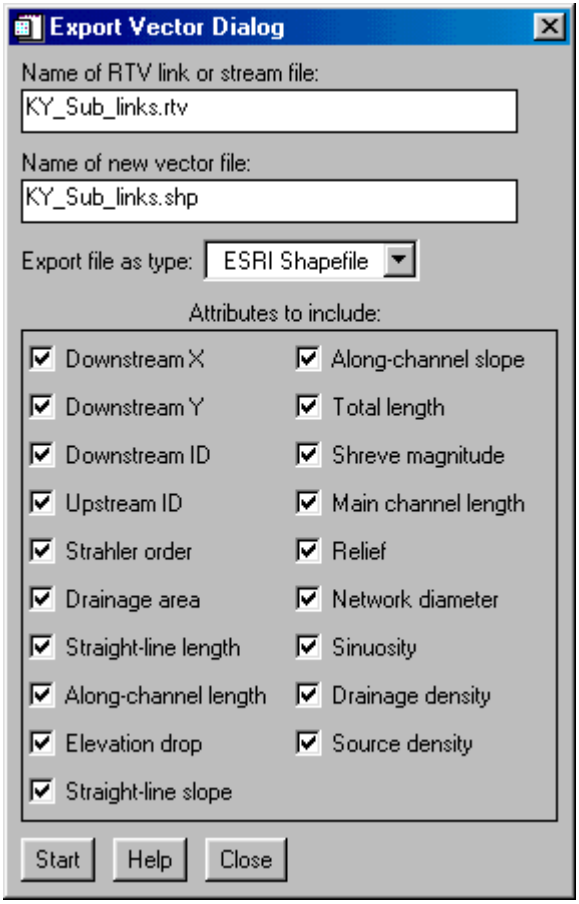

Figure 1: File → Export Vector Dialog

- **File → Export Vector → Boundaries** — This new dialog allows you to export the spatial coordinates and attributes of the boundaries of "shapes" stored in a RiverTools Mask (RTM) file to an ESRI Shapefile. Exporting files as ESRI Shapefiles makes it easy to then import the data into other GIS software. The attributes area, diameter and shape factor are included in the output file. Listed attributes are defined in Appendix B, "RiverTools Glossary" of the *User's Guide*.

Other File Menu Improvements

RiverTools 2.4 has added support for over 50 ellipsoid models of the Earth through the **File → Set Preferences – Planet Info category**. Other File menu improvements include a new **Printing Options** dialog, the ability to read text files within RiverTools and the ability to control more aspects of the RiverTools session.

- **File → Change Basin Prefix** — This is a renamed and relocated version of the former **File → Edit Filename Info** dialog, that allows you to select and work with a previously extracted set of files for a particular basin in your DEM.
- **File → Set Preferences - Planet Info category** — This dialog lets you choose from over 50 different ellipsoid models of the Earth, so that all length, slope and area calculations are based on the currently selected ellipsoid. This is in sharp contrast to most GIS programs that treat all pixels as if they have the same geometry in these calculations. (In other programs, DEMs need to be reprojected into an equal-area projection which leads to distortion and reduced accuracy for measured quantities.)

  The selected ellipsoid is used throughout RiverTools to calculate lengths, slopes and areas for DEMs with geographic (latitude /longitude) coordinates or fixed-angle pixel geometry. Prior to processing, you should choose the ellipsoid that matches the source information for the DEMs you are using. For USGS DEMs, it is usually the GRS 80 ellipsoid (North American Datum 1983) or Clarke 1866 (North American Datum 1927).
- **File → View Text File** — This new dialog provides a convenient way to view any text file, including RTI files and log files, from within RiverTools.
- **File → Printing Options** — This new dialog allows printing at full resolution and is streamlined for user efficiency. The information in this dialog is used by RiverTools to set the size, position, orientation, and resolution of an image that is to be printed to the printer via **File → Print** or to a PostScript file via **File → Print to File**. The current aspect ratio (ratio of width to height) of the image in the display window is preserved, but the width on the page can be set to any value less than the paper width. You can also adjust the margins.

  By default, raster images are printed at the highest resolution supported by your printer. You can reduce the resolution below this value by entering a reduction factor larger than the one shown. The width required to print a DEM-based image at full resolution is shown. Vector-based images such as line drawings and contour plots are unaffected by the reduction factor.

Sometimes printers add a small amount to the margins which you may need to subtract. You can confirm that margins are set correctly by printing to a PostScript file via **File** → **Print To File**, and viewing it.

The "Print via screen capture" option provides a method for printing insets such as scale bars and color bars that have been "burned into" a raster image.

- **File** → **Set Preferences - General category** — The values in this dialog control various aspects of the current RiverTools session. All values less than or equal to the NODATA threshold are treated as NODATA until the value is changed. It is often necessary to set this value to 0.0 when working with DEMs that border the sea.

