5. SPATIAL DATA ANALYSIS USING RP_GIS

Data input requirements of most hydrological models, including the *RationalPeak* Model, can be grossly categorized as climatic and catchment characteristics. These data requirements of *RationalPeak* are discussed in other sections of this document. Therefore, this chapter deals with spatial data analysis for deriving value of the basic catchment characteristics related input parameters of the model using its GIS interface, the RP_GIS Module.

5.1 Locating Water Resource Development Sites on Map

Water resource development sites such as ponds, dams and diversion weirs are commonly represented in maps as a point feature. Furthermore, a point is the basis for most spatial analysis in RP_GIS such as for catchment delineation and main channel length computations. Hence, many of the procedures detailed in this section serve as a steppingstone for the other analyses discussed in the following sections. To create a point feature in RP_GIS:

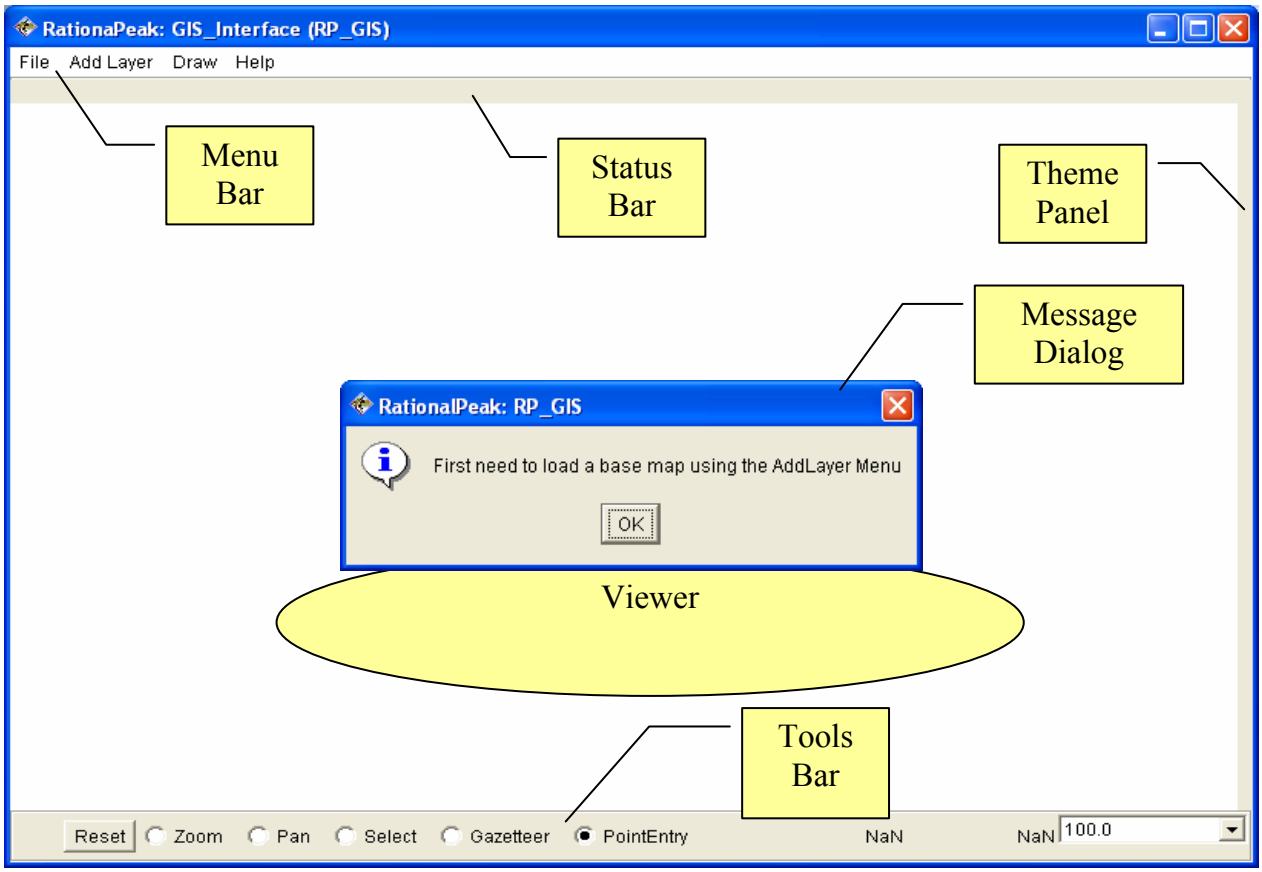

Figure 5.1 Basic components of the RP_GIS main window

1. Click the RationalPeak_GIS Button on the main window to open the RP_GIS window. This window appears blank with components as shown on the preceding figure. However, if the user clicks on the viewer component or tries to draw new feature using the New Submenu of the Draw Menu a message window appears informing the user to first load a base map.
2. Add a base map to the viewer using one of the submenus of the Add Layer Menu and an open dialog that accompanies them. The current version of RP_GIS requires the user to add a base map before commencing any spatial analysis. The base map is any existing shape file