Exercise C4 – Analyzing Endpoints Using the BASINS Climate Assessment Tool (CAT)

In this exercise, we will run an HSPF simulation using BASINS CAT. After we have run that simulation, we will look at endpoint values through the CAT results tables and pivot tables.

Questions addressed in this exercise:

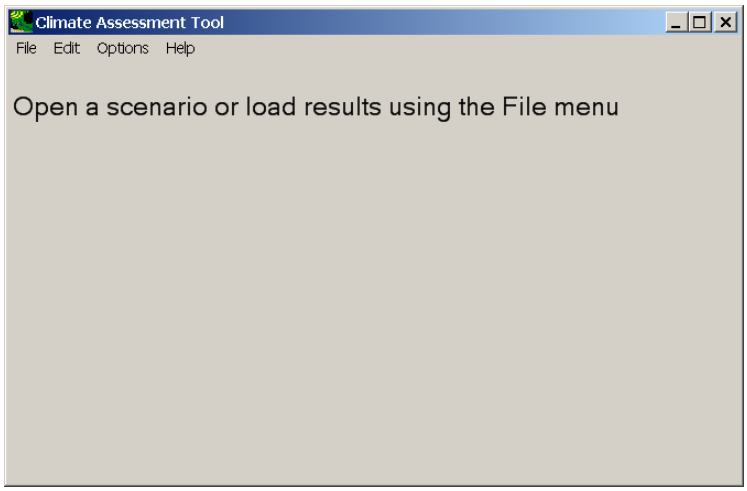
1) How do I run an HSPF simulation using BASINS CAT?
2) How do I use results tables of assessment endpoint values?
3) How do I use pivot tables of assessment endpoint values?
4) How do I export assessment endpoint results to files?
5) How do I use the additional BASINS tools for analysis and display?

A. Running an HSPF Simulation Using BASINS CAT

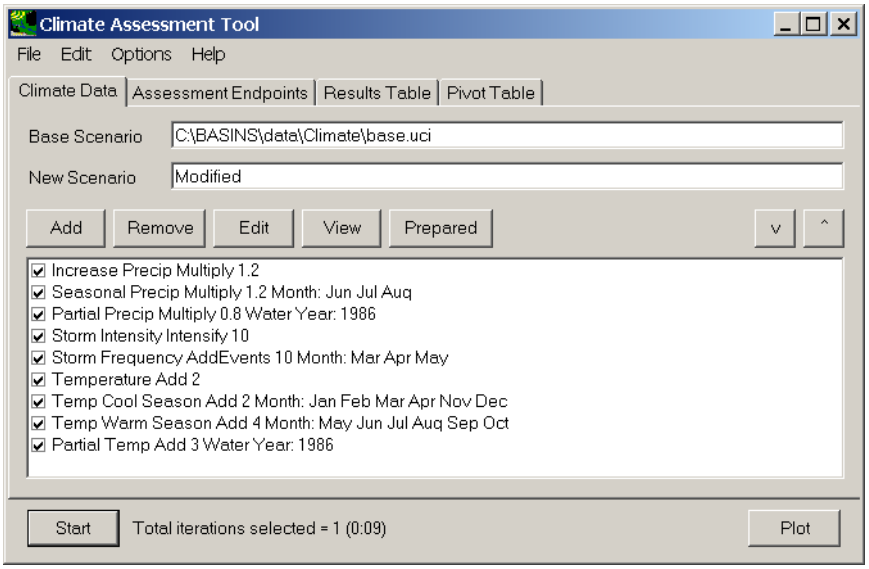
QUESTION ANSWERED:
1) How do I run an HSPF simulation using BASINS CAT?

This section demonstrates how to run an HSPF simulation using BASINS CAT. To begin, at least one climate change scenario and one hydrologic or water quality endpoint must be defined. Climate change scenarios are defined by selecting any number of record adjustments developed in Exercise C1 and C2. Hydrologic or water quality endpoints are defined in Exercise C3. This exercise refers to climate record adjustments and hydrologic and water quality endpoints defined in the previous exercises. It is also possible, however, to perform this exercise using other record adjustments (climate scenarios) and assessment endpoints.

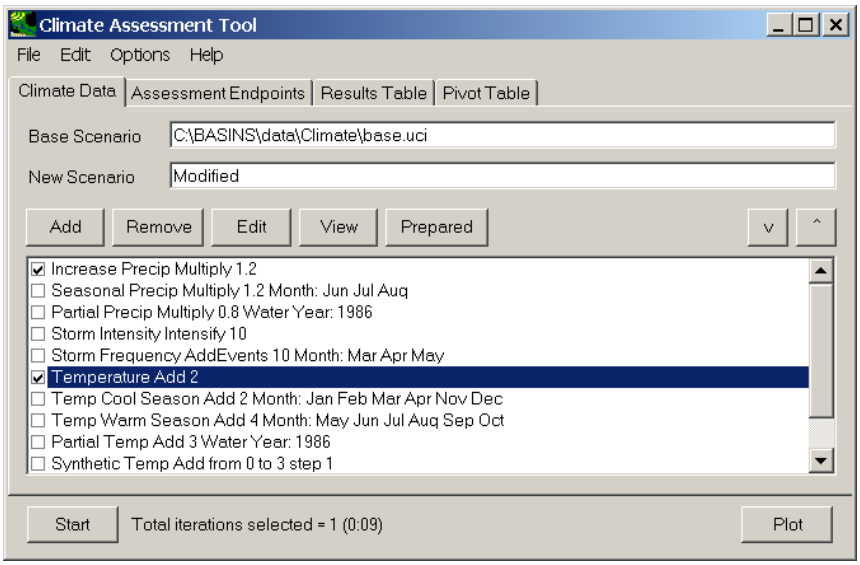
1. Open BASINS and select the **Analysis:Climate Assessment Tool** menu option. The following form will appear.



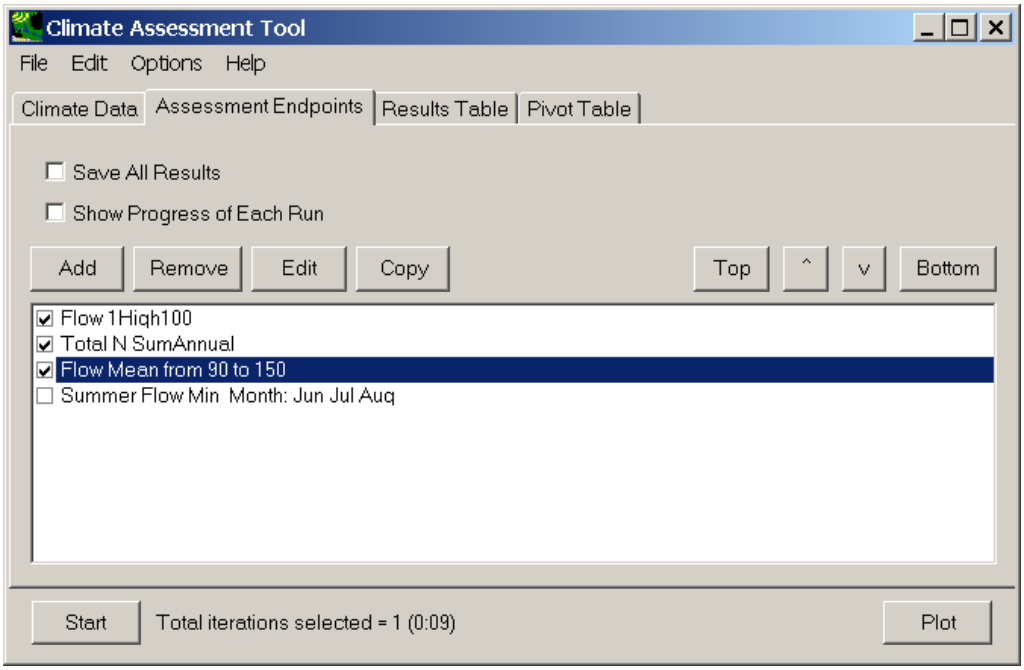
2. From the **File** menu, choose **Load Climate and Endpoints**. In the file dialog, choose the file *CAT-Tutorial.xml* saved in the previous exercise. The CAT form will now look like the following:



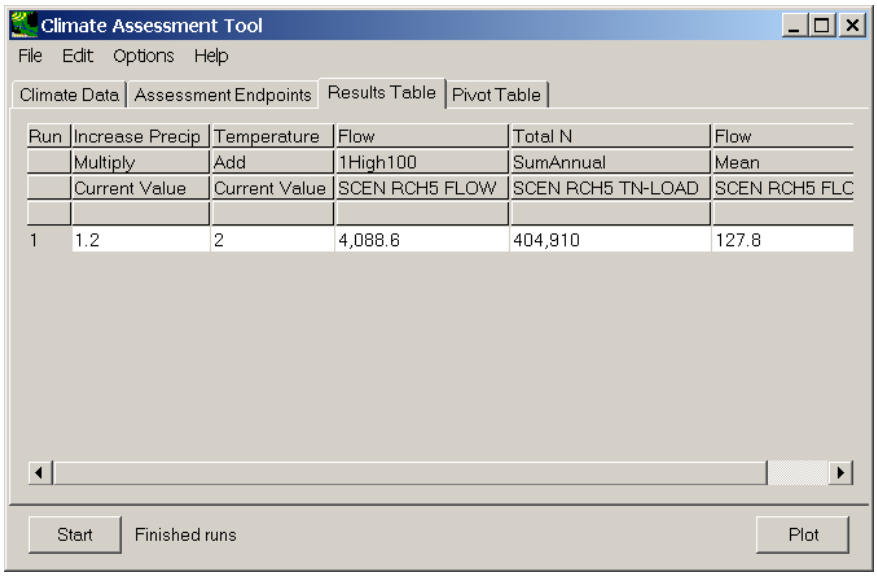
3. Go to the **Climate Data** tab and select the two record adjustments shown below to build a climate scenario for this assessment. Record adjustments are selected by placing a check in the appropriate checkbox.


Climate Assessment Tool
File Edit Options Help
Climate Data
Assessment Endpoints
Results Table
Pivot Table
Base Scenario
C:\BASINS\data\Climate\base.uci
New Scenario
Modified
Add
Remove
Edit
View
Prepared
v
^
Increase Precip Multiply 1.2
Seasonal Precip Multiply 1.2 Month: Jun Jul Aug
Partial Precip Multiply 0.8 Water Year: 1986
Storm Intensity Intensify 10
Storm Frequency AddEvents 10 Month: Mar Apr May
Temperature Add 2
Temp Cool Season Add 2 Month: Jan Feb Mar Apr Nov Dec
Temp Warm Season Add 4 Month: May Jun Jul Aug Sep Oct
Partial Temp Add 3 Water Year: 1986
Synthetic Temp Add from 0 to 3 step 1
Start
Total iterations selected = 1 (0:09)
Plot

4. The next step is selecting the hydrologic and water quality endpoints of interest. Any number of endpoints can be selected. Go to the **Assessment Endpoints** tab and select the endpoints shown below. Endpoints are selected by placing a check in the appropriate checkbox.



5. Before model execution, two additional options on the **Assessment Endpoints** tab can be set: **Save All Results** and **Show Progress of Each Run**. The **Save All Results** check box is used to specify whether or not all model output time series data is saved, not just the assessment endpoint values. Checking this box will save model output in a new data set. The text entered in the **New Scenario** field on the **Climate Data** tab will be used as the base file name for the new output files. When saving results from synthetic scenarios, this base name will also have model run number added to it (i.e., modified-1, modified-2, etc.). The **Show Progress of Each Run** check box is used to set whether or not a status monitor will be displayed while the model is running. If a model run is particularly long, or a series of model runs are being made using synthetic data, checking this box can be useful to see the progress of the model run(s). For this example, leave these two boxes unchecked. Click the **Start** button to run the model. The **Results Table** tab will be activated to display the endpoint results.



B. CAT Output Assessment

The BASINS CAT interface provides standard tabular (results table) and pivot table options for summarizing and visualizing the results of HSPF simulations. Additional graphics and data listing capabilities are also available from within the BASINS system.

The steps in this section illustrate the following options for viewing results:

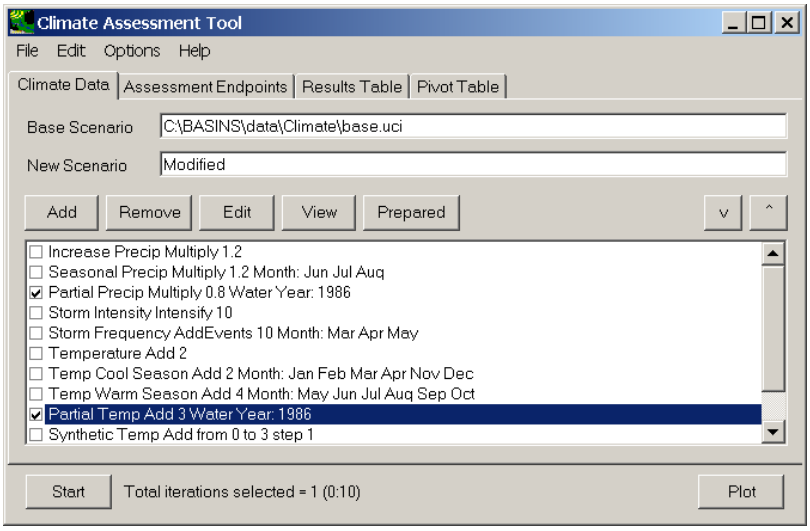
- Results Tables – BASINS-CAT's tabular output of assessment endpoint values
- Pivot Tables – BASINS-CAT's pivot table output of assessment endpoint values
- Exporting Results - output of assessment endpoint values to files in a format that can be analyzed or visualized using external software
- Additional BASINS Tools - analysis and display features available in BASINS

Example 1. Results Tables

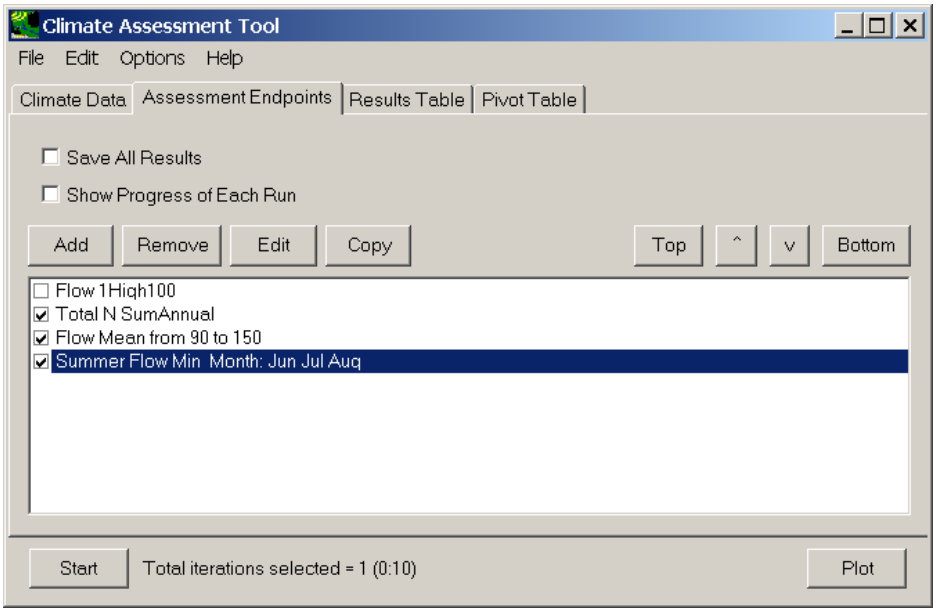
QUESTION ANSWERED:
2) How do I use results tables of assessment endpoint values?

