4.3 Geospatial view

The Geospatial View of the workspace provides a spatially coherent display of the modeled basin by associating a map projection and its cartesian coordinate system with the view. Users locate objects and a background map image in this coordinate system, allowing RiverWare to display a schematic view of the modeled basin overlaid in registry with the map. That is, RiverWare objects are displayed at their location on the map. By providing an intuitive and information-rich view of a basin, the Geospatial view complements the Simulation and Accounting views of the workspace.

The key features of the Geospatial View are:

- The Geospatial canvas has an associated map projection and location (rectangular extent) within the projection's coordinate system.
- A map image with a known location in the coordinate system can be displayed in the background layer of the view.
- Images can be georeferenced interactively or automatically via an accompanying world file.
- The background image (map) can be changed to another with the same projection without requiring any change to the spatial locations (geospatial view coordinates) of the objects.
- Objects are geo-referenced (given spatial coordinates) and displayed at that location.
- A distinction is made between an object's *display* and *actual* spatial coordinates.
- Object coordinates can be shared between models and external GIS applications.
- Additional control over the schematic view is provided including sizing and labelling of the icons.
- The coordinates of the mouse in the map projection are continuously presented in the status bar.

4.3.1 Introduction to GIS concepts

Graphical information systems (GISs) support storage, analysis, and display of spatial data. This section introduces some basic GIS terminology and concepts which are relevant to the Geospatial View.

Locations on the spherical earth are most often represented as a pair of coordinates representing latitude and longitude. For some applications, a third coordinate representing an elevation relative to mean sea level is also used. To display a part of the curved surface of the earth on a flat surface necessarily requires a projection, and GIS systems typically represent flat display locations as cartesian coordinates in a plane onto which the surface of the globe has been projected.

Several standards have been developed to provide agreed-upon coordinate systems for a given area. These standard coordinate systems define a set of map projections which together cover the target area. One common coordinate system which covers the globe is the Universal Transverse Mercator (UTM) coordinate system. This system defines a projection for the northern and southern areas of each of 60 longitudinal zones spanning the globe. For example, in the projection UTM Zone 11 North, the coordinates eastings = 397,800 m, northings = 4,922,900 m, corresponds to a location in central Oregon, USA.

Another standard coordinate system is the State Plane coordinate system which defines a set of projections for the United States. In this system, each state is divided into one or more zones, so a location is specified by a state, zone designation, and x, y coordinates.

Note that a standard coordinate system defines a mathematical coordinate system corresponding to each projection of a set of projections; when these two uses of the term “coordinate system” would be confusing, we use the term to refer to the standard, and use the term “projection” or “map projection” for the component (mathematical) coordinate systems.

Coordinates, whether they be geographic (latitude and longitude) or correspond to a map projection, are specific to a datum. A datum is a reference surface and surveyed coordinates for a set of actual points and lines. Examples of common datums include the North American Datum of 1983 (NAD83) and the World Geodetic System of 1984 (WGS84).

The Geospatial View has a map projection associated with it, and everything displayed in that view (e.g., object icons, background image) needs to be displayed in that projection. Because RiverWare assumes that a single projection is shared between the Geospatial View, the object coordinates, and the map, RiverWare does not need to know the mathematical details of that projection.

4.3.2 The Geospatial Canvas Configuration Dialog

The Geospatial View is most useful when a map of the basin exists for which some coordinates within the map projection are known. If this information is not available, consider using the Simulation View with a background image.

The Canvas Configuration Dialog allows you to specify information about your geo-referenced image and how it relates to the RiverWare workspace. It is accessed by:

- right clicking on the geospatial workspace and choosing **Canvas Properties**.
- using the **Workspace ➥ Canvas Properties** menu when the Geospatial View is shown.

Following is a description of each part of the Canvas Configuration Dialog.