which could be a contour, stream or land cover layer. Once the base map is loaded, however, the drawing of features and subsequent analysis can be conducted in any part of the viewer including outside the periphery of the base map. The Add Layer Menu has three submenus, *viz*. Contour, Stream and Land Cover.

    - The Contour Submenu is used to load and view a shape file of contour type. This submenu displays elevation of each contour in the form of tip text and assigns the feature a pink color.
    - The Stream Submenu is used to display a shape file of stream type and shows the drainage pattern of a certain area. When loaded using this submenu the stream features have blue color.
    - The Land Cover Submenu is used to load and view shape files of land cover types. It provides land cover/land use type information in the form of tip text for each land use category represented by a distinct color. The land use categories are painted with a color range of green to orange.

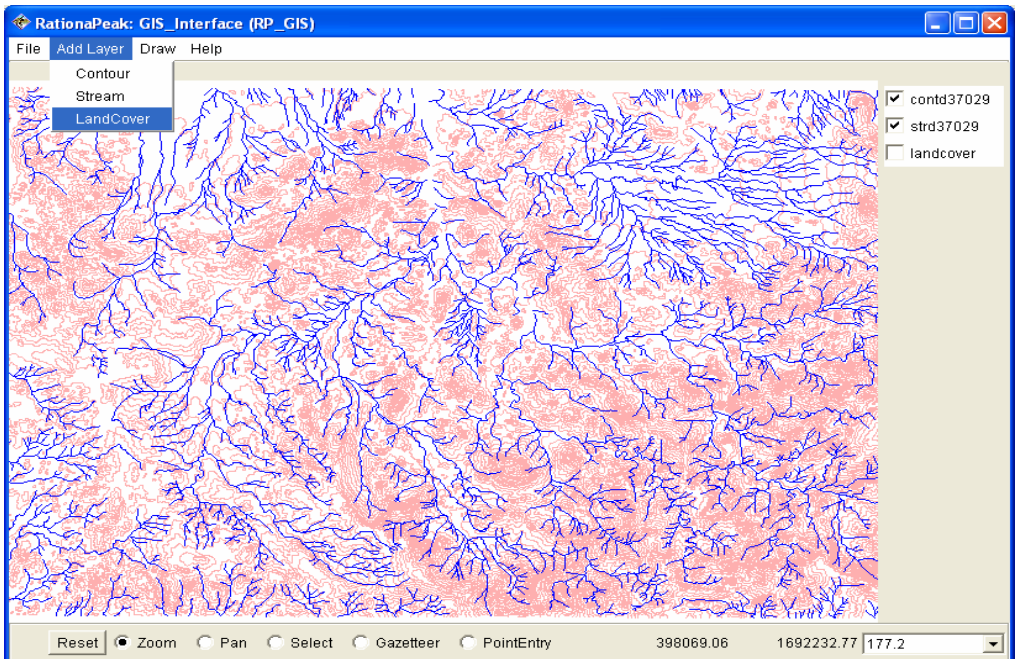

Figure 5.2 The RP_GIS main window and its components after some layers are loaded to its viewer using submenus of the Add Layer Menu

Once a theme is loaded to the viewer, its name appears on the Theme Panel and the switch at the left side of each theme's name is used to show or hide the particular layer from the viewer. Although, theme names fail to displace each others position in the current version of RP_GIS, layer order i.e. bringing to front or sending to back of one layer with respect to the other layers could be controlled by drag and drop of theme name. A red horizontal strip appears when drugging a theme name showing the current position of the theme.