This exercise demonstrates the standard tabular output capabilities of BASINS-CAT. To begin this exercise, at least one climate change scenario and one hydrologic or water quality endpoint must be defined. Climate change scenarios are defined by selecting any number of record adjustments developed in the Exercises C1 and C2. Hydrologic or water quality endpoints are defined in the Exercise C3. This exercise refers to record adjustments and hydrologic or water quality endpoints developed in previous exercises. It is also possible, however, to perform this exercise using other adjustments and endpoints.

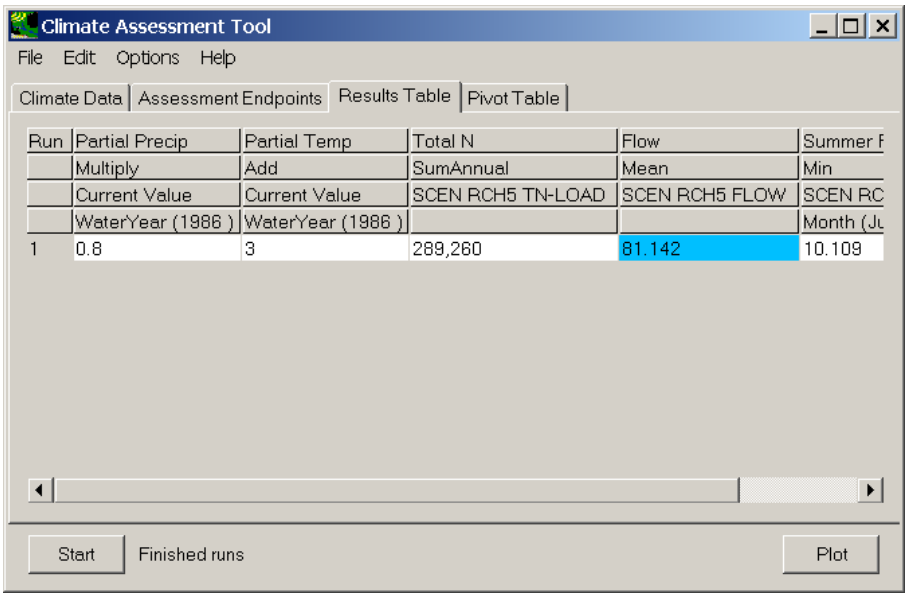
1. Begin this example by defining a climate change scenario. Go to the **Climate Data** tab and select the record adjustments shown below.



2. Next, select the hydrologic or water quality endpoints of interest for this assessment. For this example, go to the **Assessment Endpoints** tab and select the endpoints shown below.



3. To execute the model run for this assessment, click the **Start** button at the bottom of the form. When the model has completed, BASINS CAT will report the resulting endpoint values on the **Results Table** tab. The BASINS CAT form can be resized to show all resulting values at the same time. Note that for this assessment, the average flow value falls below the minimum value of concern specified for that endpoint (indicated by blue highlighting).



4. Output tables in BASINS CAT can also be saved to an external file for use outside of the program. Choose the **Save Results** item from the **File** menu and a dialogue form will prompt for the file name in which the results are to be saved. Results are saved in a tab-delimited format, suitable for import into Excel and other analysis programs.

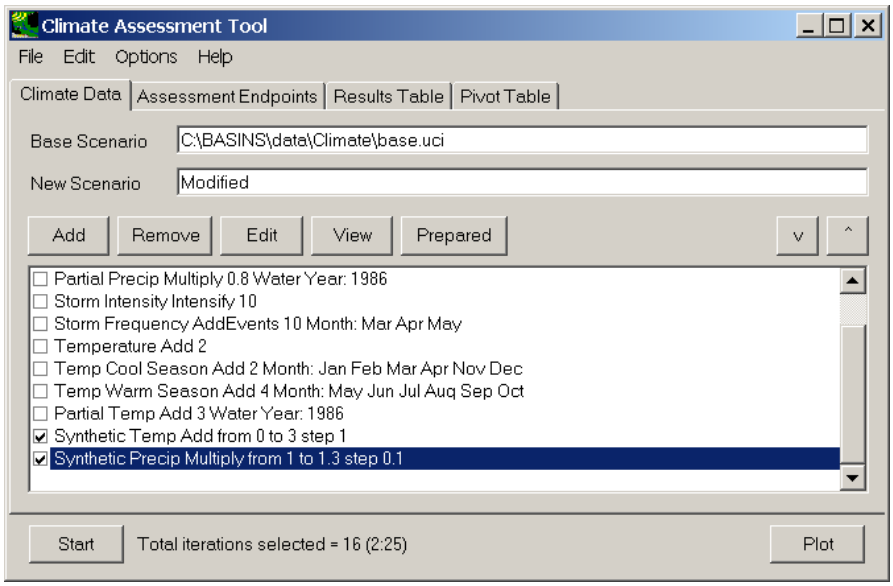
Example 2. Pivot Tables

QUESTION ANSWERED:
3) How do I use pivot tables of assessment endpoint values?

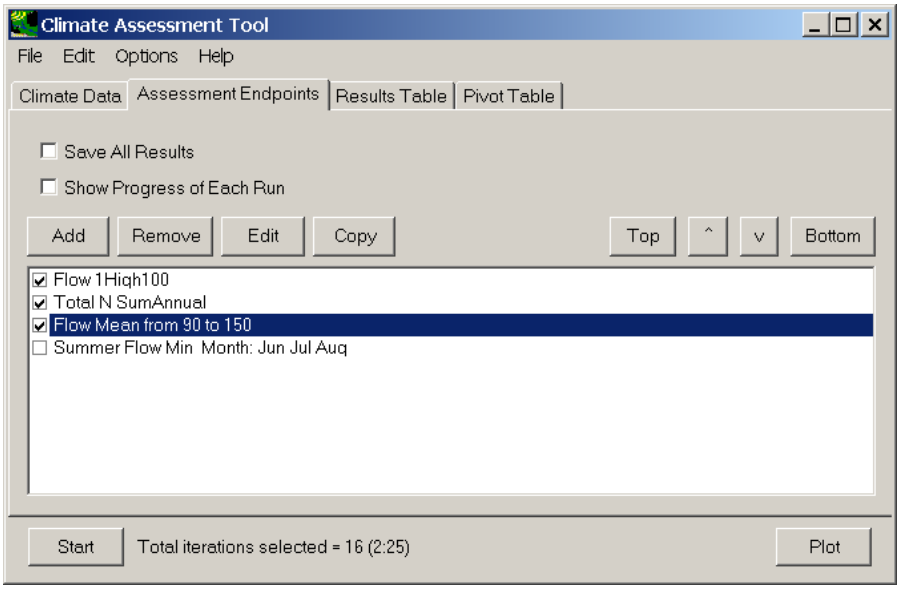
This exercise demonstrates how to view BASINS-CAT results in the form of a pivot table. A pivot table is a data visualization and mining tool that allows users to reorganize selected columns and rows of data within a database. The term pivot refers to turning the data to view it from different perspectives. Pivot tables are useful for summarizing large amounts of data in a compact format, looking for patterns and relationships within a data set, and organizing data into a format suitable for plotting as a chart. The pivot table feature is particularly useful for displaying results produced when running multiple synthetic climate change scenarios.