  Many processing routines process large data sets in pieces that are less than the Max RAM block size. The default is fairly low and can be raised to a value around half of available RAM.

Floating dialogs are dialogs that cannot fall "beneath" the main log window. In this mode, an entire RiverTools session can be minimized into a single icon if your platform supports this behavior.

Figure 2: Planet Info Preferences in File → Set Preferences

New Display Menu Dialogs

New Display menu functions include the ability to import and display vector graphic files and the ability to display a function as a plot once it has been saved as a text file.

- **Display → Density Plot** —This dialog has been improved so that you can now choose from a droplist of stretches including histogram equalization, linear, power laws, logarithmic, and "cycle plotting colors."
- **Display → Vector Graphic → ESRI Shapefile** —This dialog allows you to import an ESRI Shapefile, plot the entities, and display a table of associated attributes. You can include vector data from Shapefiles in a multi-layer plot in the standard way using **Display → Multi-Layer Plot**. Point, PolyLine, and Polygon vector layers are all supported. This dialog can be used to re-import and display RiverTools vector data after it has been exported to a Shapefile via the **File → Export Vector** dialog.
- **Display → Vector Graphic → DLG-SDTS** — This dialog allows you to import and plot a USGS Digital Line Graph (DLG) in SDTS format (Topological Vector Profile). The USGS currently distributes its high-resolution 1:24K DLGs for free in this newly mandated format on the Internet. The older DLG-Optional format is not yet supported. You can include vector data from DLGs in a multi-layer plot in the standard way using **Display → Multi-layer Plot**.
- **Display → Function** — This dialog allows you to plot a function saved as one or more columns of numbers in a text file. There are several places in RiverTools where you can save a function or a profile in this format. You may also wish to create your own functions with IDL.

  Entries in a row can be separated by white space, commas, semi-colons, or colons. Null lines and any lines that do not contain enough columns are skipped. If the data is preceded by several lines of header information, you can use the View File button to view the text file and count the number of header lines. You must then enter this number in the text box that is labeled "Lines to skip".

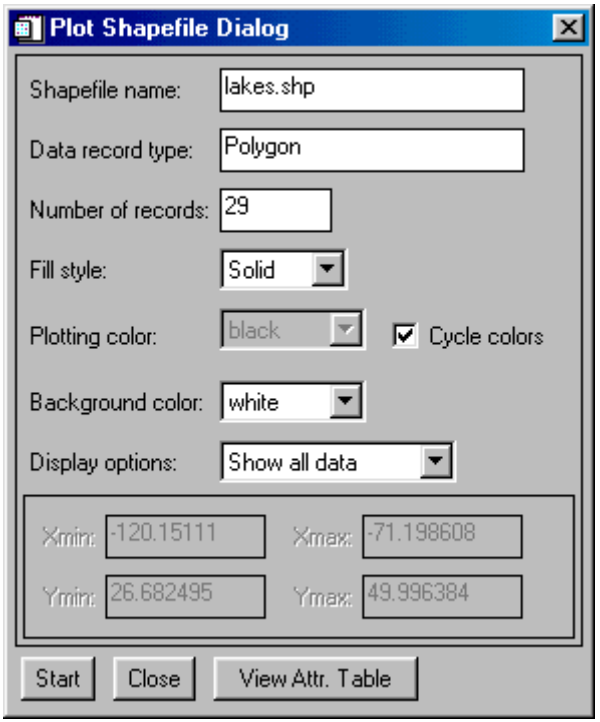

Figure 3: Display → Vector Graphic → ESRI Shapefile Dialog

New Prepare Menu Enhancements

Enhancements to the Prepare menu include the ability to compress and uncompress files, an improved dialog for mosaicking RiverTools DEM grid files, the ability to merge or concatenate a set of files and the ability to quickly create RTI files for numerous USGS 1-Degree DEMs.

Merging RTV and RTM Files

This tool is for merging two or more files into a single file. Any set of RiverTools mask (*.rtm) files that index the same DEM grid file can be merged. You can also merge a set of RiverTools linkfiles (*_links.rtv) or a set of RiverTools streamfiles (*_streams.rtv) that correspond to different basins in the same DEM. Each of these basins will have its own basin prefix. It does not make sense to merge a linkfile and a streamfile, or to merge two linkfiles or streamfiles that are associated with different DEMs.

The new filename should have the same prefix and extension as the files that are merged, such as ".rtm, "_links.rtv", "_streams.rtv" or ".txt". Otherwise, it may not be recognized and will not appear in droplists of available files. For link and stream files, it is helpful to use a new basin prefix.

You can also use this dialog to concatenate a set of text files. In this case, the order of the files matters and will be the same as shown in the list.