3. From the Draw Menu select the New Submenu. A new window appears with the following two coordinate entry options:

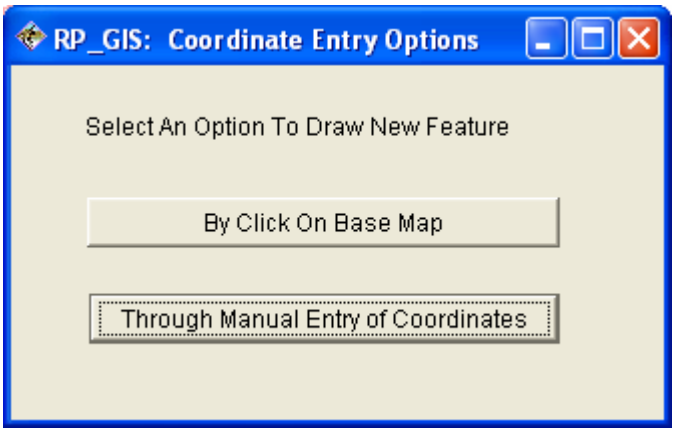

Figure 5.3 The Coordinate Entry Options Window in RP_GIS

i. By Click on Base Map

When this option is chosen, RP_GIS records coordinate values of each point clicked on the viewer after the New Submenu is called. The water resources development site which is required to be displayed on map could be within the base map or in any part of the viewer outside the base map. Note, however, that the PointEntry Tool on the Tools Bar has to be selected before commencing to record by clicking on the viewer. The total number of coordinate values and number of coordinate values recorded by RP_GIS since the New Submenu command is called are displayed on the status bar. Thus, when ever the user clicks on the viewer (while the PointEntry Tool is selected) the total and new numbers of vertex value are updated to help the user make sure that a particular clicked point is actually recorded. Furthermore, the x and y coordinate values at the current position of the curser are displayed on the tools bar to help locate a certain site with an existing (GPS read) coordinate values. A single or multiple points can be recorded at a time depending on the user's preference.

ii. Through Manual Entry of Coordinates

This option is used if the user has an existing coordinate value of each point and wants to manually input each coordinate value for further analysis. Selection of this option opens a new window, the Manual Entry of Coordinates Window. This window is basically a data base window with tools provided in its tool bar that enable the user such as to add a new row at the end of existing records, insert a blank row between two existing records and to edit or delete rows. However, the current version of RP_GIS does not provide the user with a tool or means to add new fields. Rather, only two hard coded fields are available in the window, *viz*. the X_Coord and Y_Coord fields denoting for the x and y coordinate values of a given point.

