Nile Decision Support Tool

River Simulation & Reservoir Management: User Manual

Burundi
Congo
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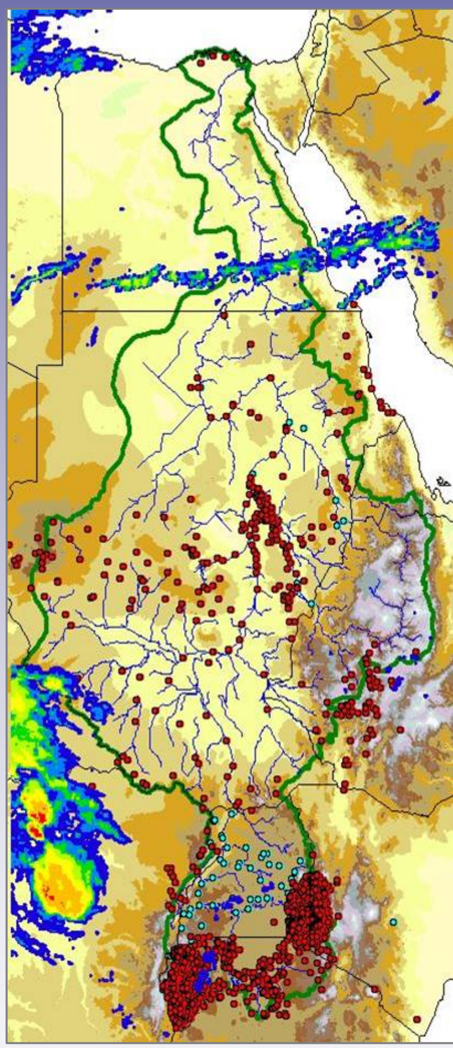

Developed collaboratively by

The Nile Basin Nations,

The Georgia Water Resources Institute at the Georgia Institute of Technology,

and

The Food and Agriculture Organization of the United Nations

July 2007

Nile Decision Support Tool (Nile DST)
River Simulation & Reservoir Management

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In collaboration with

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The Food and Agriculture Organization (FAO)
of the United Nations

Nile Basin Water Resources Project
(TF/UGA/CPA 177517-2005/AGLW)

July 2007

Acknowledgements

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The GWRI Director and project staff are grateful to the Nile Basin nations (Burundi, Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda), their focal point institutions, their Project Steering Committee (PSC) members, and their National Modelers for entrusting us to work with them in this important basin-wide project. The development of databases, models, technical reports, software, and user manuals are key but not the only project accomplishments. Even more important are the evolving contributions relating to people and the difference the project is poised to make in data and information sharing, developing a common knowledge base for policy debates, and long term capacity building.

GWRI is also grateful to the Government of Italy and to FAO and its Chief Technical Advisor, Mr. Bart Hilhorst, for sponsoring the project and for providing dependable logistical and technical support through the FAO office in Entebbe.

It is our hope that the Nile DST effort will contribute in some positive way to the historic process of the Nile Basin nations to create a sustainable and peaceful future.

Aris Georgakakos
GWRI Director
Atlanta, July 2007

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Table of Contents

1. Introduction

The **Nile DST River Basin Management Module (NileDST-RBM)** includes a database, several utility tools, and a scenario assessment model to study the impact of the system under various scenarios.

The NileDST-RBM database stores various system parameters, historical time series, and model inputs and outputs. System parameters, such as reservoir elevation curves and turbine characteristic curves, are unlikely to change frequently. Time series data such as reservoir inflows will grow with time. When available, new data may be added to the database. The NileDST-RBM provides convenient tools to update the database files.
To access the NileDST-RBM database, please go to Chapter 3.

NileDST-RBM provides a set of utility tools to process and prepare data as required by its applications. Most data processing tools pertain to system data, and they will run at the development phase, unless system characteristics change. Later on, the main usage of these tools is to view the processed system data.
To access the NileDST-RBM utility tools, please go to chapter 4.

NileDST-RBM currently includes a scenario assessment model based on heuristic operating rules. The user can specify/provide different rules to operate the reservoirs. The model simulates the system dynamics using the selected historical inflow records and generates applicable simulation statistics. The interface provides convenient tools to prepare the inputs and visualize the outputs.
To run the simulation model, go to chapter 5.

2. System Requirements and Software Installation

NileDST-RBM runs on IBM-compatible personal computers with the Microsoft Windows XP environment. Its graphical user interface (GUI) is written in Microsoft Visual Basic Language, while its optimal control models are programmed in FORTRAN 90 Language and compiled by Microsoft FORTRAN Power Station 4.0. The database of **NileDST-RBM** is supported by ADO 2.5 model powered by Microsoft Access. To run **NileDST-RBM**, you will need the following hardware and software:

- An IBM-compatible PC with a Pentium III processor or higher
- A hard disk with at least 10 Gigabytes of available space
- A CD-ROM
- A color monitor with resolution at least 1280 X 1024
- A mouse
- MS Windows XP
- MS Office XP

Installation Procedure:

- Insert the installation CD into the drive;
- Open the Windows Explorer and run NileDSTRBM**Install.exe** in the CD;
- Follow the Setup instructions on the screen.