1. Begin this example by defining a climate change scenario. On the **Climate Data** tab, select the two synthetic climate change scenarios, as shown below. Note that since

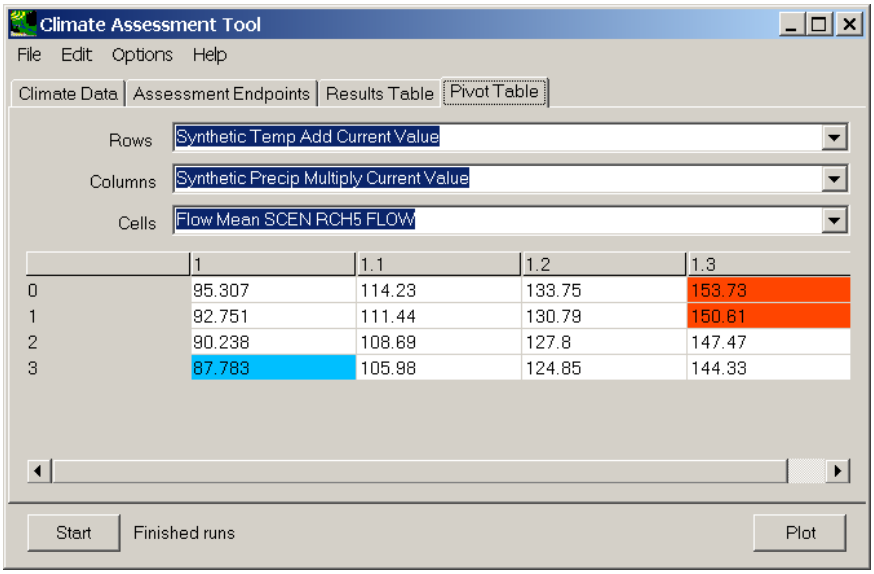
each synthetic scenario has four iterations, a total of 16 model runs will be made, one for each unique combination of precipitation and temperature values.



2. Next, select the hydrologic or water quality endpoints of interest for this assessment. For this example, go to the **Assessment Endpoints** tab and select the endpoints shown below.



3. Since this assessment will involve 16 model runs, it is advisable to activate the **Show Progress of Each Run** option. This will provide feedback on the rate at which BASINS CAT is processing the model runs. To execute the model runs for this assessment, click the **Start** button at the bottom of the form. When the model has completed, BASINS CAT will report the resulting endpoint values on the **Results Table** tab. Click on the **Pivot Table** tab to explore additional BASINS CAT output features. The first two fields of this form are used to specify what element to vary in the **Rows** and **Columns** of the pivot table. For this exercise, select **Synthetic Temp Add Current Value** and **Synthetic Precip Multiply Current Value** for the **Rows** and **Columns** field values. The **Cells** field is used to specify what element will be displayed in the pivot table's cells. Select **Flow Mean SCEN RCH5 FLOW** for this field and the resulting pivot table will appear as follows.



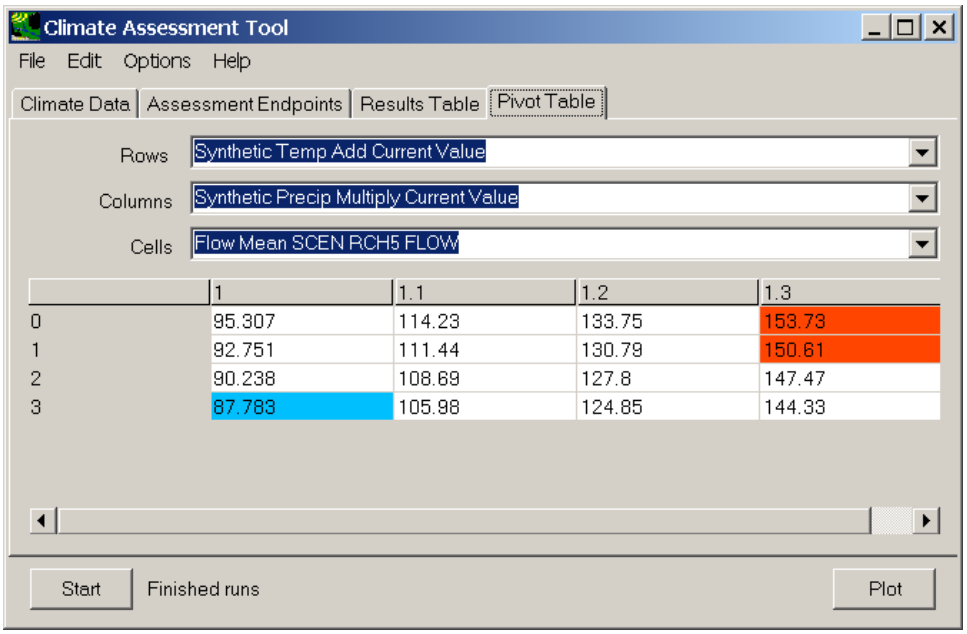
4. Note that some of the flow values fall below or above the minimum and maximum values of concern that were specified when defining this endpoint. As desired, users can familiarize themselves with the pivot table's capabilities by changing the selections in the 3 fields above the table.

Example 3. Exporting Results for Use With External Software

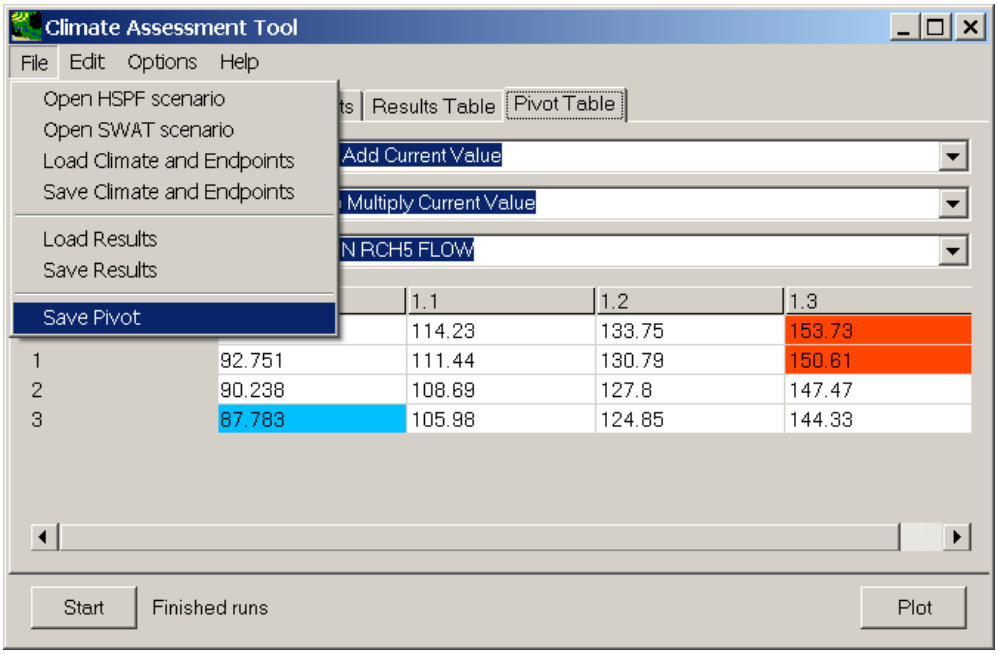
QUESTION ANSWERED:
4) How do I export results of assessment endpoint values to files?