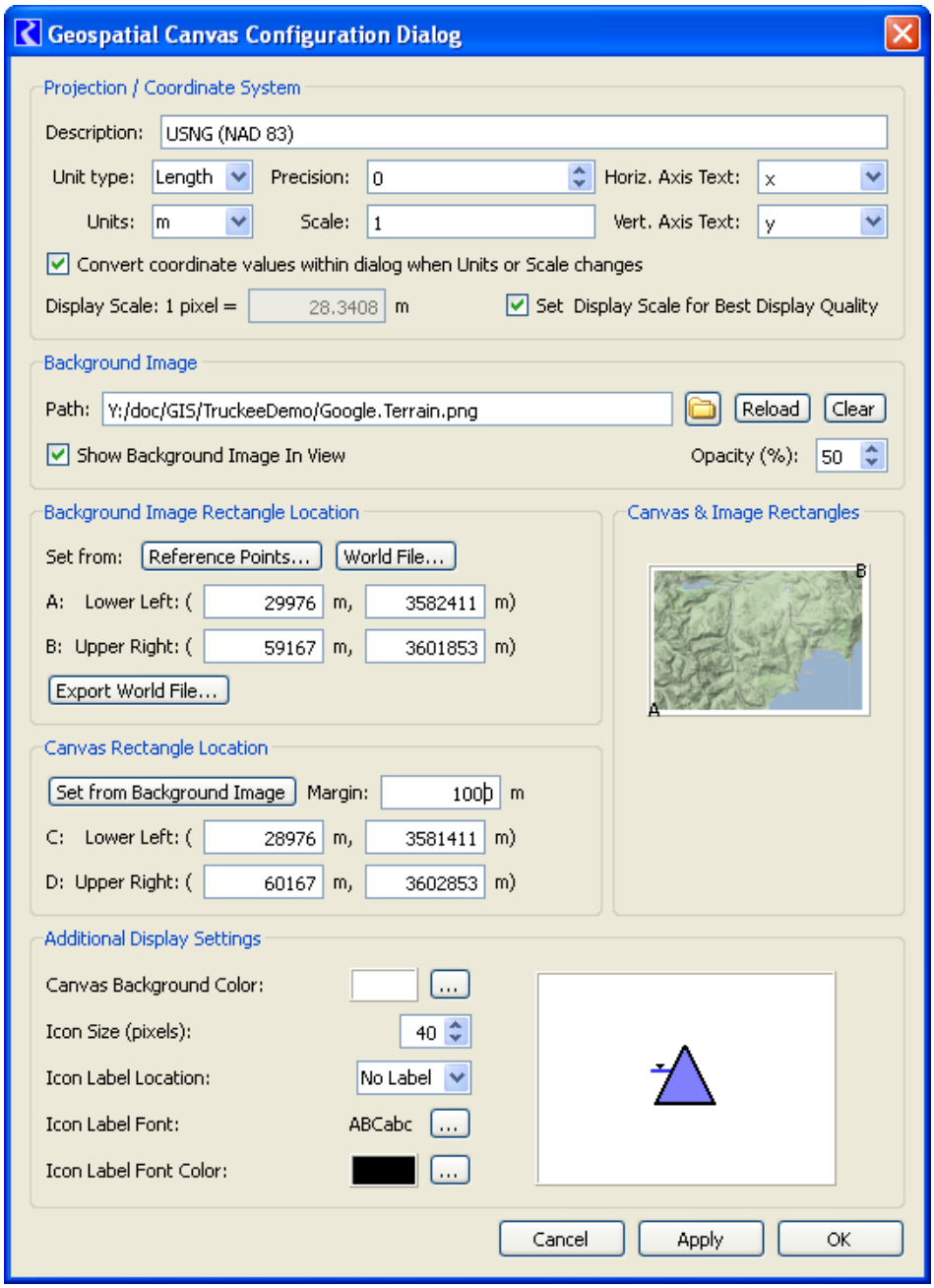


Figure 1: The Geospatial View's Canvas Configuration Dialog.