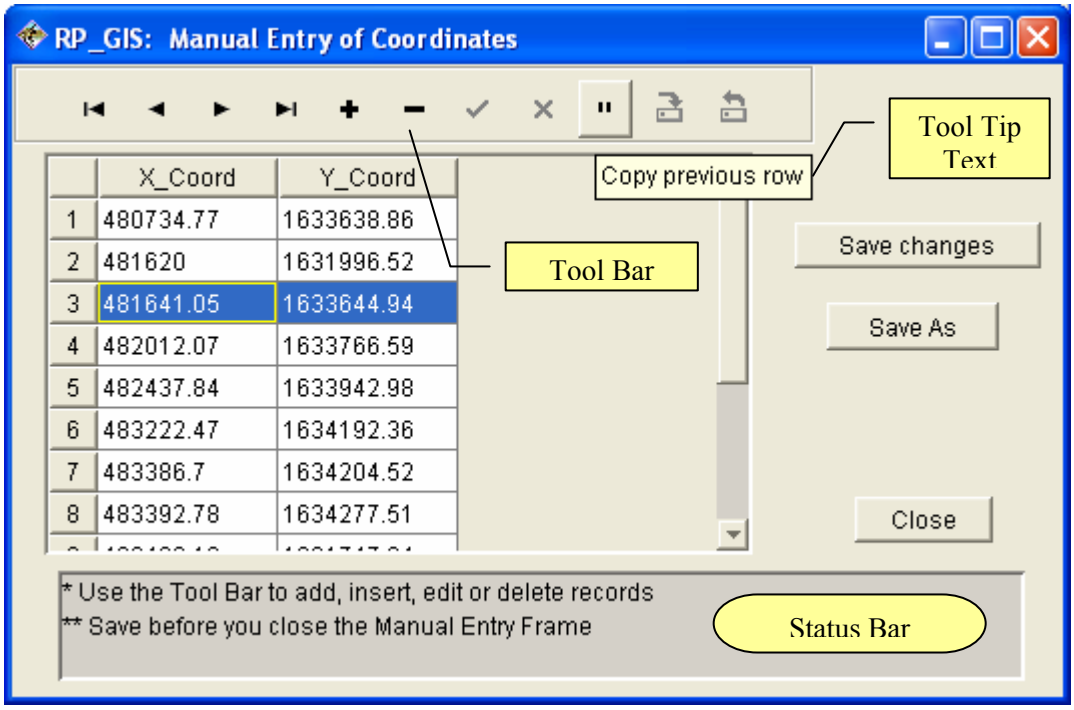

Figure 5.4 The Manual Entry of Coordinates Window in RP_GIS

To start input of new records the user can delete the existing coordinates if a default file is available as shown on the previous figure, or create new row by clicking the right arrow (the Move to next row Tool). The tools provided on the tool bar can be used as required and brief description of each tool is presented in the form of tool tip text if the curser is placed over a certain tool. Once all the data are fed, the user should save before exiting the current window. The user is prompted again to save his/her input if the Close Button is pressed. A saved data is written in a default file named LocationFile.rp with a location in the Input_Output Folder of the *RationalPeak* Model. However, if the user wants to save the data with a different file name or location he/she should use the Save As Button. Thus, the user has an option to save his/her data in any file name and location but not to load it. Loading (displaying) a previously saved data with a file name or path other

than the default ones, requires renaming of the file to LocationFile.rp placed in the Input_Output Folder of the *RationalPeak* Model.

4. Select Point Submenu from the Draw Menu and a point with red line and grey fill will appear at the specified location. Auto theme name of each point also appears at the theme panel and generally the naming system follows the form of Point_n, where n represents point number. If a point falls out side the periphery of the base map, it might not initially appear on the viewer. In such instances press the Reset Button on the tools bar of the RP_GIS main window.

5.2 Catchment Delineation

In order to carry out catchment related analysis such as catchment area, slope and stream length determination, the user needs a prior delineation of the catchment boundary. Catchment delineation using RP_GIS involves using the following steps depending on level of available data and the user's preference:

i. If the user does not have GPS read (existing) water divide coordinate values and wants to delineate the catchment based on topographic and drainage pattern maps of the area

1. Add a contour map to the viewer using the Contour Submenu of the Add Layer Menu.
2. Add a stream map to the viewer using the Stream Submenu of the Add Layer Menu.
3. Locate the proposed WRD site using the procedure outlined in the previous section.
4. Choose the New Submenu from the Draw Menu.
5. On the Coordinate Entry Options Window, press the "By Click on Base Map" Button.
6. Select the PointEntry Tool of the tool bar on the RP_GIS main window if it is deselected.
7. Zoom in, if deemed necessary, to clearly view the topographic (contour) map and drainage pattern (streams) of the area. Zooming in RP_GIS can be accomplished using two options. The Zoom Tool (next to the Reset Button) is used if the user wants to zoom in to a certain selected area with in the range of the viewer. Alternatively, the user can select a predefined zoom level from the popup list of the Zoom Level Picker (on the right end of the tool bar) to zoom in or out. In the current version of RP_GIS zooming in focuses only at center of the viewer resulting to hiding of the map which is out of the range of the viewer. However, the user can use the Pan Tool from the tool bar of RP_GIS main window to move the viewer to a desired location.
8. Starting from the proposed WRD site click clockwise throughout the water divides. After every click always remember to check the new vertex number at the status bar for some times the click could be skipped without being recorded. An increase in vertex number from its previous value shows recording of the recent click.