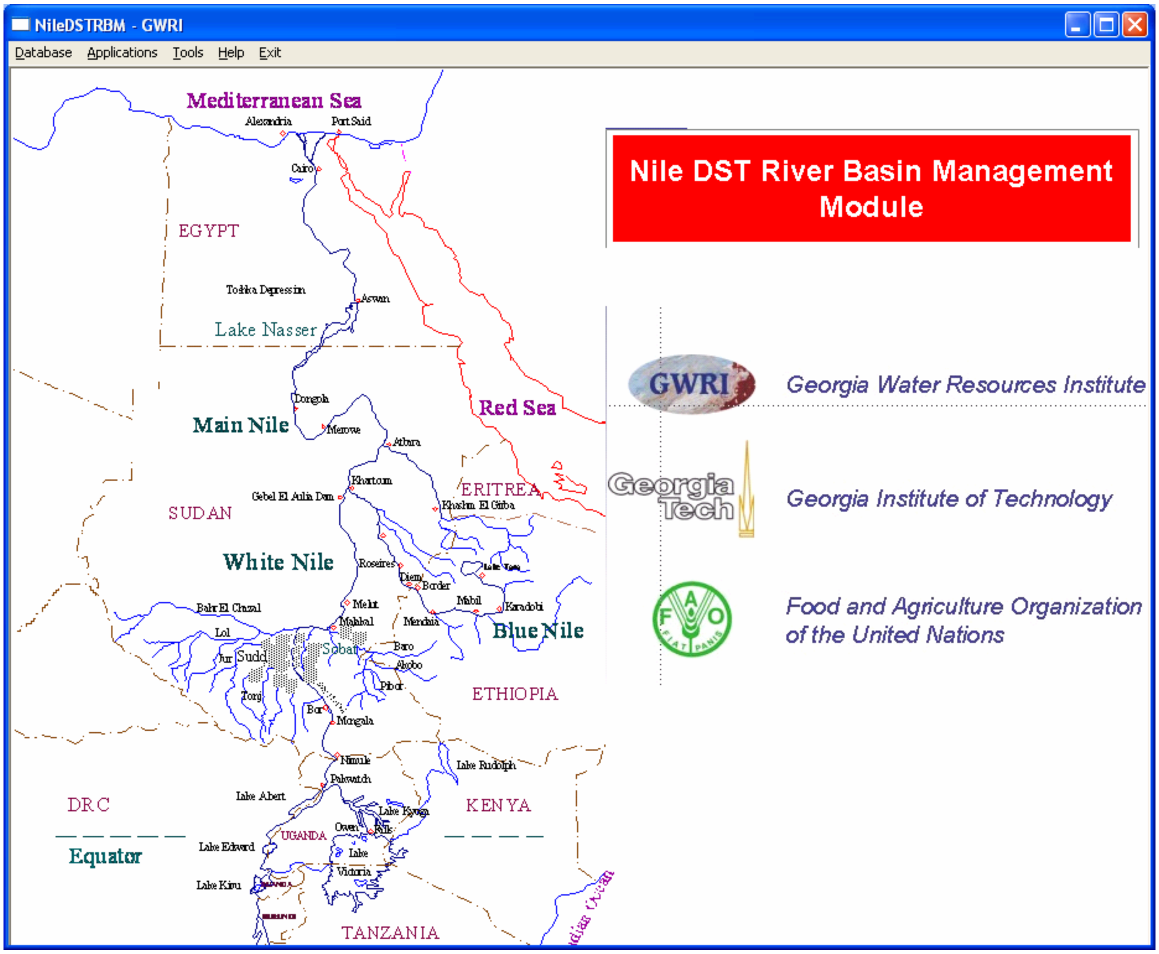
NileDST-RBM Directory Structure:

- **\NileDSTRBM\: NileDSTRBM** root directory, specified during installation;
- **\ NileDSTRBM \Bin\:** application programs and their inputs and outputs;
- **\ NileDSTRBM \Database\:** database files and Excel template files;
- **\ NileDSTRBM \Documents\:** technical report and manual;
- **\ NileDSTRBM \ExcelResults\:** Excel templates for output reports.

NileDST-RBM is started by double clicking the icon from the desktop**.** The title window of **NileDST-RBM** appears and automatically disappears after about 5 seconds. The Program Gateway Window appears next on the screen. The Gateway Window is the starting place to access all functionalities in this module. Five menu choices are provided on the menu bar at the top of the window. The choices are as follows:

- Database
- Applications
- Tools
- Help
- Close

From this menu bar, you have direct access to all data and applications in the **NileDST-RBM** by selecting the appropriate item. If you click menu **Close**, the Program closes**.** The **Help** menu provides access to this document on-line. The chapters that follow describe the features of NileDST-RBM.