The buttons on the right apply to the highlighted file in the list on the left. Use the Add and Remove buttons to add or remove files from the list. Edit the filename filter to restrict the set files in the Add dialog. When you have finished adding files to the list, press the Start button to begin the merge operation.

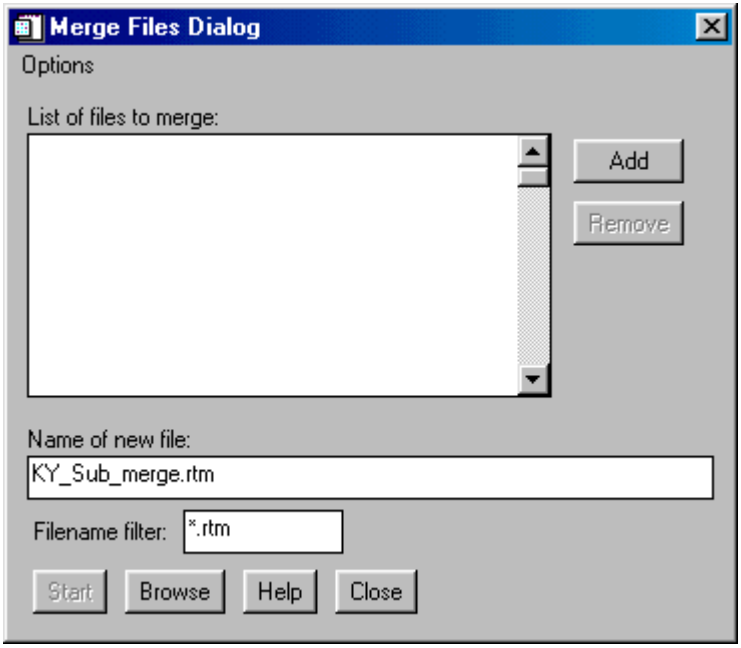

Figure 4: New Prepare → Merge Files Dialog

Compressing and Uncompressing Files

The new **Prepare → Gzip File** and the **Prepare → Ungzip File** dialogs allow you to compress or uncompress any file with the well-known GZIP algorithm. Filenames for gzipped files should end in ".gz". Compressed files take up less hard disk space and take less time to transfer over a network. However, they must be uncompressed before use.

Mosaicking RiverTools DEM Grid Files

The **Prepare → Patch RTG DEMs** tool is for "patching together" or mosaicking RiverTools DEM grid files. The buttons on the right apply to the highlighted DEM grid file in the list on the left. Use the Add and Remove buttons to add and remove DEMs from the list. You can also preview a shaded relief image of the DEM (scaled to fit the screen) with the Preview button, and view or edit an RTI info file for the DEM by pressing the Edit Infofile button.

When you have finished adding DEMs to the list, press the Start button. A preview image showing how the DEMs fit together is displayed. Pixels with NODATA values are shown in white. Regions for which no data is available are assigned the NODATA value you have indicated in your Preferences.

Click and drag inside the preview window to select the region for which you want to create a new DEM. Info about the selected region is printed in the output log. You can select the entire window by clicking the right mouse button. This is the default selection.

Press the Save New DEM button to create the new DEM, a "raw" DEM copy, and an RTI info file.

The new "Options" menu at the top of the dialog lets you save a list of DEMs or to use a saved list so you don't have to add them again. There is also a Change Backdrop option that lets you choose between Density Plot or Shaded Relief backdrops. Additionally, a new Label DEMs button on the patching preview window lets you label each component DEM with its name.

Making RTI Files for USGS 1-Degree DEMs

RTI files are automatically created whenever you import a DEM with the **File** → **Import DEM** dialog. However, USGS 1-Degree DEMs are sometimes distributed in a nonstandard format where the lat/lon of the southeast corner is recorded in a 5-digit filename prefix. The new **Prepare** → **USGS 1-Deg. DEMs** → **Make RTI Files** dialog lets you make RTI files for a large number of USGS 1-Degree DEMs with this naming convention. This dialog allows you to quickly create RTI files for a set of USGS 1-Degree DEMs as long as the following two conditions are met:

- Converted to flat binary, row-major format.
- Given filenames with a 5-digit lat/lon prefix.

Some vendors re-distribute USGS 1-Degree DEMs in this format. Conversion to this format can also be done as a batch process by using wildcards in the **Prepare** → **Convert Grid** dialog.

Filenames must consist of a 5-digit lat/lon prefix. Bounding box info can then be determined from the filenames. All other geocoding info for these DEMs can then be determined automatically, even for DEMs in Alaska. Latitudes and longitudes in this dialog refer to southeast corners.

RTI filenames will have the same prefixes and end in ".rti". Once RTI files have been created for a set of 1-Degree DEMs, they can easily be mosaicked with the **Prepare** → **Patch RTG DEMs** dialog described previously.