9. Choose the Polygon Submenu from the Draw Menu to display the catchment on the viewer. The catchment appears on the viewer with a grey fill and name of the catchment theme appears on the Theme Panel in the form of Polygon_n, where, n in this case represents catchment number. Note as well that important parameters of the catchment, *viz*. its area and perimeter, are displayed on the status bar.
10. Follow steps 4 to 9 to load additional catchments if your catchment is composed of two or more sub-catchments.

ii. If the user has GPS read water divide coordinate values and wants to delineate the catchment based on these values

1. Add any shape file, preferably for the same or closer geographical location to the catchment of interest, using one of the submenus of the Add Layer Menu. This shape file is meant to serve as a base file. If the base file is at a distant location relative to the area of interest, the catchment might appear extremely small for the viewer has to accommodate all loaded features within its limited range after the Reset Button is pressed.
2. Choose the New Submenu from the Draw Menu.

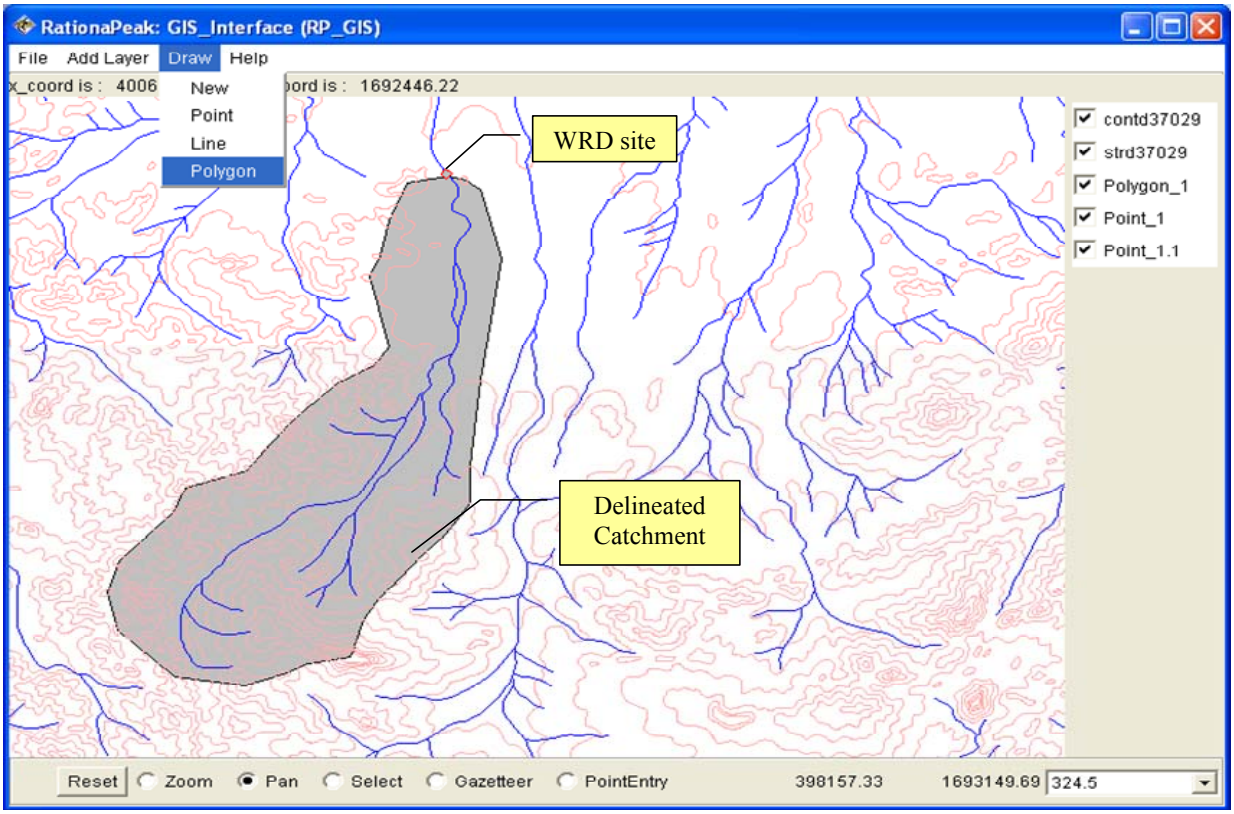

Figure 5.5 Locating Water Resources Development (WRD) site and catchment delineation in RP_GIS (Note that the map is zoomed in (magnified) to more than three times of its actual size)

3. On the Coordinate Entry Options Window, press the “Through Manual Entry of Coordinates” Button.
4. Input your x and y coordinate values of the catchment’s water divide to the data base window as discussed in the previous section.
5. Choose the Polygon Submenu of the Draw Menu to display the catchment on the viewer. Press the Reset Button on the tool bar if the catchment did not appear on the viewer.

Both coordinate entry options, *viz*. “By Click on Base Map” and “Through Manual Entry of Coordinates” can be alternatively used several times to delineate multiple catchments (sub-catchments) on the same viewer.

5.3 Channel Length Computation