Program Gateway Window

3. Database

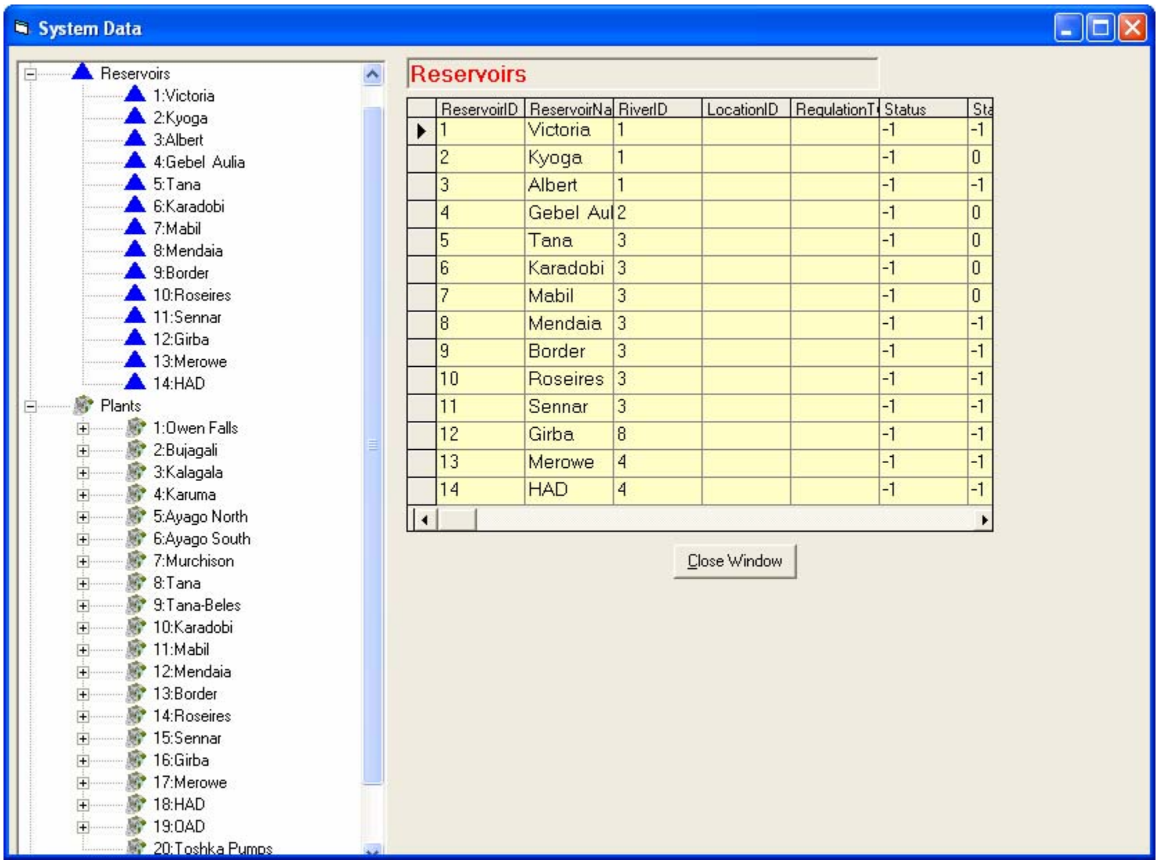
All data are saved in database file **NileDSTRBMSIMDatabase.mdb**. The information in the database includes system data and model inputs and outputs. This chapter describes the usage of the NileDST-RBM tools for accessing and updating the system data. The descriptions of the model inputs and outputs are presented together with the models to which they apply. The database is accessed through the menu **Database**, which includes the following items:

- System Information
- System Curves
- Hydro Turbine Characteristic Curves
- Inflow Scenario Dataset
- Reservoir Release Rules

The use of these items is described in detail in the following sections.

3.1. System Information

This screen contains basic information of reservoirs and hydro plants. Use the datatree to browse the reservoirs and plants in the system. The system data are not editable by the user.



Remarks: The current version of NileDST-RBM includes 14 existing and planning reservoirs (Victoria, Kyoga, Albert, Gebel Aulia, Tana, Karadobi, Mabil, Mendaia, Border, Roseires, Sennar, Girba, Merowe, HAD), 20 existing and planning hydro power plants (Owen Falls, Bujagali, Kalagala, Karuma, Ayago North, Ayago South, Murchison, Tana, Tana-Beles, Karadobi, Mabil, Mendaia, Border, Roseires, Sennar, Girba, Merowe, HAD, OAD, and Toshka Pump Station), 13 inflow nodes, 16 river nodes, and 15 demand nodes.

Common Toolbar Buttons:

Toolbar buttons are used in many screens of NileDST-RBM. Their functionalities are everywhere the same and are described below:

Export: Export the data or image of selected charts to a file or a printer.

