Digital Precipitation and Runoff QA/QC Application

Introduction

This software was written in Delphi/Object Pascal, and originally compiled in 2003 with Delphi 7. It was recompiled in 2011 with Delphi 2010. It uses the Borland Database Engine (BDE), along with a MicroSoft ODBC driver for SQL Server. There is a windows installer for the BDE. The ODBC driver is configured manually, see Appendix I. The current developer of Delphi, Embarcadero Software, no longer supports the BDE.

This application uses several database tables in addition to the precipitation and runoff tables. The "vertices" table contains vertices for Walnut Gulch Thiessen polygons and SRER triangles. The tables "runOffEventsBkUp" and "runOffPointsBkUp" are used to store the original data when runoff events are edited, in case the edits need to be reversed. The program also uses a text file, "boundary.dat", which defines the outer boundary of Walnut Gulch.

The purpose of this software is to identify potential errors in the digital precipitation and runoff data. The main interface is a resizable window divided into nine panels of equal size, in three rows by three columns. Each column represents one day, and the second row is labeled with the day of year (DOY). The top row panels are color maps showing the total daily precipitation or runoff depth. The middle row is depth for a selected event: cumulative event depth for precipitation or flow depth for runoff. The bottom row shows corresponding precipitation intensity or runoff discharge rate, both in inches/hour.

Running the Application

When the application is started, a dialog window appears allowing the user to enter the database username and password. There is also a drop-down box to select the watershed, either Walnut Gulch or Santa Rita. The Walnut Gulch data will include the wider network of precipitation gauges numbered from 400.

After the application is started, the menu item at the upper left, "Interval", can be selected to load data. A dialog window will allow entry of the starting and ending dates of the interval to be examined. Note that the interval is truncated to the end of the year if it continues into the next year. If the amount of data within the interval exceeds available memory, an "An error occurred while retrieving data" message will be displayed, in which case a shorter interval will have to be chosen.

To toggle between precipitation and runoff data, select the "Data" menu item. For Walnut Gulch, the top row of panels will display Thiessen polygons for precipitation and the subwatershed boundaries for runoff. For Santa Rita, both precipitation and runoff will display the same abstract representation of watersheds as triangles.

Examining Precipitation Data

A screenshot of a computer

AI-generated content may be incorrect.