Main channel length is one of the basic catchment characteristics input to the *RationalPeak* Model. After delineating the catchment as detailed in the previous section, channel length can be determined in RP_GIS as follows:

1. Select the New Submenu of the Draw Menu.
2. From the followed Coordinate Entry Options Window, select “By Click on Base Map” Button.
3. Starting from the catchment outlet (WRD site) trace (click throughout) the main channel (remember to select the PointEntry tool on the tool bar if it is deselected).
4. Select the Line Submenu of the Draw Menu and the main channel length appears at the status bar.

5.4 Slope Analysis

Both general and sub-catchment slopes are required for peak discharge computation using the *RationalPeak* Model. General slope is computed as the fraction of the elevation difference (between the highest elevation of the catchment and its outlet) and main channel length. The highest and lowest elevation values can be read from the tip text that appears if the cursor is placed over a contour and main channel length can be computed as discussed in the previous section. Therefore, this section focuses on sub-catchment slope computation. Following are the basic steps to determine slope of a given sub-catchment.

1. Select the New Submenu of the Draw Menu.
2. From the followed Coordinate Entry Options Window, select “By Click on Base Map” Button.
3. Click at two ends of a representative site of a certain area (the two ends need to touch contours).
4. Select the Line Submenu of the Draw Menu and the line length appears at the status bar.
5. Place the cursor over the two contour lines to read their elevation values from the tip text. For some contours elevation values might be misplaced. Thus the user

has to compare elevation value of a given contour against the upstream and downstream contour values.

6. Compute the slope represented by the line from the elevation difference of the two contours and the horizontal distance as computed by the line length.
7. Repeat steps one to six for other representative sites of the given sub-catchment and take an average to get sub-catchment slope.