This example shows how results from HSPF simulations conducted using BASINS-CAT can be exported for analysis and visualization outside of the BASINS system. To perform this example, it is necessary to first complete the exercise for using Pivot Tables above.

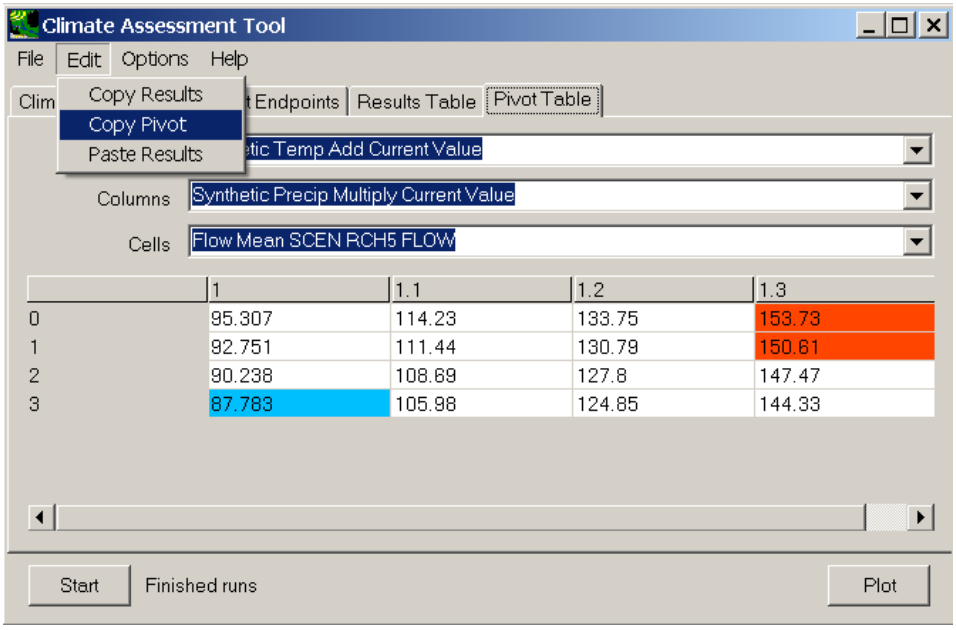
1. This example begins with the final step of the previous example, which should be the display of a pivot table on the BASINS-CAT form.



2. Output results from both the **Pivot Table** and the results table can be saved to an external file. The **Save Pivot** option in the **File** menu provides access to saving the table. A file dialog form will then prompt for the name of the output file. The results will be saved in a tab-delimited format, which are readily imported into Excel and other analysis packages. As described previously, the Results Table can also be saved to an external file in the same manner.



3. Results from the results table or a pivot table can also be copied to the clipboard. These results can then be directly pasted into an external program.

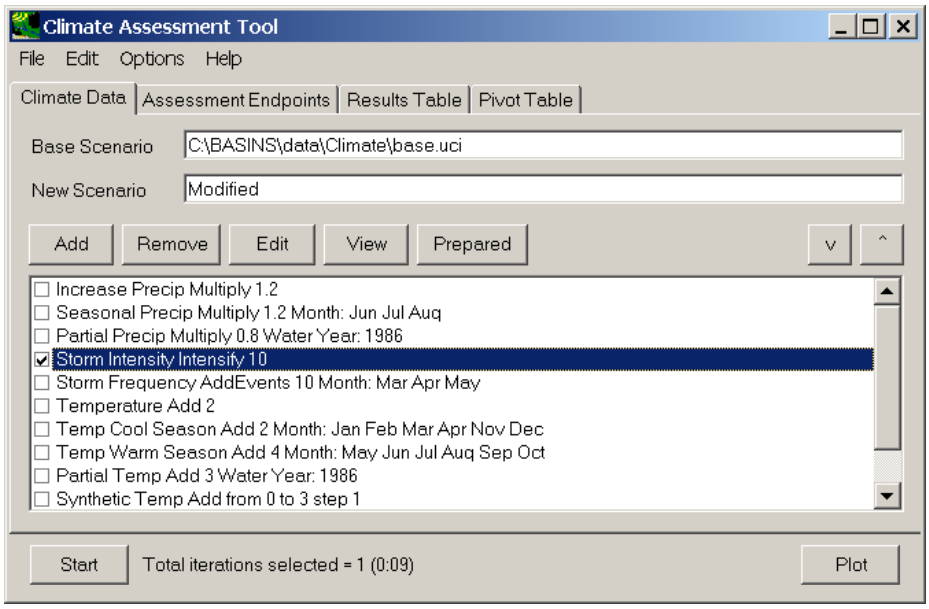


Example 4. Additional BASINS Tools for Summarizing and Visualizing Results

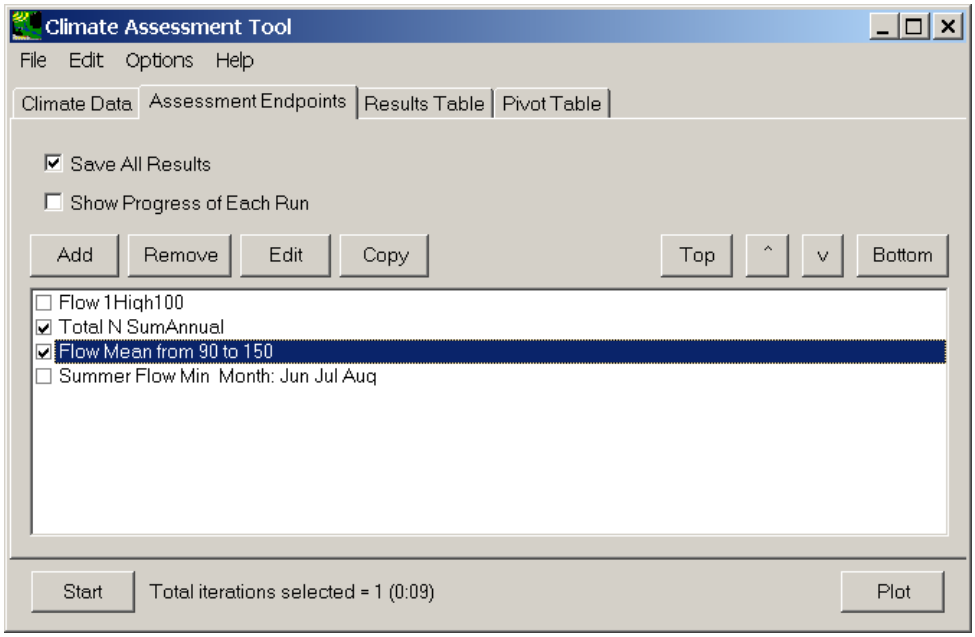
QUESTION ANSWERED:
5) How do I use additional BASINS tools for analysis and display?