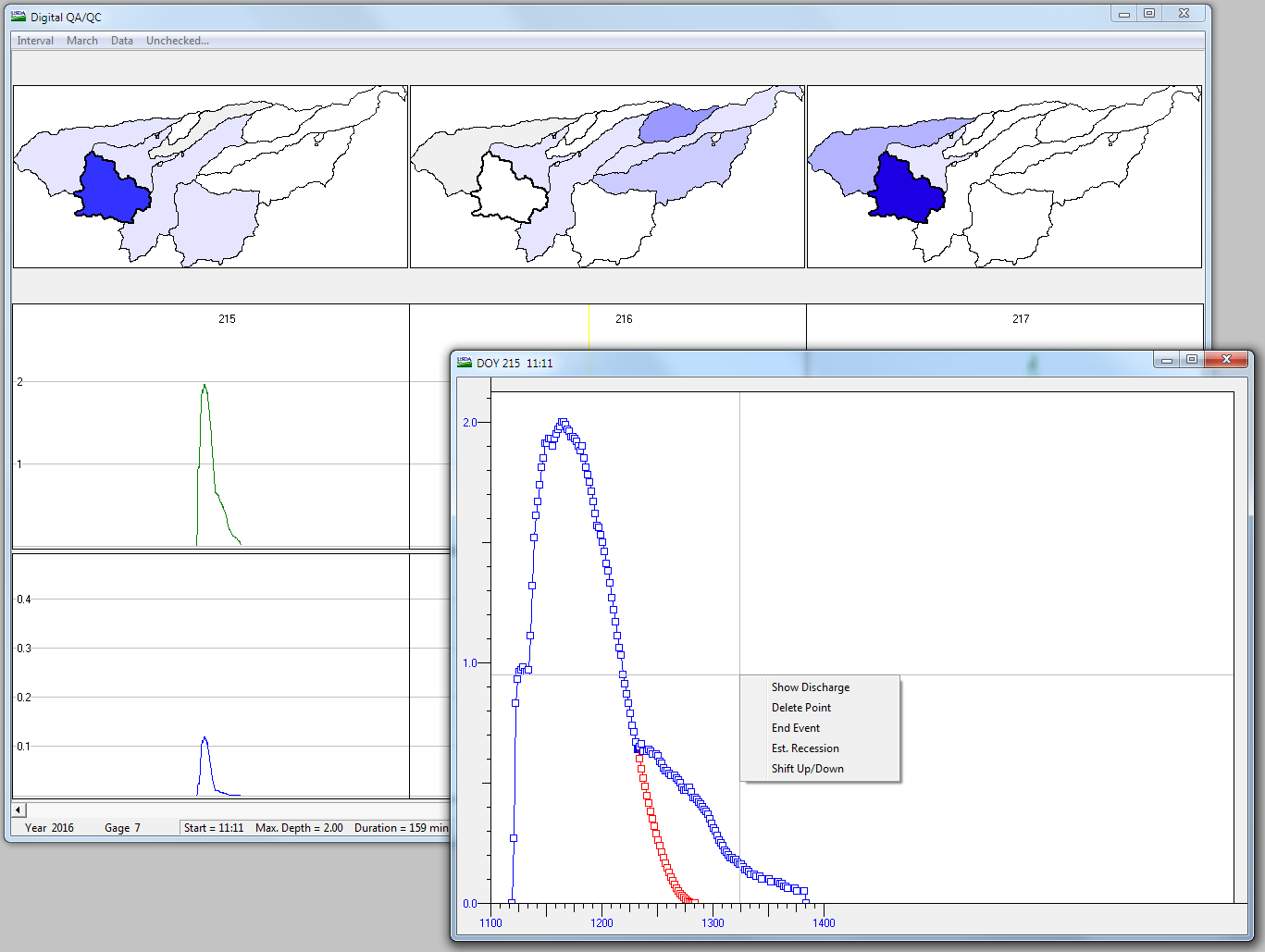
To navigate through the data for a given gauge, either click inside the Thiessen polygon or triangle for the desired gauge on any top map panel, or right-click over any top panel to get a drop-down list of gauges. For Walnut Gulch, the drop-down list will also include gauges outside of the watershed. When selected, the polygon will be highlighted by a thicker line, and the selected gauge number will be shown on the lower left of the window. There is also a function to iterate through the gauges in numerical order. Click on the "March" menu item, then "Start" to initiate the march. Use the Page Up key on the keyboard to move forward one gauge, and Page Down to move backward. If a gauge is selected manually during the march, the Home key will return to the current gauge in the marching sequence. To stop the march, go back to the "March" menu item and click "Stop".

If there is precipitation on a given day, one or more polygons/triangles will show color. If the selected gauge has precipitation on that day, the middle and bottom panel will show blue, green or red lines. The middle panel will show the cumulative depth (inches) with time and the bottom panel will show intensity (inches/hour). Hovering the mouse over a colored line in a middle panel will cause the event's starting time, maximum depth, and duration to be displayed at the bottom of the window. There may be vertical yellow lines on the middle panels, these indicate that the maintenance switch was toggled. The vertical scale of the middle and bottom rows of panels can be changed by right-clicking when the mouse is over either row.

The color of the line indicates the status of the data: either unchecked, approved, or not approved. Unchecked status is displayed as blue and indicates the data has neither been approved nor rejected. Approved status is indicated by a green line, while red indicates the data was deemed erroneous. Double-clicking a colored line on a middle panel will bring up a dialog window for approving or rejecting the event. If the event is rejected (Not Approved), a reason should be chosen from the drop-down box. If none of the entries describe the situation, a new description can be typed in.

There are two shortcut keys that affect data for the selected gauge over the three days currently displayed. Pressing the F8 key will approve all events during the three day period. F9 will "clear" the same events, i.e. set their status to unchecked.