Enhanced Hydrologic Analysis Features

RiverTools 2.4 has a significantly expanded set of tools for hydrologic analysis that provide the latest advancements and algorithms in the field. Examples include:

- Two new options for assigning flow directions through broad, flat valleys through the **Extract → Flow Grid (D8)** function, based on the "imposed gradient" method of Garbrecht and Martz (1997) and a new variant of that method. See "New Extract > Flow Grid Features" on page 21 for more information
- Support through the **Extract → D-Infinity Grid** routines for continuous flow angles and multiple flow directions via the D-Infinity algorithms of Tarboton (1997). See "New Extract > D-Infinity Grid Routines" on page 21 for details.
- The **Extract → RT Treefile** routine can now read a set of outlets from a text file. See "Enhanced Extract > RT Treefile Routine" on page 22 for more information.
- Several new D8-based Grid routines now feature the ability to compute curvature of flow paths, flow distances, Horton-Strahler grids and watershed subunits. See "New Extract > D8-based Grid Routines" on page 22 for more information.
- The new **Extract → D8-based Grid → Watershed Subunits** dialog lets you create a "watershed segmentation" grid and RTM file from a RiverTools linkfile. See "New Extract > D8-based Grid Routines" on page 22 for details.
- Two new routines now feature the ability to derive a topographic index grid or a product of two RiverTools grids. See "New Extract > Derived Grid Routines" on page 23 for details.
- Additional peak, ridge, and grid threshold masking routines for creating RiverTools mask files from grids. See "New Masking Routines" on page 24 for details.
- More options for area-altitude plots are detailed in the section, "Enhanced Area-Altitude Function" on page 24.
- The **Analyze → Subbasins → Shape Plots** dialog has several new features. This dialog lets you closely examine the shapes or "mask cells" in a RiverTools mask file (RTM) one at a time. See "Enhanced Basin Shape Analysis" on page 25 for more information.

Note

Most functionality of the **Extract → Data from RTV File**, renamed from Export Vector in RiverTools 2.0, has been superseded by the new **File → Export Vector** dialog. See "New File > Export Features" on page 10 for more information.

New Extract > Flow Grid Features

The **Extract → Flow Grid (D8)** routine offers new options for assigning flow directions within flats, including the Garbrecht and Martz (1997) "imposed gradients" algorithm and a new variant. This routine performs two major tasks:

1. Creates a depressionless DEM from your original DEM. These files have the file extensions "_DEM.rtg" and "_rawDEM.rtg".
2. Creates a RiverTools D8 flow grid file using this new depressionless DEM. This file will have the filename extension "_flow.rtg".

There are now three different options for resolving flow direction in flats. "Iterative linking" is the method used in version 2.0, but can produce parallel flow lines within broad flat valleys. "Imposed gradients" is the method proposed by Garbrecht and Martz (1997) which attempts to center flow within flat valleys and reduces parallel flow. "Imposed gradients plus" is a new variant of the "imposed gradients" method which further refines flow within flats to eliminate virtually all parallel flow. The latter two methods are slower but yield better results when flats are an issue.

Note

Although these routines are very efficient they are computationally intensive and may take several hours for very large DEMs. Your computer may be unresponsive during this time.

New Extract > D-Infinity Grid Routines

The **Extract → D-Infinity Grid → Continuous Flow Angles** routine computes a continuous flow angle grid and a slope grid using the D-infinity algorithm of Tarboton (1997). This algorithm divides flow between one or two of a pixel's eight neighbors, and is better-suited to modeling flow over divergent hillslopes than the D8 algorithm.

The D-infinity algorithm relies on a pre-existing D8 flow grid to assign a reasonable flow angle in ambiguous situations. Flow angles are stored as floating point numbers between 0 and 2 π, as measured counter-clockwise in radians from due east.

Computed values are saved in a binary file as double precision floating point numbers (8 bytes per pixel).

The **Extract → D-Infinity Grid → Upslope Areas** routine computes a specific area grid from a continuous flow angle grid, using the D-infinity algorithm of Tarboton (1997). This algorithm divides contributing area between two neighbors, where one is in a cardinal direction and the other is in a diagonal direction. This method is better-suited to modeling flow over divergent hillslopes than the D8 algorithm.

A D-infinity flow angle grid stores flow angles as floating point numbers between 0 and 2 π, as measured counter-clockwise in radians from due east. Computed values are saved in a binary file as double precision floating point numbers (8 bytes per pixel).

Note

These routines are computationally intensive. It could take several hours to process very large DEMs. Your computer may be unresponsive during this time.