Projection / Coordinate System: In this panel, you provides information about the Geospatial View's map projection and coordinate system. Note that RiverWare requires that the projection's vertical and horizontal dimensions are the same. The user provides the following setting for the projection:

- **Description**: textual description of the projection. This could include a technical description of the projection such as “UTM NAD83 Zone 11N”, but RiverWare will not make any assumptions about the description contents. This text field is strictly a description for your use, and is not used elsewhere.
- **Unit type**: unit type of the projection coordinate system: Length or None.
- **User units**: the preferred units for displaying coordinates.
- **Scale**: the preferred scale for displaying coordinates.
- **Precision**: number of digits to the right of the decimal point with which to display coordinates.
- **Horiz. Axis Text**: label associated with the horizontal dimension of the projection’s coordinate system. It is usually “x” or “Easting” but you can also select <custom> and enter your own text.
- **Vert. Axis Text**: label associated with the vertical dimension of the projection’s coordinate system. It is usually “y” or “Northing” but you can also select <custom> and enter your own text.
- **Convert coordinate values within dialog when Units or Scale changes**: When you change units or scale, do you want existing values to be converted to the new units/scale.
- **Display Scale**: the projection units per pixel used for displaying the canvas on the screen at a zoom factor of 100%. This setting relates the projection to the screen display of the canvas. When the **Set Display Scale for Best Quality Display** box is checked, RiverWare sets this automatically, usually using the display scale which leads one pixel in the background image to be displayed as one pixel on the screen.

Background Image: Image files are specified by full path names with environment variable expansion. Currently two image formats are supported: JPEG and PNG. Environment variables are specified using the $PATH syntax. If the image changes outside of RiverWare you may need to **Reload** it using the button.

When an image is loaded, RiverWare checks for the presence of an associated file in the world file format, a plain text file format developed by ESRI for georeferencing raster map images. If RiverWare detects a world file for the image, the user is presented with a dialog asking if they would like to use the contents of the world file to locate the image image in the projection’s coordinate system.

A valid world file contains 6 lines, each containing a floating point value, denoted here by the letters A-F. These values define an affine transformation from pixel coordinates to projection coordinates in the form:

$$x_1 = Ax + By + C$$
$$y_1 = Dx + Ey + F$$

where

x_1 = calculated x-coordinate of the projection location
y_1 = calculated y-coordinate of the projection location
x = column number of a pixel in the image
y = row number of a pixel in the image
A = x-scale; dimension of a pixel in map units in x direction

B, D = rotation terms
C, F = translation terms; x,y map coordinates of the center of the upper left pixel
E = negative of y-scale; dimension of a pixel in map units in y direction

The Geospatial View assumes rectagular pixels with no rotation, thus not all map images that can be described with a world file can be displayed as background images. When a world file is loaded, RiverWare checks that B and D are zero and that A and E are equal, and notifies the user if one of these conditions is violated.

For many GIS applications, creating an image with a world file is relatively straightforward. For example, to do this in ArcMap 10.0, select File->Export Map...", then check the "Write World File" checkbox option within the subsequent dialog. On the other hand, when this is not possible, the world file format is simple enough that it can be created by hand with a text editor.

Within the Background Image panel, you can also specify whether to **Show Background Image in View** and set the % **Opacity**.

Background Image Rectangle Location: In order to display the background image at the proper location on the canvas, RiverWare needs to know its location in the projection's coordinate system. There are several alternatives for providing this information if RiverWare did not read it from a world file when the image was loaded. The first is to directly enter the coordinates of the lower left and upper right corners of the image's rectangle.

Note: When you enter a set of two coordinates (four values), you really only need to enter three values, RiverWare will compute the fourth.

Another option for registering the image is to click on the **Set from: World File** button. RiverWare will then present a file chooser dialog for specifying the world file containing the image's georeferencing information.