Examining Runoff Data



Runoff data is selected and approved in the same way as precipitation data, with the middle and bottom panels showing flow depth in feet and discharge in inches per hour, respectively. As with precipitation, double-clicking an event will bring up a dialog window for approving or rejecting the event. Additionally, right-clicking an event will bring up a window with three menu items. Clicking the top item (Approve/Reject Event) will bring up the standard dialog window for approving or rejecting the event. Clicking the second item (Event Window) will bring up a window that allows some editing of the event data. The third item (Revert Event) will undo changes to the data from the previous editing session.

The editing window is used to:

* Break up an event that includes two or more hydrographs connected by low flow. The low flow could be baseflow or a false flow due to issues with the flume.
* Remove a rain-on-flume response that precedes the actual hydrograph.
* Estimate the lower part of the recession curve if it appears to be affected by sediment.
* Shift the hydrograph up or down to correct for an erroneous zero level.

The edit window allows the user to select a data point by clicking on it, and access to a pop-up menu by right-clicking anywhere inside the window. The pop-up window allows the user to:

* Toggle between depth or discharge on the y-axis.
* Delete the selected point.
* End the event at the selected point.
* Estimate the recession curve starting at the selected point.
* Shift the hydrograph up or down.

Separating an event into two hydrographs usually requires ending the event at the beginning of the second hydrograph. The second hydrograph will then become another event. To remove the extended "tail" from the first hydrograph, there are two options. If the recession shows a convex "hump" before the tail, use the recession estimator to end the event. Otherwise, select a suitable point and end the event there. This will leave a vestigial event between the two hydrographs. After the editing window is dismissed, double-click the event and mark it as not approved. For an event with more than two hydrographs, repeat the above procedure, moving left to right.

Ensuring That All Data Has Been Reviewed

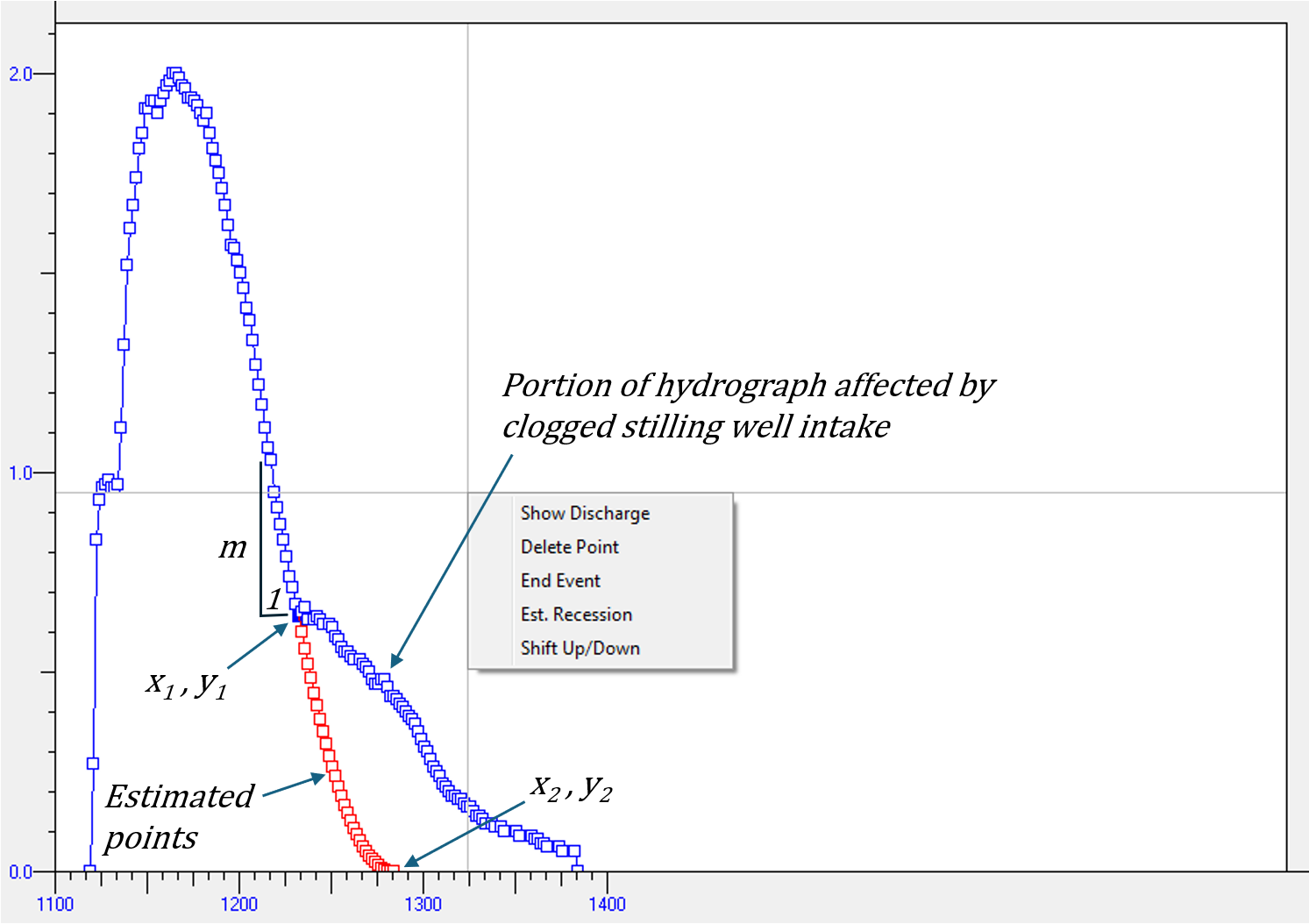
Select the "Unchecked" menu item at the top left of the application window to generate a text file listing all events with unchecked status. This will include both precipitation and runoff from Walnut Gulch and Santa Rita.