Enhanced Extract > RT Treefile Routine

This routine creates a RiverTools treefile from a RiverTools flow grid. This dialog can now read a set of basin outlets from a text file. The treefile is a vector-formatted file with the extension: "_tree.rtv" while the flow grid is a raster-formatted file with the extension: "_flow.rtg". You can create a treefile by either:

1. Using a single outlet pixel that you selected and saved via the **Extract → Basin Outlet** dialog.
2. Using all pixels that have a flow code of zero as basin outlets, which includes the four edges of the DEM and the nodata pixels in the DEM.
3. Using a set of pixels whose coordinates are listed as two columns in a text file. This option is new. A treefile can store data for many disjoint subbasins.

New Extract > D8-based Grid Routines

The **Extract → D8-based Grid → Downstream Curvatures** computes local curvature along flow paths for every pixel in a DEM grid, using a RiverTools flow grid and a slope grid. Local curvature is defined as the difference in slope between a pixel and the adjacent pixel in the direction of flow, divided by the distance between the pixel centers. This definition makes the curvature positive where a channel profile is concave up and negative otherwise.

Local slope is the slope defined by a pixel and the adjacent pixel in the direction of flow, as "rise over run." Curvatures have units of (1/km) and are saved in a binary grid file as 4-byte floats.

The **Extract → D8-based Grid → Flow Distance** routine computes the flow distance to the set of pixels in a RiverTools mask (RTM) file, for every pixel in a DEM. It uses a RiverTools D8 flow grid and accounts for the latitude-dependence of pixel dimensions in fixed-angle DEMs using the ellipsoid model specified in the preferences.

RTM files can be created via dialogs in the **Extract → Mask** menu. If no RTM file is specified, then the distance is computed to either the edge of the DEM or to the first nodata pixel encountered. Computed flow distances are saved in a binary file as 4-byte floating point numbers.

Note

This routine is efficient but computationally intensive and may take several hours for very large DEMs. Your computer may be unresponsive during this time.

The new routine, **Extract → D8-based Grid → Horton-Strahler Order**, creates a Horton-Strahler stream order grid from a RiverTools D8 flow grid. Values are saved in a binary grid file as 1-byte integers.

Extract → D8-based Grid → Watershed Subunits routine uses a RiverTools "link file" to create a RiverTools grid file mask for the "watershed subunits" that contribute flow to the sides of interior links and the upstream ends of exterior links in a river network. Together, these subregions form a hydrologic partition of a given drainage basin.

RiverTools mask (RTM) files can be viewed with the **Display → Masked Region** routine. RiverTools grid (RTG) files can be viewed with the **Display → Density Plot** routine.

New Extract > Derived Grid Routines

The new **Extract → Derived Grid → Topographic Index** routine computes a topographic index or "wetness index" for every pixel in a raster DEM, using previously computed area and slope grid files. Topographic index is defined as: TI = Ln [Area / Slope]. Computed values are saved in a binary file as 4-byte floating point numbers. Zero-slope and edge pixels are mapped to (min(TI) - 0.1).

The **Extract → Derived Grid → Product of 2 Grids** routine computes the product of any two RiverTools grid files that have the same dimensions as the currently

selected DEM. Computed values are saved in a binary file with the same data type as the grid with the highest precision.

Example application: In the idealized case of unit excess rainrate, the product of a slope grid and an area grid is proportional to the flow power per unit width perpendicular to the direction of flow.

The **Extract → Derived Grid → Difference of 2 Grids** routine computes the difference of any two RiverTools grid files that have the same dimensions as the currently selected DEM. Computed values are saved in a binary file with the same data type as the grid with the highest precision.

The **Extract → Derived Grid → Restricted to Mask** routine creates a RiverTools Grid (RTG) file from an existing RTG and RTM file. Pixels in the original RTG file that are included in the RTM file are set to a nodata value in the new RTG file. One use of this is to create a shaded relief image that is restricted to a particular basin.

New Masking Routines

The **Extract → Mask → Peak Mask (1 pixel)** routine creates a RiverTools mask file for the pixels in a DEM known as "peaks." Peaks are defined here as single pixels that have a higher elevation than any of their eight neighbor pixels. Note that multi-pixel peaks are excluded.

The **Extract → Mask → Ridge Mask** routine creates a RiverTools mask file for the "ridge" pixels in a DEM. Ridges are defined in a simple manner here as pixels that are higher in elevation than six or more of their eight neighbor pixels.

Extract → Mask → Grid Threshold Mask routine creates a RiverTools mask file for the pixels in a binary RiverTools grid that lie in a user-specified range.

Extract → Mask → Connected-to-Seed Mask routine creates a RiverTools mask file for the pixels in a binary RiverTools grid that lie in a user-specified range and have a contiguous path of connectivity to the specified seed pixel. One use of this dialog is to create an RTM file for one or more lakes.