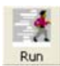
Import: Import data from an Excel template file and replace the existing data in the database for the selected item.

Refresh: Redraw screen charts after a new selection.

Close: Close the current window and return to the previous screen.

DataSet: Add or delete a scenario and data set from the database.

InputKey: Dropdown buttons to add, delete, or update a scheme name.



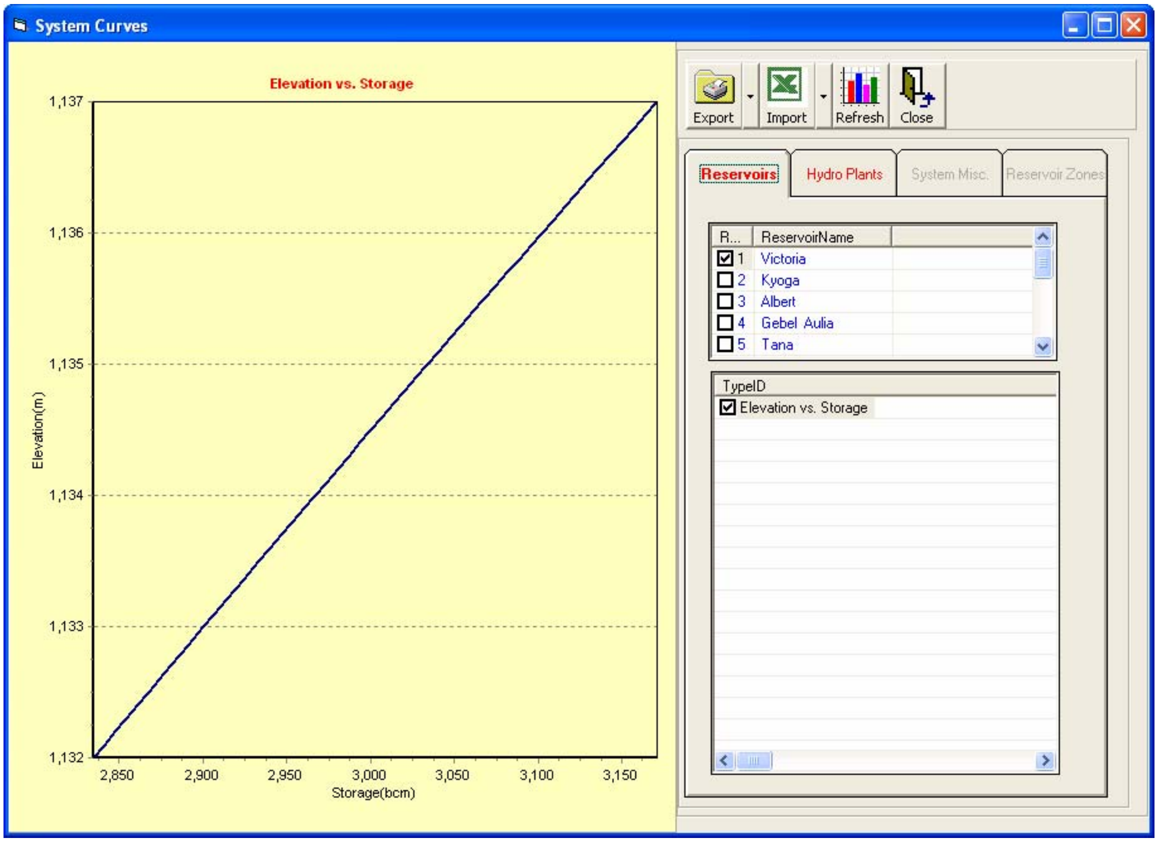
Run: Launch a model run.

Results: Open model output screen.

Stats: Show output statistics in tabular format.

3.2. System Curves

Interface Functionality: Retrieve and update reservoir characteristic curves, tail water curves downstream of power plants, and other system curves.



Data Items:

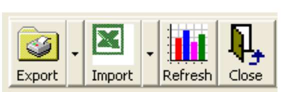
Reservoir Curves:

- Elevation vs. Storage;

Plant Curves:

- Tail water elevation vs. discharge;
- Hydraulic Loss Functions.

Toolbar Buttons and Other Screen Options:

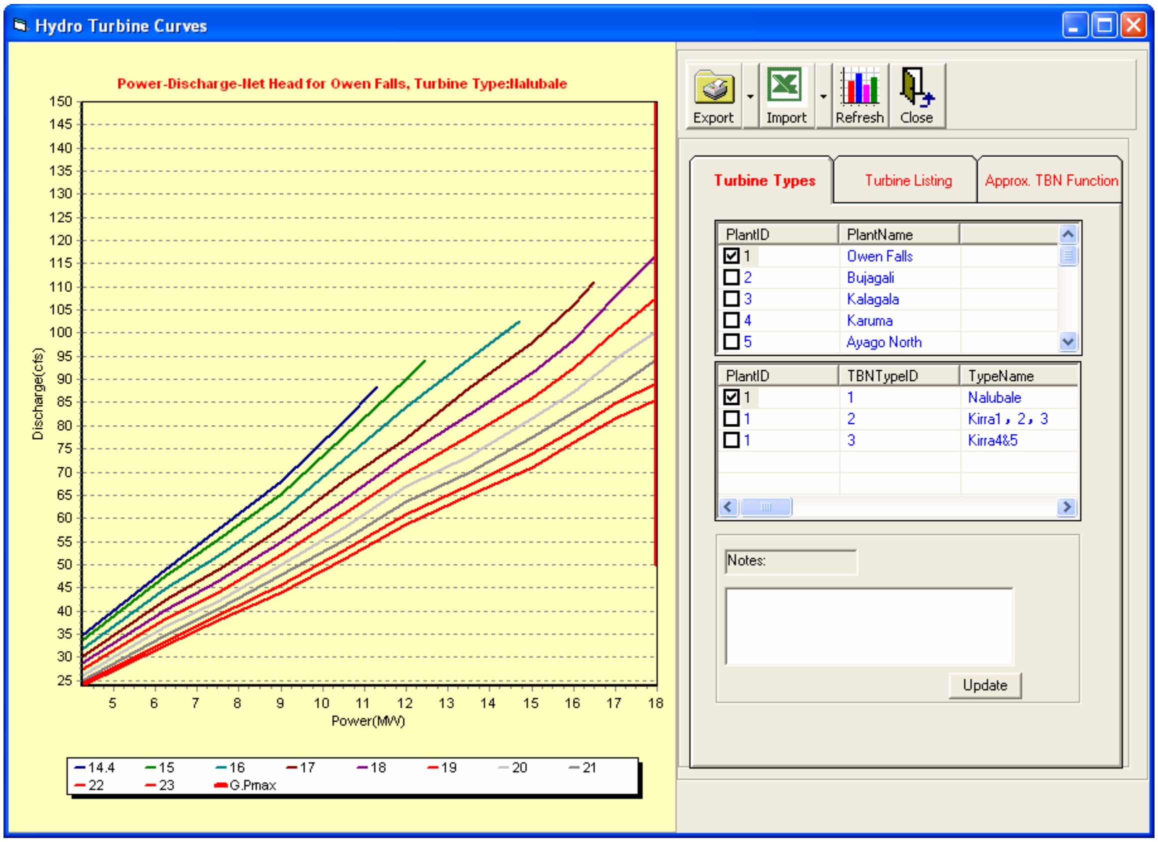


Excel Template File Name: CurvesImport.xls.

Remarks: To update the data, use the Excel template file to prepare the data first, then import. The format of the data preparation in Excel sheets is self-explanatory. Pressing **Import** button will import the data from the Excel file and replace the corresponding existing data in the database.

3.3. Hydro Turbine Characteristic Curves

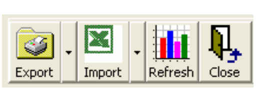
Interface Functionality: Prepare turbine power curves.



Data Items:

- **Turbine Power Curves**: Power vs. Discharge and Head functions for each turbine type;
- **Turbine Listing:** Number of turbines for each plant
- **Approximate TBN Function:** Generate the turbine power curves if the manufacturer's curves are not available.