Runoff Recession Curve Estimator

The Walnut Gulch supercritical flumes are usually effective at preventing sediment deposition in the flumes. However, during the latter part of the recession, sediment can fill the intake and stilling well pipe, preventing the free flow of water out of the stilling well. This produces a characteristic convex “hump” in what should be a concave recession curve. The Recession Curve Estimator (RCE) replaces the original approach of using a French curve and pencil to draw an estimated recession curve on the flume chart. The RCE replaces the French curve with a quadratic polynomial having specific endpoint conditions.

Referring to the figure below, the first endpoint is the final “good” data point, labeled *x1*, *y1*. Note that *x1* and *y1* are known values. An additional condition is that the slope at that point is equal to *m*. The value of *m* is determined by fitting a line from *x1*, *y1* through the nine previous points using the method of least squares.

At the ending point, labeled *x2*, *y2*, *y2* = 0 and there is an additional condition that the slope = 0. Note that *x2* is unknown.



Solving for the coefficients a, b, and c of the quadratic polynomial

The equation for the quadratic polynomial at *x1*, *y1* is:

With the condition that = m:

The equation for the quadratic polynomial at *x2*, *y2* is:

With the condition that = 0:

Solving equations 2 and 4 for *b*, equating them, and solving for *x2*:

Substitute Eq. 10 into Eq. 3:

Subtract Eq. 13 from Eq. 1:

Substitute Eq. 7 for :

From Eq. 5:

From Eq. 1:

Source Code

The source code for the RCE is in file *EventFormUnit.pas*. The above solution and computation of the estimated recession points is in procedure *RecessionMenuClick*.

Appendix - Borland Database Engine and ODBC Setup

Instructions for Windows XP

Run setup.exe and choose Typical Installation.

You may see a couple of error messages during installation - dismiss them.

In Control Panel, go to Administrative Tools and open Data Sources (ODBC).

Hit the Add button and select SQL Server from the list, then hit Finish.

In the next window, type the following (all caps)

Name: DAP

Description: <leave blank>

Server: SINKHOLE

Hit Next, then the following two items should be selected/checked:

"With SQL Server authentication using a login ID and password..."

"Connect to SQL Server to obtain default settings..."

For login ID and password

Login ID: dapwriter

Password: theHulk2003

(note the capital H)

Hit Next.

Hit Finish.

Hit Test Data Source, then OK.

Hit OK.

Hit OK.

The QAQC program (QAQC.exe) will be in C:\Program Files\USDA\QAQC

The username/password is the same as above, dapwriter/theHulk2003