Note

RiverTools mask files can be viewed with the **Display → Masked Region** routine.

Enhanced Area-Altitude Function

The **Analyze → Entire Grid → Area-Altitude Function** dialog now allows you to create hypsometric curves in either the classic "percentage hypsometric curve" style or in the style of a cumulative distribution function (CDF). The **Analyze →**

Subbasins → Area-Altitude Function dialog allows you to create area-altitude plots for individual basins or other "shapes" stored in a RiverTools Mask (RTM) file.

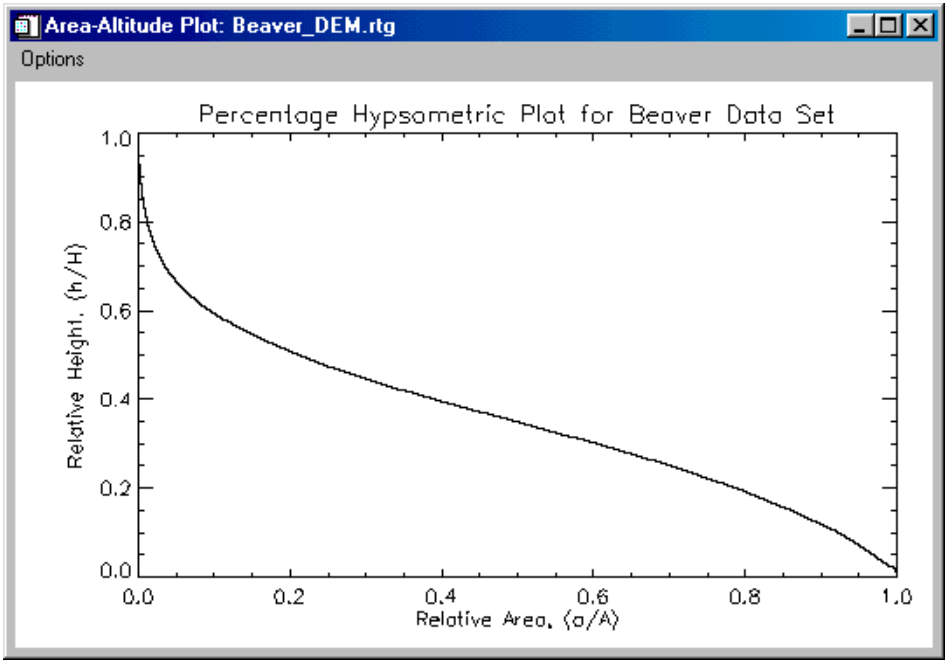

Figure 5: Percentage Hypsometric Curve Plot

Enhanced Basin Shape Analysis

The **Analyze → Subbasins → Shape Plots** dialog has several new features. This dialog lets you closely examine the shapes or "mask cells" in a RiverTools mask file (RTM) one at a time. The button labeled **Plot All Cells with Labels** can be used to display an image of all shapes in the RTM file, along with numeric labels that indicate their relative position within the RTM file.

You can then enter the number of the shape you want to examine and press Start. Click on the >> or << button to view the next or previous shape in the file. The **Current Avg** button gives the ensemble average for all shapes up to the current shape.

A selected shape is displayed along with its convex hull and the longest chord contained within the shape. The area, diameter, and shape factor are reported in the

main log window for both the shape itself and the convex hull polygon. This information can be used to quantify trends in basin shape.

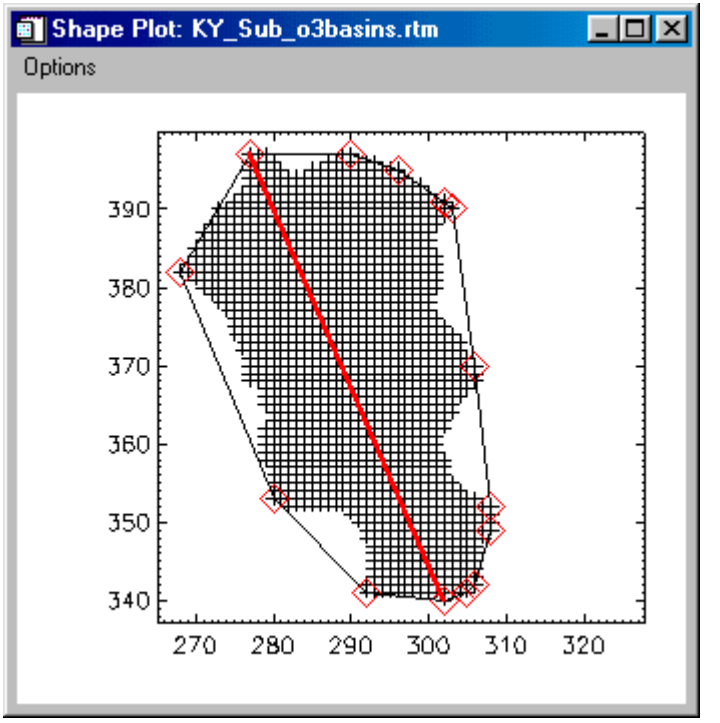

Figure 6: Basin Shape Plot from Analyze → Subbasins → Shape Plots

While the default option is to view shapes one by one, you can also display all of the shapes as an animation sequence by choosing that display option. Since this could take a while, you can stop the animation by pressing any key.