This example demonstrates how to access additional tools within the BASINS system for viewing the results of HSPF simulations using BASINS CAT. To begin this example, at least one climate change scenario and one hydrologic or water quality endpoint must be defined. Climate change scenarios are defined by selecting any number of record adjustments developed in the Exercise C1 and C2. Hydrologic or water quality endpoints are defined in the Exercise C3. This example refers to climate record adjustments and hydrologic and water quality endpoints developed in previous exercises. It is possible, however, to perform this exercise using other climate record adjustments and assessment endpoints. More detailed documentation of data viewing and analysis capabilities within the BASINS system are available from the EPA BASINS web site (http://www.epa.gov/waterscience/basins/).

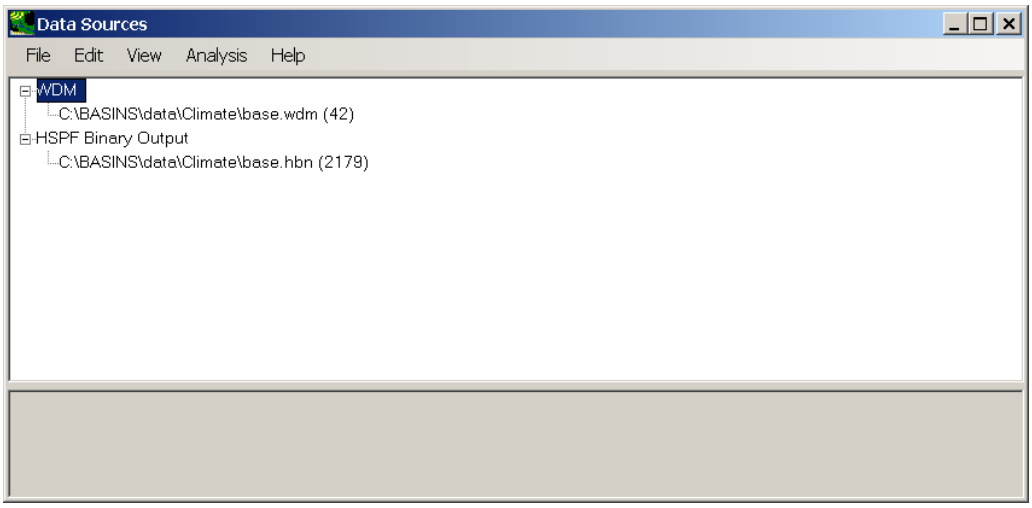
1. Begin this example by defining a climate change scenario. For this example, a simple scenario of intensifying precipitation will be used.



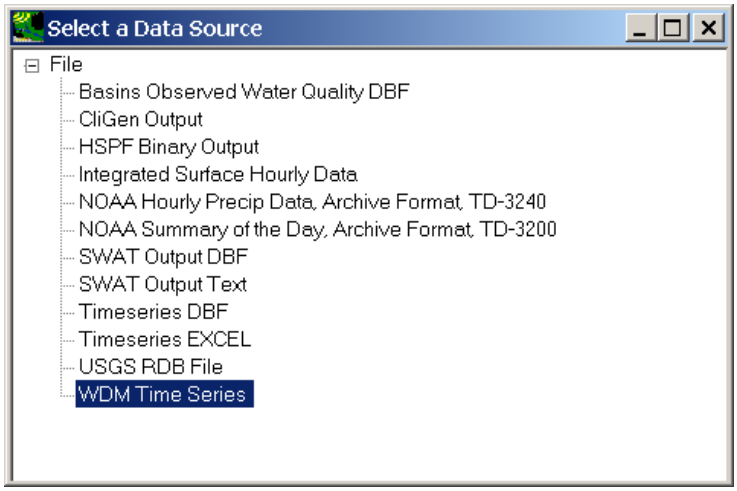
2. Next, select the hydrologic or water quality endpoints of interest for this assessment. This example will focus on total nitrogen loads, so go to the **Assessment Endpoints** tab and select the endpoints shown below. (Note: If you did not perform the exercises that developed these endpoints, you can select other endpoints and continue with this exercise.) This exercise will demonstrate further analysis capabilities within BASINS, so be sure the "Save All Results" option is checked.



3. To execute the model run for this assessment, click the **Start** button at the bottom of the form. When the model has completed, BASINS CAT will report the resulting endpoint values on the **Results Table** tab. To begin using BASINS analysis tools, return to the main BASINS form and select the **Manage Data** option from the **File** menu. The **Data Sources** form shows the data sources that are currently open, these being the WDM and binary output (hbn) file from the Base run. From here the results from the modified climate scenario can be loaded into the current BASINS project. Begin this process by selecting the **Open** option from the **File** menu.

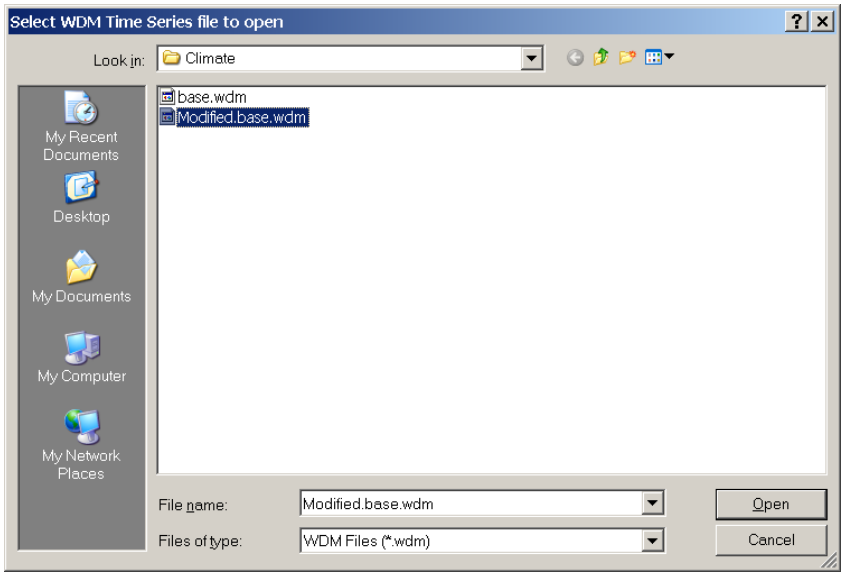


4. The **Select a Data Source** form displays the various data formats that BASINS can read. Double-click on the **WDM Time Series** item.