If no world file is available and if the coordinates of the image corners are not know, then a third option is to provide coordinates for two specific locations in the map, in which case RiverWare will use these reference point coordinates to compute projection coordinates fro the full image. To provide this information to RiverWare, select the **Set from: Reference Points** button. This opens the **Image Location Dialog** which displays a view of your image. For this utility, a reference point is a location for which you know the coordinates and you can locate in the image. Only 2 reference points are needed to locate the image in the projection coordinate system. As shown in the image, you do three steps

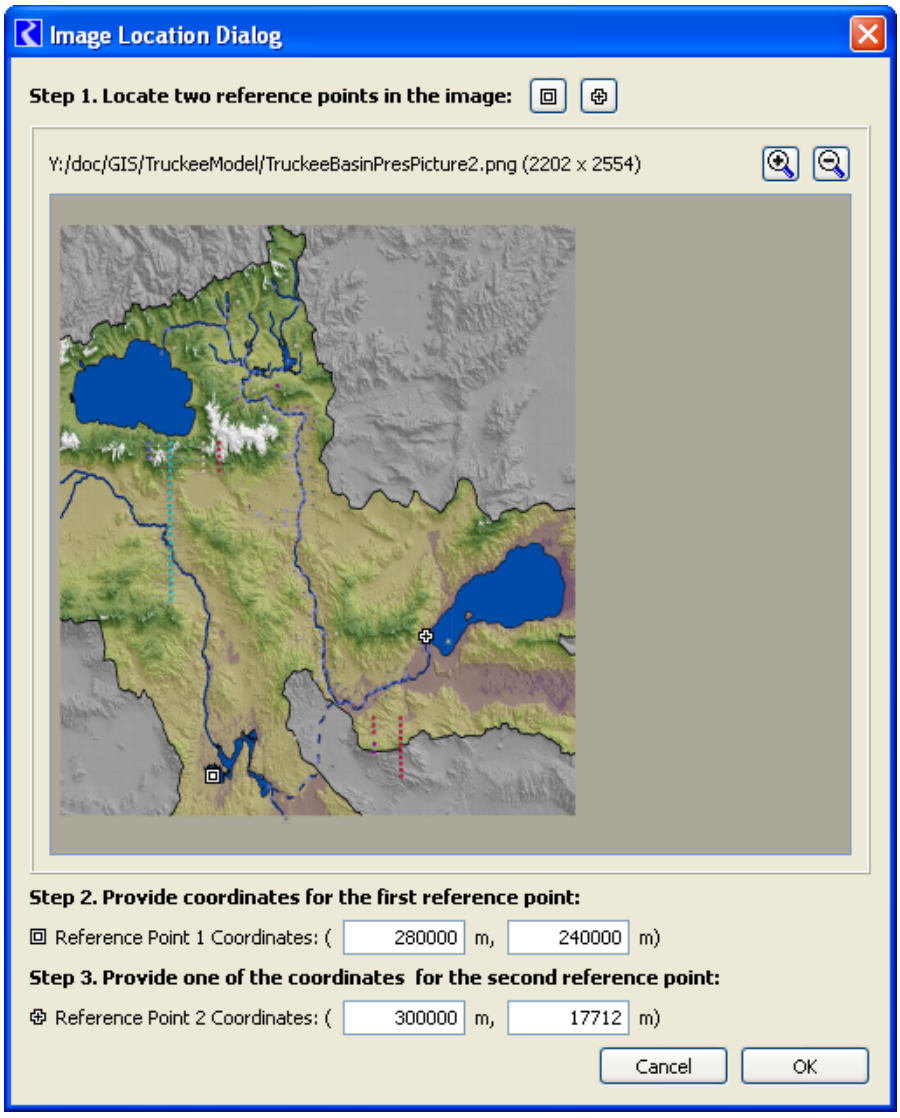


Figure 2: The Geospatial View's Image Location Dialog

- Step 1.

  Locate a reference points in the image. Use the zooming tools to get as close as possible to the first reference location. Click on the button and then click in the image to locate the first reference point one. Zoom/Scroll to the 2nd reference location. Click on the second button and click in the image to locate the second reference point.

- Step 2.

  For the first reference point corresponding to , enter the coordinates in the dialog.