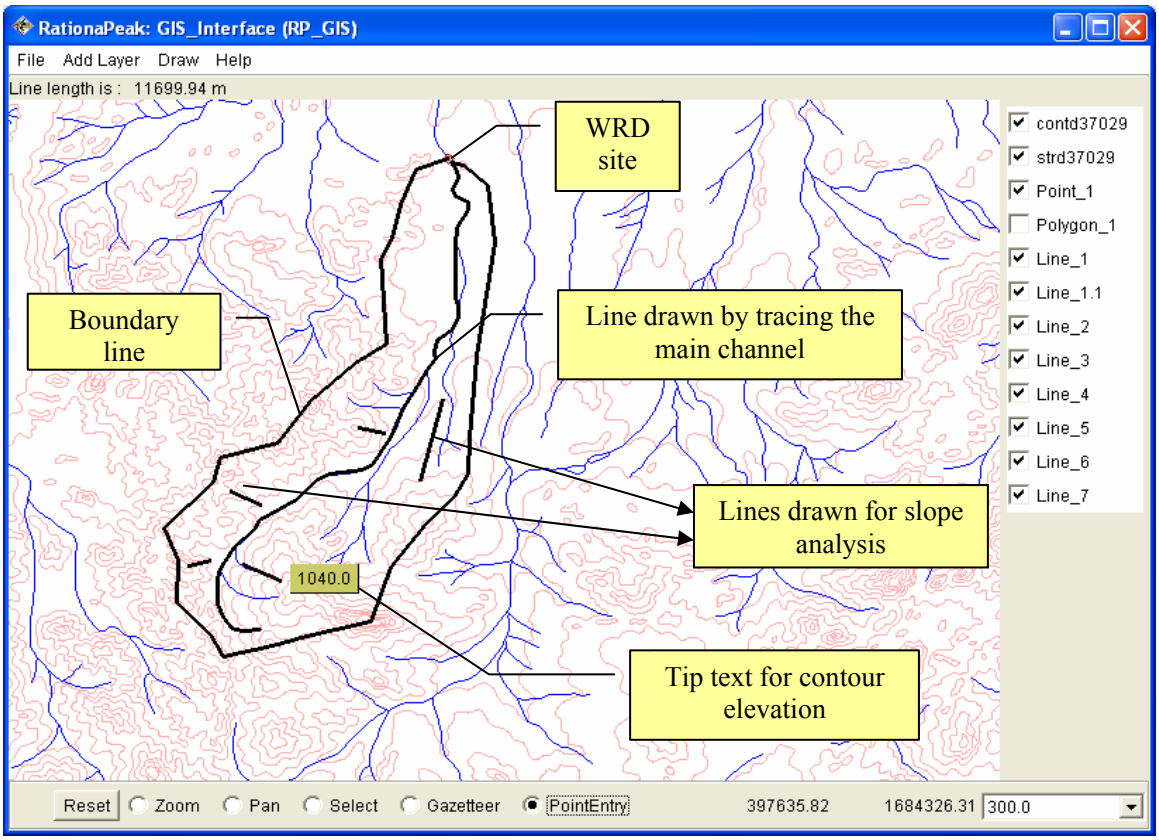

Figure 5.6 Channel length computation and slope analysis in RP_GIS

Although, layers (themes) in RP_GIS can be reordered using their names on the Theme Panel, contour lines appear less clear due to the grey fill of the catchment area even if the theme is brought to front. Therefore, it is advisable if the user draws a line for the same coordinate values immediately after the polygon (catchment) is drawn so that the polygon name on the Theme Panel can be deselected and the Line Theme, which shows catchment boundary, could be used instead during subsequent slope analysis.

5.5 Displaying Catchment Area and Perimeter Values Using the Select Tool

Catchment area is one of the basic input parameters of *RationalPeak* and once the delineated catchment is displayed using the Polygon Submenu of the Draw Menu, its value appears on the status bar. However, if another command is called for subsequent spatial analysis this information might get replaced with a message relating to the most recent analysis. Thus, to help the user refer back on the area and perimeter values of

any (sub) catchment, a means is provided in RP_GIS where the user can easily get parameter values of all or a particular sub catchment.

To display area and perimeter values of sub-catchments:

1. Select (switch on) the Select Tool from the tool bar .
2. If the user is interested to view parameter values of all sub-catchments currently displayed on the viewer, he/she has to simply click on any part of the viewer. An information dialog displaying information on each sub-catchment will then appear with sub-catchment name (in the form of Polygon_n), catchment area and perimeter. However, if the user is interested only in particular sub-catchment, he/she has to select it by dragging the cursor. If fully encompassed with in the selection rectangle (if actually selected) the sub-catchment is shaded by orange color and its name, area and perimeter appear on the information dialog.
3. To deselect a sub-catchment simply drag (select) on any part of the sub-catchment.