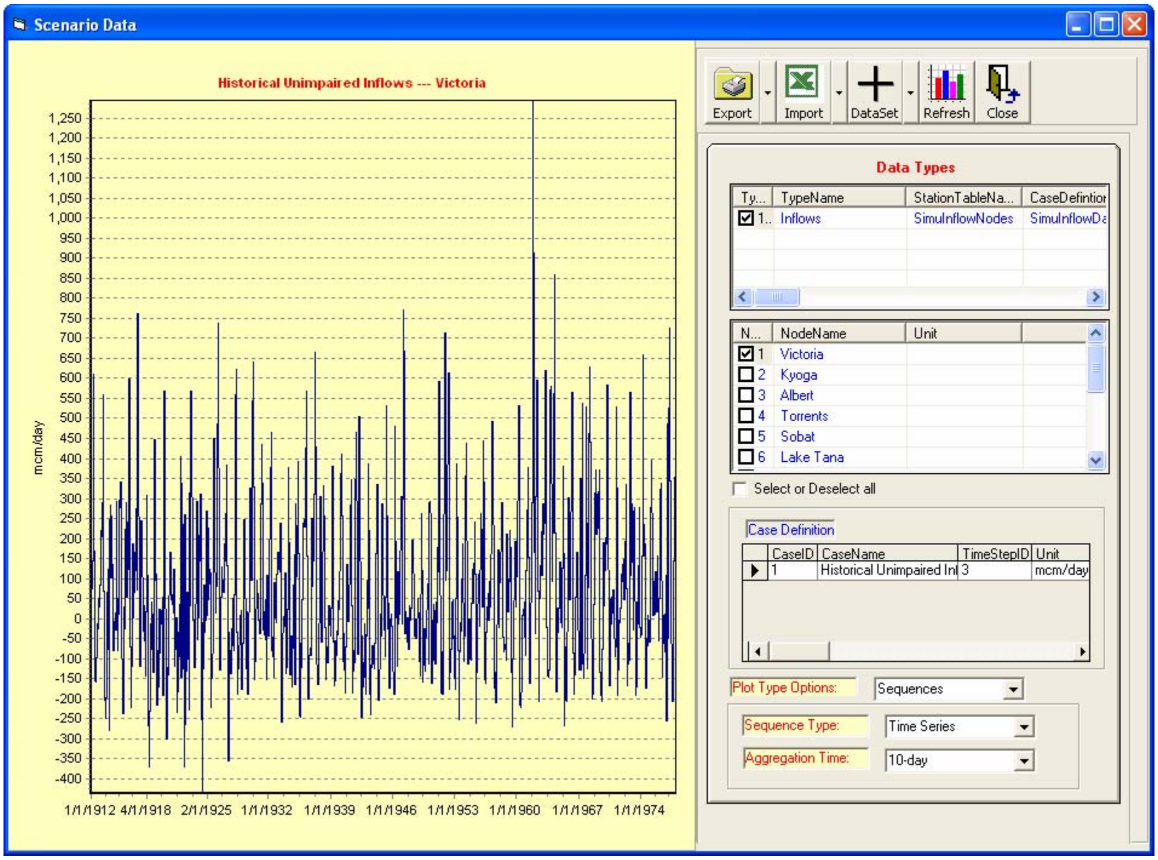
Toolbar Buttons and Other Screen Options:



Excel Template File Name: TBNCurvesImportTemplate.xls.

3.4. Inflow Scenario Dataset

Interface Functionality: Define inflow scenarios for the assessment model.



Data Items:

- 10-day inflow sequences.

Toolbar Buttons and Other Screen Options:

Excel Template File Name: SimuScenarioInputTemplate.xls.

Remarks: The inflows are local or incremental for a selected reservoir or river node. This quantity is usually not directly measurable. It is computed using the water balance of a reservoir. The simulation models use the inflows as inputs. Furthermore, the inflow records are used by the forecasting model to derive forecasts in the optimal simulation model.

The system allows you to enter different inflow scenarios to run the simulation model. This is a convenient feature for conducting sensitivity of the various inflows on system performance. To prepare one inflow scenario, you need to prepare a set of concurrent 10-day inflow sequences for all the locations shown in the middle list box.

Different inflow scenarios are identified by the CaseID and CaseName. To create a new scenario, press the **Add** button, then type a unique CaseID and CaseName. The historical record from 1912 to 1977 is the baseline case in the system with an ID “1” and case name “Default.”

The actual data sequences are prepared using the Excel Template file. Pressing the **View** button will open the Excel Template file **SimuflowTemplate.xls.** The format of the template file is self-explanatory. The 10-day inflow sequences are in mcm/day. Pressing the **Import** button will import the data.

Be careful with the **Delete** button. If pressed, the selected scenario will be deleted permanently from the database. This is an irreversible operation. Once the data is deleted, the only way to get it back is to import from a backup copy or other source.