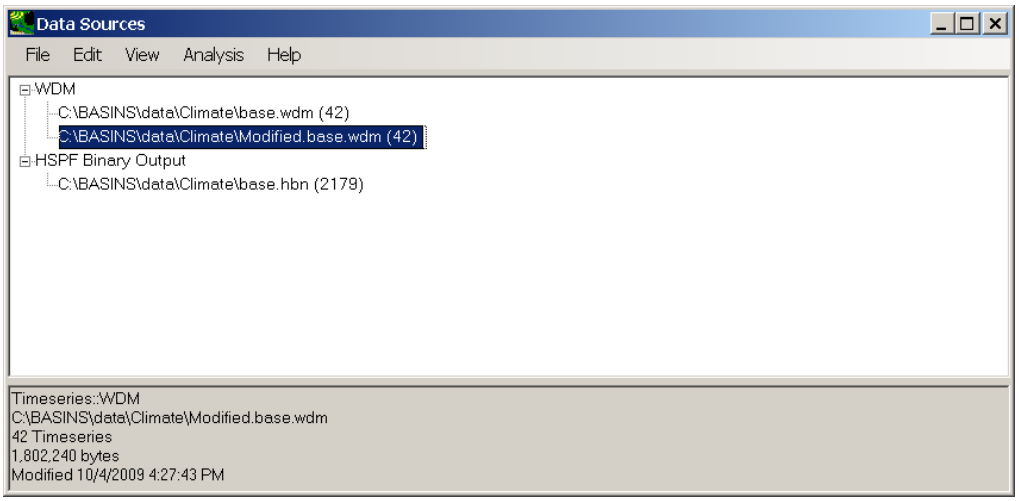


As BASINS CAT scenarios are run, their results are stored in a copy of the base WDM file, but containing the modified input and output data. The file name is comprised of the **New Scenario** and **Base Scenario** names (e.g., modified.base.wdm). If multiple scenarios are run and the **Save All Results** option is selected (as in step 2 above), additional WDM file copies are created with numbers inserted in their file names. The most recently run scenario will be stored in the WDM file with the largest number.

5. On the ensuing dialogue form, select the WDM file starting with “modified” and having the highest number, if any, in the file name. Click **Open**.

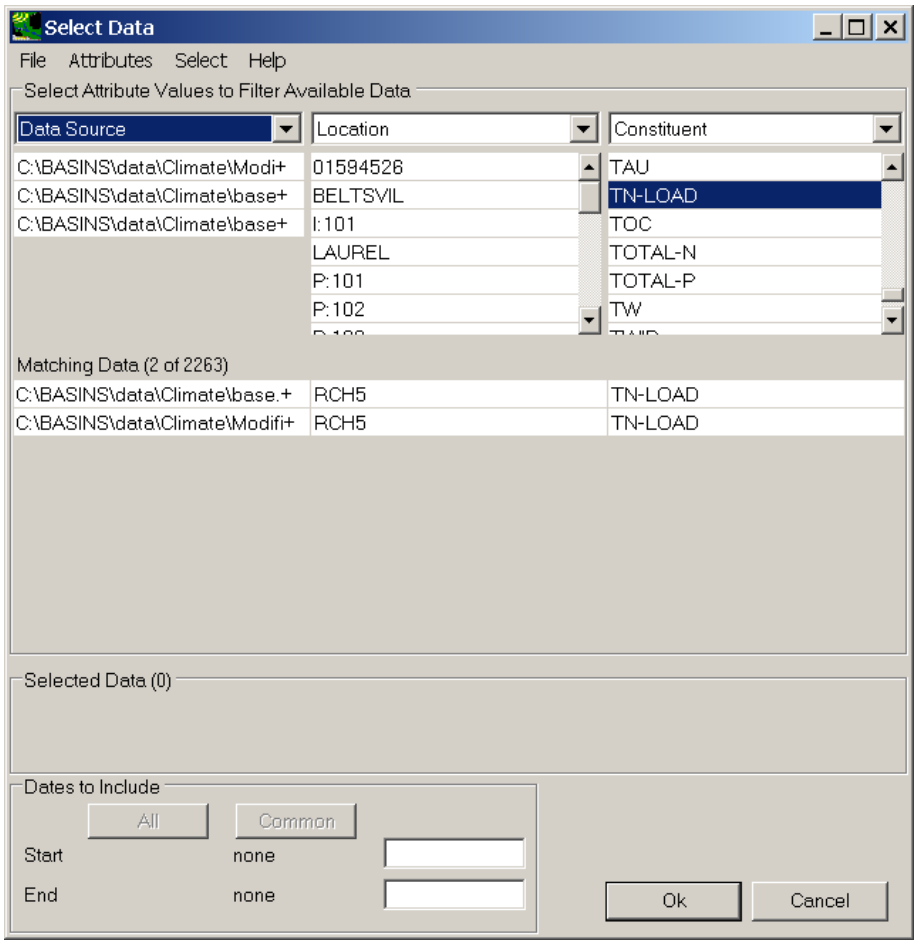


6. The **Data Sources** form will now list this WDM file along with the “Base” files.

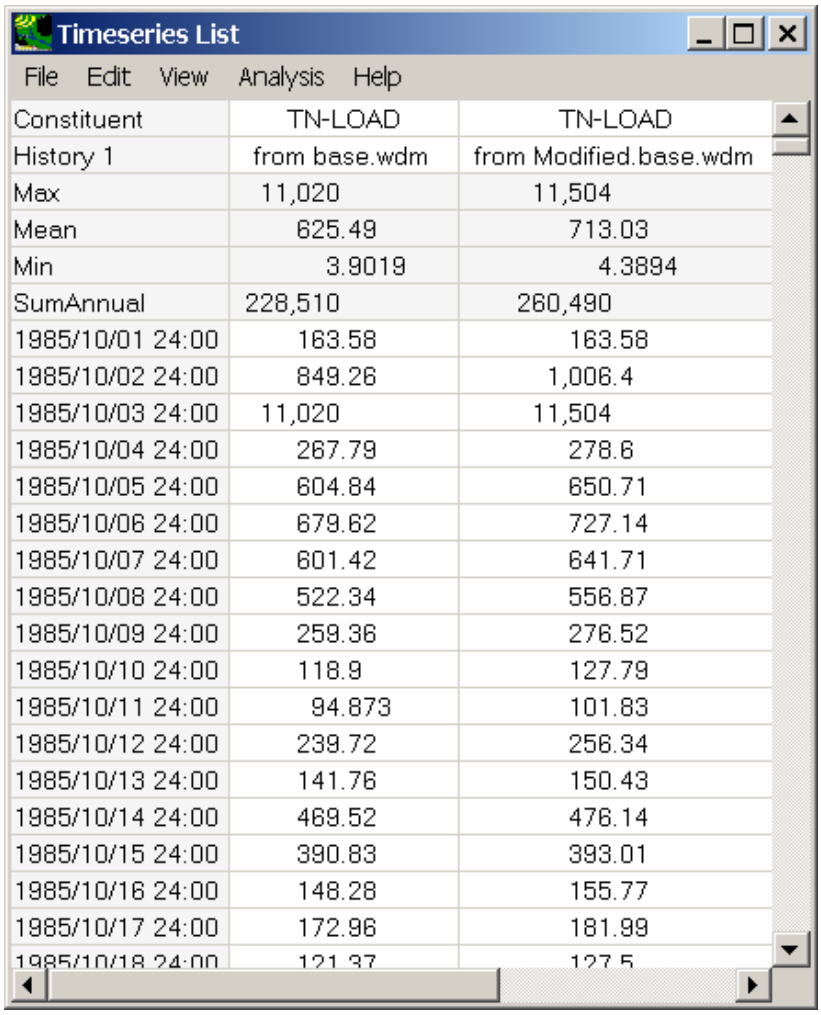


7. The **Data Sources** form can now be closed.

8. The **Analysis** menu contains a variety of features to aid in assessment. To view the daily Nitrogen loads, select the **List** option from this menu and the user will be prompted for the data sets to be listed. In the third column, labeled **Constituent**, scroll down and select the **TN-LOAD** item. Two data sets with the same **Scenario**, **Location**, and **Constituent** are available. To distinguish between the two, it is necessary to change the attribute listed in one of the three columns. Go to the first column, labeled **Scenario**, and click the pull-down list at the top of the column. Scroll up the list and select the **Data Source** attribute, which shows the file name of each data set.