- Step 3.

  For the second reference point corresponding to , enter either the x or y coordinate; the other coordinate will be computed by RiverWare.

Click **OK** to confirm the entry and close the dialog.

If you have set the background image rectangle location interactively, either by entering the corner coordinated directly or by specifying the coordinates for two reference points, you can export the corresponding georeferencing information by selecting the **Export World File** button. RiverWare will allow you to select a file name and write the background image's georeferencing information to that file in the world file format. This file can then be used to automatically register the image within other RiverWare models or with any application that can supports the world file format.

Canvas Rectangle Location: In the Canvas Rectangle Location area, you specify where the canvas rectangle lies in the projection's coordinate system, by giving the coordinates of the lower left and upper right corners of that rectangle. Selecting the **Set from Background Image** button will set the location to be that of the Background Image with an optional margin added to each side.

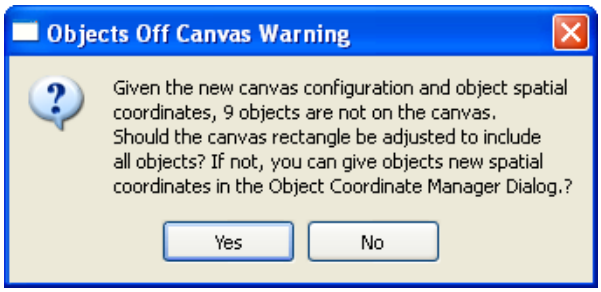
Canvas & Image Rectangles: This panel provides a high-level view of the canvas and image rectangles, drawn as rectangles whose size and relationship to each other matches that defined in the Background Image Rectangle Location and Canvas Rectangle Location panels. The locations of each coordinate (A, B, C, and D) are shown in the thumbnail.

Additional Display Settings: In this area, you can specify additional display settings for the geospatial workspace:

- **Canvas Background Color**: Click the button to bring up a color chooser.
- **Icon Size**: Enter a new value for the RiverWare icon size at 100% zoom factor. Note, the standard size is 40 pixels. Currently, this setting is "global" for the geospatial canvas. In the future, this may be changed to a per-object setting.
- **Icon Label Location**: choose the location of the label: below, above, left, right of the object. Note that **No Label** is an option. Currently, this setting is "global" for the geospatial canvas. In the future, this may be changed to a per-object setting.
- **Icon Label Font**: Provide a font and size for the label text.
- **Icon Label Font Color**: Choose a color for the object label text.

All selections in this frame are applies to the sample reservoir icon immediately, but are applied to your workspace when the **OK** or **Apply** button are clicked.

If you click **OK** or **Apply** and one or more Object Coordinates do not fall within the defined canvas boundaries, you will be prompted with the warning dialog shown. If you click **Yes**, the canvas will be extended to fit all objects. If you click No, the canvas boundaries will remain the same and objects will be off the canvas. You can then use the **Object Coordinate Dialog** (describe below) to reposition objects within the canvas.



Following are some strategies for dealing with overlapping icons which is sometimes called "icon clustering."

- Use smaller icons and place labels to one side or the other.
- Give clustered objects **display** spatial coordinates that allow for a clear display, deviating somewhat from their **actual** coordinates as necessary.

4.3.3 Object Coordinates

To support the Geospatial View of the workspace, RiverWare associates coordinates in the view's projection with each object on the workspace. To provide more flexibility for the user, this is distinguished between **Actual** and **Display** spatial coordinates. Actual coordinates are the static coordinates of the object which may come from other sources. The display coordinates are the location where the object is shown on the geospatial view. Often the display coordinates differ from the actual coordinates because the object was moved slightly for less icon clustering or better display.