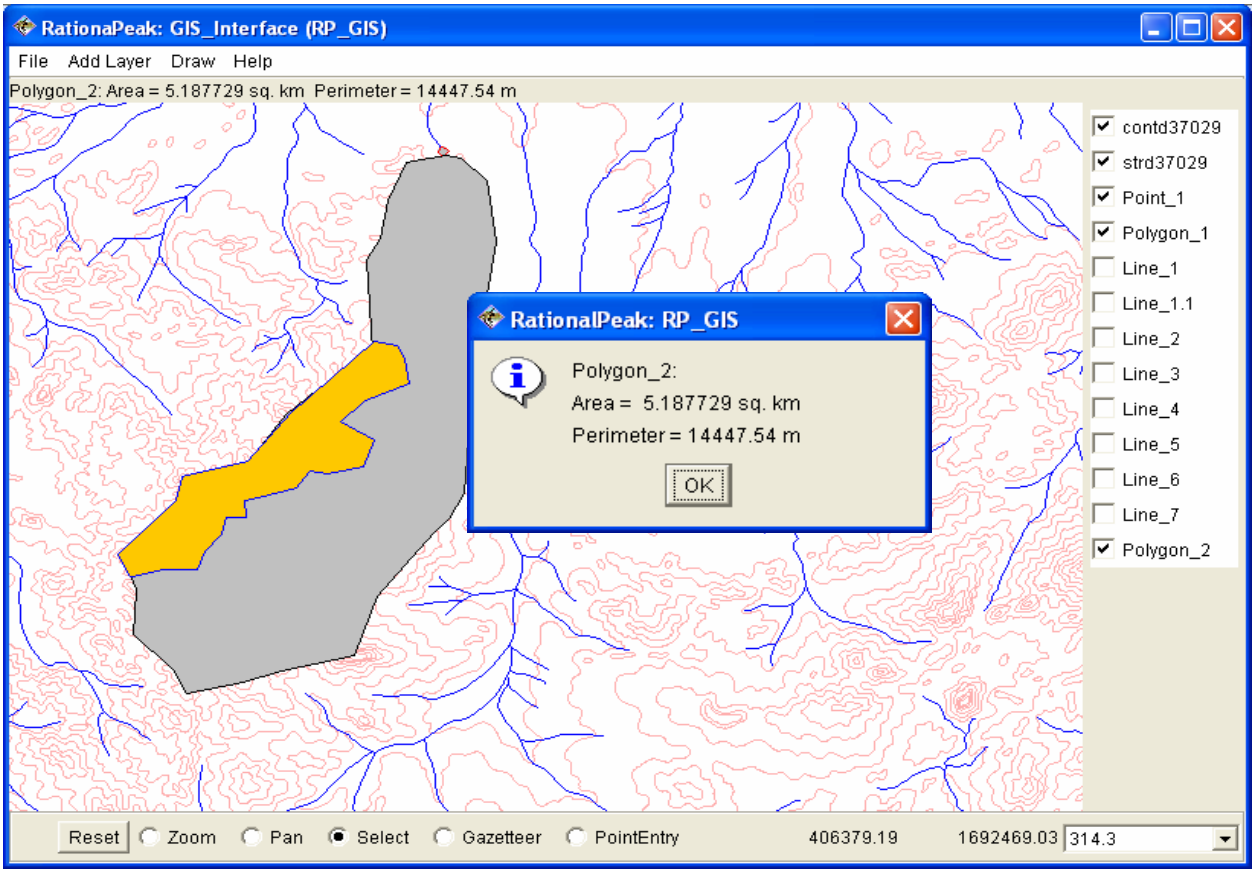

Figure 5.7 Displaying sub-catchment area and perimeter values in RP_GIS using the Select Tool