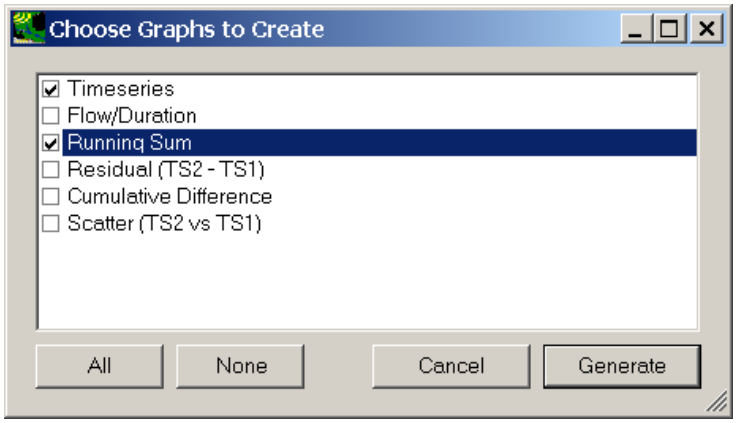


9. Clicking the **Ok** will automatically select the two **Matching** data sets and generate the listing of the data sets' values. A variety of attributes are available for display at the top of the listing. These are accessed through the **File:Select Attributes** menu option. Select this option and customize the listing as desired.

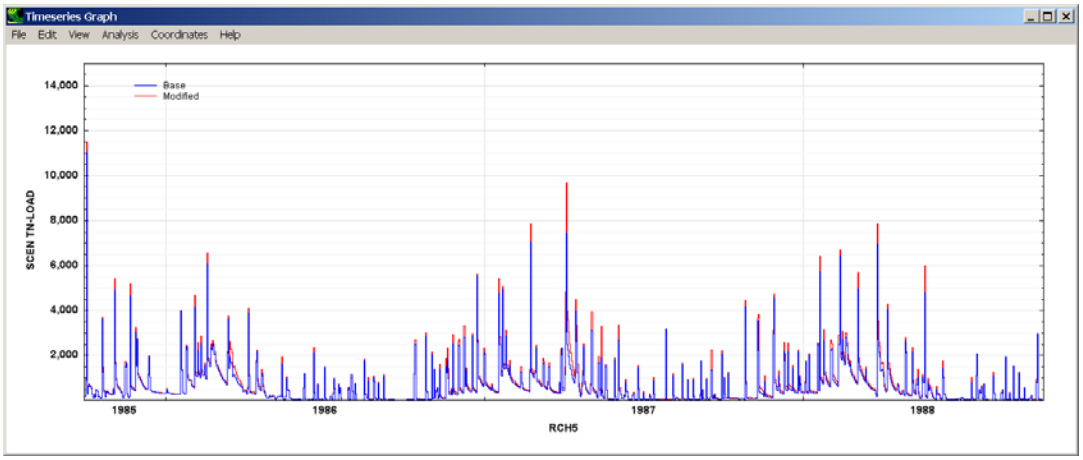


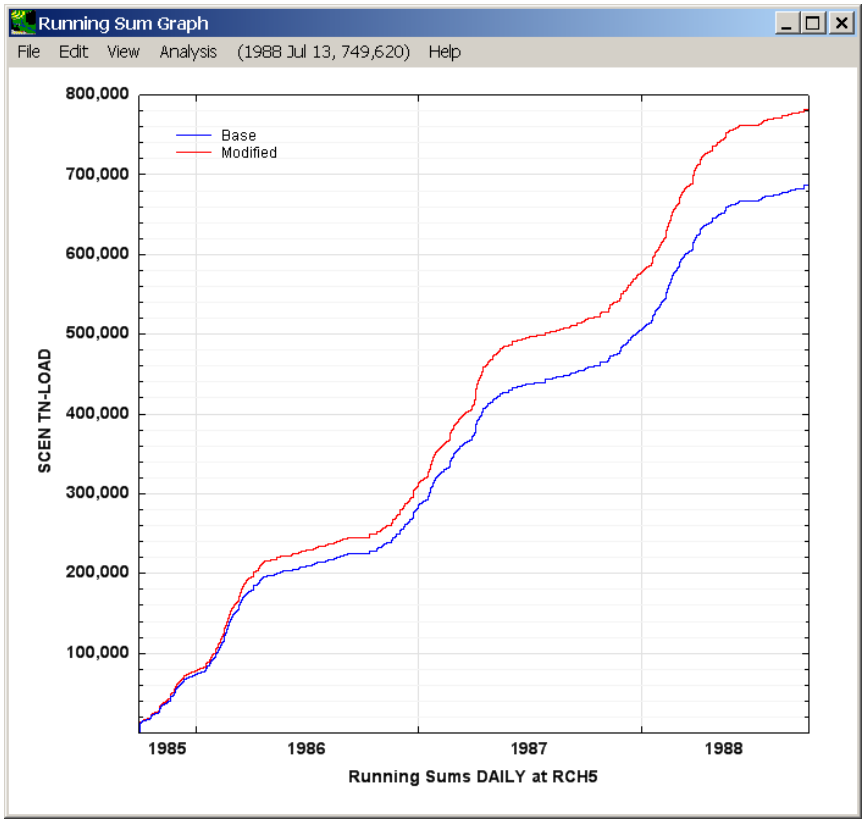
Constituent	TN-LOAD	TN-LOAD
History 1	from base.wdm	from Modified.base.wdm
Max	11,020	11,504
Mean	625.49	713.03
Min	3.9019	4.3894
SumAnnual	228,510	260,490
1985/10/01 24:00	163.58	163.58
1985/10/02 24:00	849.26	1,006.4
1985/10/03 24:00	11,020	11,504
1985/10/04 24:00	267.79	278.6
1985/10/05 24:00	604.84	650.71
1985/10/06 24:00	679.62	727.14
1985/10/07 24:00	601.42	641.71
1985/10/08 24:00	522.34	556.87
1985/10/09 24:00	259.36	276.52
1985/10/10 24:00	118.9	127.79
1985/10/11 24:00	94.873	101.83
1985/10/12 24:00	239.72	256.34
1985/10/13 24:00	141.76	150.43
1985/10/14 24:00	469.52	476.14
1985/10/15 24:00	390.83	393.01
1985/10/16 24:00	148.28	155.77
1985/10/17 24:00	172.96	181.99
1985/10/18 24:00	121.37	127.5

10. The **Analysis** menu on the **Time series List** form contains many of the same analysis functions as the main BASINS form. Select the **Graph** option from the Analysis menu and the **Choose Graphs to Create** form is displayed.



11. To see two examples of different graphs, select the **Time series** and **Running Sum** graphs and then click the **Generate** button.





11. BASINS graphs can be manipulated in a variety of ways including resizing, zooming, and customizing the various graph components. If time permits, feel free to go on and customize the look of these graphs.

12. Along with listing and graphing, the BASINS system contains many other time series analysis features including duration-frequency computations, seasonal statistic computation, generation of additional time series from existing time series, and creation of time series of distinct events that are above or below a threshold. In particular, the SWSTAT plug-in contains many standard USGS statistical analysis techniques. It is found under the **Analysis** menu on the main BASINS form.

At the conclusion of this exercise, close the graph windows and exit BASINS.