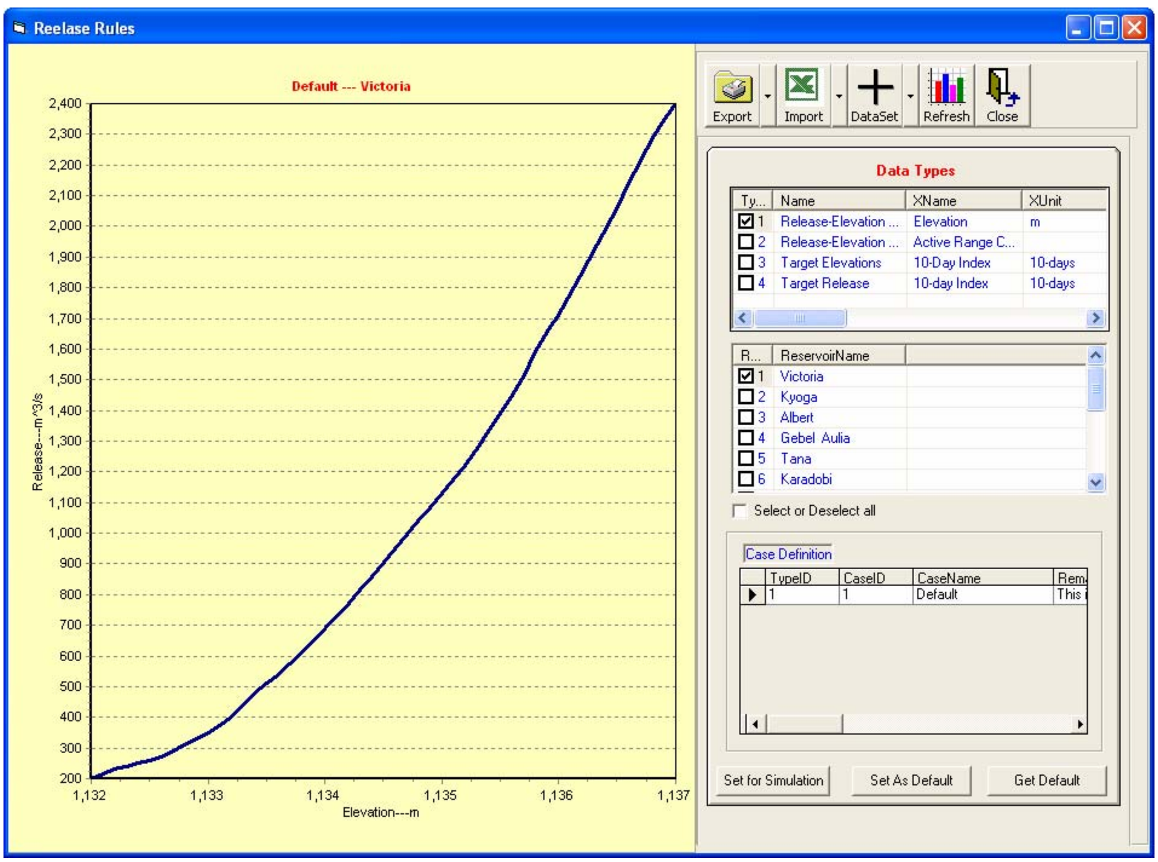
3.5. Reservoir Release Rules

The reservoir release rule is the rule to determine how much water to release for a certain period. To simulate the reservoir operation, the rule must be specified first. Many heuristic rules exist in practice. Some of these rules apply to a single reservoir, some of them apply to multiple reservoirs. The NileDST-RBM allows the user to specify two types of rules:

1) Release Rules for Individual Reservoirs
2) Coordination Release Rules

3.5.1. Release Rules for Individual Reservoirs

Interface Functionality: Define release rules for single reservoirs



Remarks: Four types of release rules are provided:

1) Release-Elevation Data Pairs
2) Release-Elevation Rule Curves

3) Target Elevations
4) Target Releases

In the first type, **Release-Elevation Pairs,** the reservoir discharge is specified as a function of elevation. The sample rules for Victoria, Kyoga, and Albert shown in the database are the agreed curves. To change them, use the provided Excel template (**RuleImportTemplate.xls**) to prepare data, and then import the data. The worksheet **RuleHQ** contains the data to be imported.

The second rule option **Release –Elevation Rule Curves** is a simplified version of the first rule. It also determines the release based on the elevation, but the relationship is specified by a set of coefficients instead of the data pairs. It divides the reservoir elevation into three intervals. The discharge follows different relationship for different elevation zones. In the lower and the upper zones, the discharge is the linear function of the elevation, while in the middle, it is a constant. The slopes of the linear functions, the constant value in the middle section, and the elevation zone classifications are parameters that can be adjusted through Qmin, Qmax, Alf, Zone1, and Zone2 in the interface. The user may edit the parameters directly on the table. The changes are reflected in the chart after the database, if updated.
In the third option **Target Elevations,** the target elevation is specified for each 10-day for a reservoir. The simulation model will determine a discharge such that the simulated elevations will try to follow the target values. Use worksheet **RuleTargetH** in the template file to prepare the data.

In the fourth option **Target Releases,** the release target is specified for each 10-day period for a reservoir. The simulation model will release the target value. Use the worksheet **RuleTargetQ** in the template file to prepare the data.

For each release rule group, you can create different rules and save them in the database for later use in the simulation model. For example, for release rule group one, **Release-Elevation Data Pairs,** you can create different Release vs. Elevation relationships for each reservoir and save them in the database. A new relationship is created by pressing the **Add** button in the tool bar, it is uniquely identified by **CaseID, CaseName.** You can also type some text to describe the new case in the **Description** box. The new relationship is imported from the Excel template file by pressing the **Import** button. To delete an existing case from the database, locate its record using navigational button, press Refresh button, then **Delete** button. You cannot delete the case with CaseID equal to 1 for all groups.

The advantage to allow multiple cases for each release rule group is to conduct sensitivity runs on the release rules conveniently. The different release rules are kept in the database and can be retrieved for future use. However, for any particular simulation run, the system uses only one case from each rule group. If you have multiple cases entered in the system for a rule group, you have to make a selection before you run the simulation model. To do it, press the **Set for Simulation.**

As you make changes in table, the existing data in the database is overwritten. The system includes default rule curves of all types. You can always use the default rule by pressing the **Get Default** button. To change the default system value, press **Save as Default.**

3.5.2. Coordination Release Rules

The rules for a single reservoir specify the discharge based on the reservoir levels or other quantities. However, in a system with multiple reservoirs, the reservoir operations have to be coordinated to maximize the total system benefit. In this case, the release rule of a reservoir is not a one-dimensional function anymore. It may depend on the elevation, demand level, and minimum flow requirement of other reservoirs. The coordination operation rules for multi-reservoir system are usually system specific. First, the system must be studied extensively and then many different combinations are tried to obtain a “reasonable” one. In other words, there is no guarantee that the rule based operation for multi reservoir system will give the best solution. The ultimate solution for this problem is to explicitly use system wide optimal control approach in the reservoir simulation.