When an object is created, it is given a location in the Simulation and Accounting Views based on where you place the object. In the Geospatial View spatial coordinates will be initialized in a similar way. Then, RiverWare provide the following mechanisms to edit or specify spatial coordinates:

- The **Object Spatial Coordinates Manager** dialog displays spatial coordinates for all objects in a single dialog. This dialog supports editing of individual values as well as cut/paste/copy (see section below for more details). This also provide a mechanism to facilitate reconciliation of an object's actual and display spatial coordinates.
- Moving an object's icon in the Geospatial View (by using the drag and drop) will change the object's **Display Coordinates** accordingly.
- Import the **Actual Coordinates** from an ESRI shape file.

Following is a description of the Object Coordinate Manager Dialog which is used to edit/view object coordinates. The **Object Coordinate Manager** is non-modal and accessed by right-clicking on the main workspace (in the Geospatial View) and then selecting **Object Coordinates...**

The **Object Coordinate Manager** dialog displays both the display and actual spatial coordinates for all workspace objects. This dialog supports editing of individual fields as well as cut/paste/copy. For each object, both the display and actual spatial coordinates are displayed. Following are operations that you can perform through the dialog:

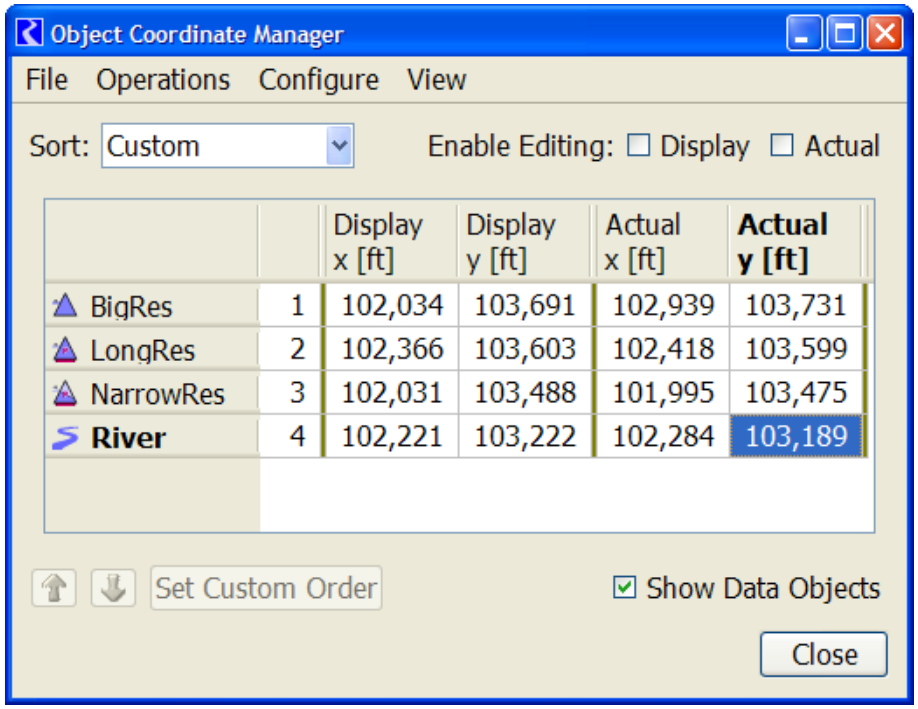


Figure 3: The Object Coordinate Manager Dialog

- **Sort**: Objects in the table can be sorted using the Sort pulldown menu. There are options to sort by Object Type, Object Name, Display X or Y, Actual X or Y, and Custom. To use the Custom sort, highlight one or more objects and use the blue up and down arrows to sort the objects.
- **Editing**: Values in the dialog are only editable when the appropriate **Enable Editing** toggle is selected. Then, double click on a value and type in a new number.
- **Show Data Objects**: The Show Data Objects toggle allows you to specify whether you wish to see data objects.
- **Show on Workspace**: Select one or more objects, then right-click and select **Show on Workspace** to highlight and select the objects on the workspace.
- **Copy Display/Actual Coordinates to the other**: The **Operations** menu has options to **Copy Display Coordinates to Actual Coordinates** and **Copy Actual Coordinates to Display Coordinates**. This allows you to move coordinates easily between the display and actual. Note, these operations copy ALL values in the column, not the selected ones. When you do this operation, it may overwrite data. Thus, a warning dialog is provided for you to confirm or cancel the operation.
- **Export Copy/Import Paste Values**: You can copy or paste any value(s) to/from the system clipboard and then to/from external text or Excel files or back to this dialog. This gives you a lot of flexibility in how you move data. Notes, when you copy/paste values, it is operating on the selected values in the sort order as it is displayed. There is also an option to **Export Copy with the Object Names** to also export the RiverWare object name. These operations are available from the right click context menu.
- **Importing/Exporting Coordinates**: Import and export spatial coordinates through the ESRI shape file format. In this context, the shape file format is a collection of three files with different suffixes:

- .shp - objects represented as points.
- .shx - indices into .shp file
- .dbf - object attributes (initially object name and object type)

RiverWare supports export of the spatial coordinates of all or selected objects. When coordinates are imported, the user will be warned that the existing coordinates will be overwritten and notified when coordinates for unknown objects are encountered.

Following is a diagram of the possible movement of coordinate data within RiverWare. Note, any operation using the system clipboard involves a Copy/Cut/Paste which involves Export Copy and Import Paste within RiverWare.

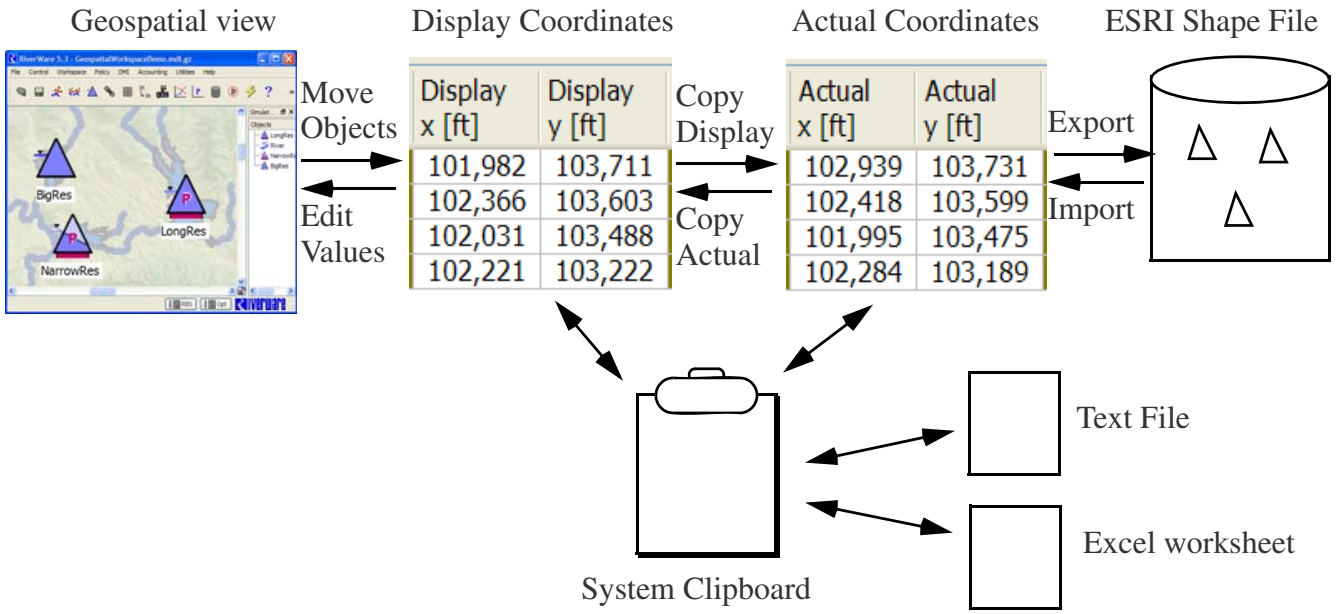


Figure 4: Data Operations in the Object Coordinate Manager Dialog