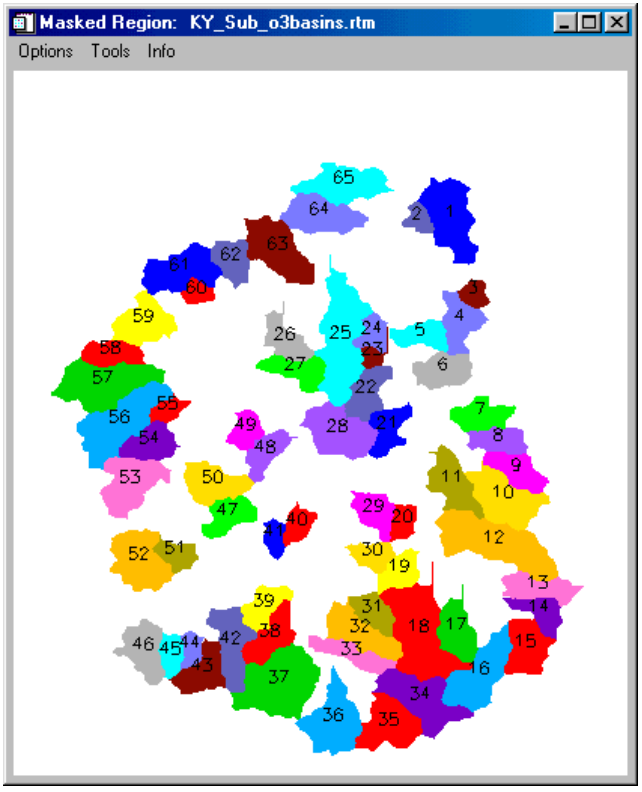

Figure 7: Order 3 subbasins from RTM file with labels

Enhanced Interactive Window Tools

Each of the interactive window tools that appear in the Tools menu of a Display window have been streamlined and enhanced with new functionality. Examples include:

- An Options menu has been added to every window tool, which provides new functionality and user control in a streamlined way.
- "Master windows" created via dialogs in the Display menu now "remember" their data set information, so tools continue to work even after you change to another data set. This can be very useful for comparing two data sets.
- UTM – Geographic – DMS coordinate conversion and display added to the Value Zoom tool.
- Ability to edit any RiverTools grid with the Value Zoom dialog.
- Greatly improved Surface Zoom dialog, shown in the following figure, offers style options of Mesh, Lego, and Shaded, more control over appearance, and the ability to enter a factor that controls your apparent distance from the surface. This feature allows you to create more compelling surface images. Another new feature lets you select and use any RiverTools grid for coloring or shading the surface.
- A more flexible Density Zoom dialog that lets you zoom in on a particular location and to select and display any RiverTools grid.
- A new option for Channel Profiles lets you select and create a profile for any RiverTools grid, rather than just the DEM. This option is useful for examining how a gridded attribute like area or slope varies along a streamline.
- A new preference that lets you choose between a simple locator box or crosshairs for showing the zoom location in the master window. Some of the tools also let you change the color of the box and crosshairs.
- A new Xobjview tool that calls an IDL user routine by the same name. This tool is similar to the Surface Zoom tool, but has a different interface.
- Improvements to the Reach Info and Flood Image tools
- You can now include scale bars and color bars in printouts by choosing the new "Print via screen capture" option in **File → Printing Options**.

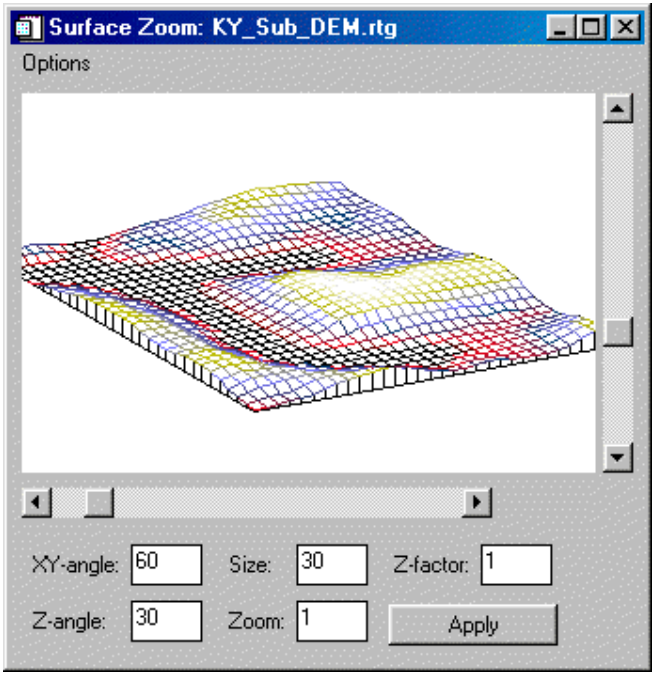

Figure 8: The new Surface Zoom window tool

Ease-of-Use Improvements

Streamlined Graphical User Interface

- Options menus in many dialogs and interactive window tools provide new functionality in a streamlined way.
- New thermometer-style "Progress Dialog" shows progress for time-intensive calculations, such as those in the **Extract** menu.
- Bitmap button toolbar provides fast access to commonly used dialogs.

Expanded Help Features

- RiverTools Help is now hyperlinked and is available from the **Help** menu.
- New hyperlinked tutorials in the **Help** → **Tutorials** menu. These are automatically launched the first time you start RiverTools.
- New RiverTools command reference under **Help** → **Contents**.
- New context-sensitive Help buttons on all dialogs provide quick access to specific help topics.

New Windows Menu

Several tools for managing windows have been moved from the **File** menu to a new **Windows** menu. These include:

- **Window** → **Find Window** — Lists the title of each RiverTools window and allows a selected window to be "brought to the front".
- **Window** → **Save Window As** — Allows you to save the image in any window to any of several supported image formats.
- **Window** → **Close All Windows** — Closes all RiverTools display windows.
- **Window** → **Close All Dialogs** — Closes all RiverTools dialogs.
- **Window** → **Clear Log Window** — Clears the text in the main RiverTools log window.
- **Window** → **Save Log Window** — Allows you to save the text in the main RiverTools log window to a text file.

New Customization Features

New Naming Conventions

All of the low-level RiverTools routines have been renamed so as to have a "name space" that does not conflict with the names of IDL or ENVI procedures and functions. Each RiverTools command now begins with "RT_". Commands that launch a dialog or graphical user interface (GUI) now begin with "RT_GUI". As before, the remaining portion of a command name follows an easy-to-remember "verb-adjective-noun" style, with separate words separated by underscores. These low-level routines can be accessed by users who purchase RiverTools+IDL. For more information, see the *RiverTools Reference Guide*.

Expanded Ability to Customize RiverTools

At startup, RiverTools will now restore any IDL ".sav" files that are found in the RiverTools Menu folder. In addition to restoring IDL ".sav" files, RiverTools+IDL will automatically compile any ".pro" files found in the RiverTools Menu folder at startup. This makes it easier for users to extend RiverTools with routines they have written or obtained from others. Using the file "user.pro" that is distributed with RiverTools, this also makes it possible to permanently alter the **User** menu.

New Data CD-ROM

RiverTools also comes with a CD-ROM full of interesting digital terrain data in many different formats. This data is ideal for teaching a course with RiverTools and for demonstrating the raster and vector import capabilities.

The CD-ROM includes high-resolution USGS DEMs for the dendritic river networks of Kentucky, portions of the Grand Canyon near Powell Plateau, Arches National Park (Utah), Canyonlands National Park (Utah), the Great Sand Dunes National Monument (Colorado) and many other areas. Also included is a new Arctic Bathymetry DEM from NGDC, GTOPO30 DEM subsets for Antarctica, Europe and the USA, the MOLA DEM for the planet Mars, a NED sample for the Mount Saint Helens region and a collection of "test surface" DEMs that are useful for testing and model development. These surfaces include a cone, plane, V-shaped valley, pyramid, saddle, monkey saddle and others.

In addition to raster data, the new CD-ROM also contains vector data, include a collection of ESRI Shapefiles for the USA and USGS Digital Line Graphs for Beaver Creek in Kentucky.

Supported Platforms

The following platforms are supported in this release of RiverTools 2.4:

Platform	Vendor	Hardware	Operating System	Supported Versions
UNIX†	SUN	SPARC	Solaris	8
Windows	Microsoft	Intel x86	Windows	NT 4.0, 2000
Macintosh	Apple	PowerMAC††	MacOS	8.*5*, *8.6*, 9.*x*

Table 1: Platforms Supported in RiverTools 2.4.

† For UNIX, the supported versions indicate that RSI software was either built on (the lowest version listed) or tested on that version. It *may* be possible to install and run RSI software on versions other than those listed if your version is binary compatible.

†† Includes G3, G4 and iMac.