The current version of NileDST-RBM includes a quite good and simple system wide coordination operation rule which can be used for quick simulations. It is flexible and robust. Various simulations can be conducted from the existing operational rules to regional coordination by changing the parameters in this rule.

The main idea of coordination rule is to release more from the upper stream reservoirs if the down stream reservoirs experience a shortage, and release less if the down stream reservoirs have more water. The current version of NileDST-RSM only implements the first case, i.e., release more from the upper stream reservoirs if the down stream reservoirs experience shortage.

For normal operation, all reservoirs release according to their individual release rule specified by the Release-Elevation relationships. Coordination occurs if all of the three conditions below are met:

1) the storage/elevation of a downstream reservoir is below a certain value SNthreshold (Threshold Value of Normalized Storage)
2) the storage/elevation of a upper stream reservoir is above a certain value SNthreshold (Threshold Value of Normalized Storage)
3) the coordination coefficient between the two reservoirs are greater than zero.

When coordination is triggered, the involved upper stream reservoir release is increased according to the release rule curve using an adjusted increased storage/elevation value.

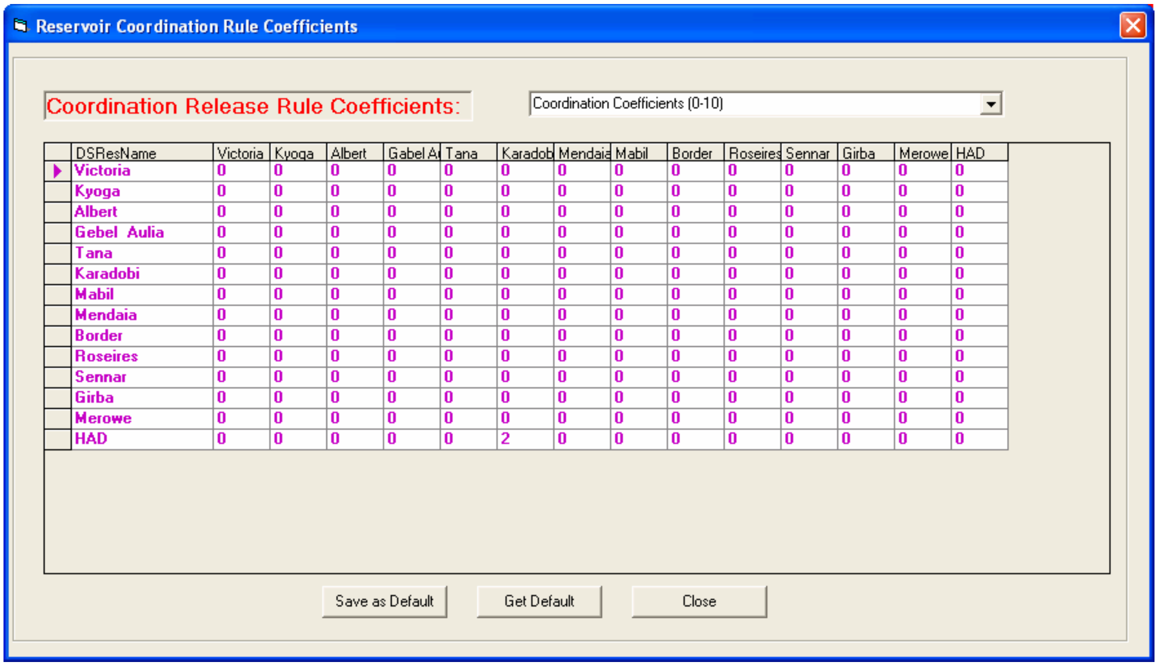
The Coordination Release Rules are defined by the following three parameters and can be modified from the interface easily:

1). Coordination coefficients;

2). Threshold value for the down stream reservoirs;

3). Threshold value for the upper stream reservoirs;

For more detailed information, please refer to the technical report.



DSResName	Victoria	Kyoga	Albert	Gabel A	Tana	Karadob	Mendaia	Mabil	Border	Roseires	Sennar	Girba	Merowe	HAD
Victoria	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kyoga	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Albert	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gebel Aulia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tana	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Karadobi	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mabil	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mendaia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Border	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Roseires	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sennar	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Girba	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Merowe	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HAD	0	0	0	0	0	2	0	0	0	0	0	0	0	0

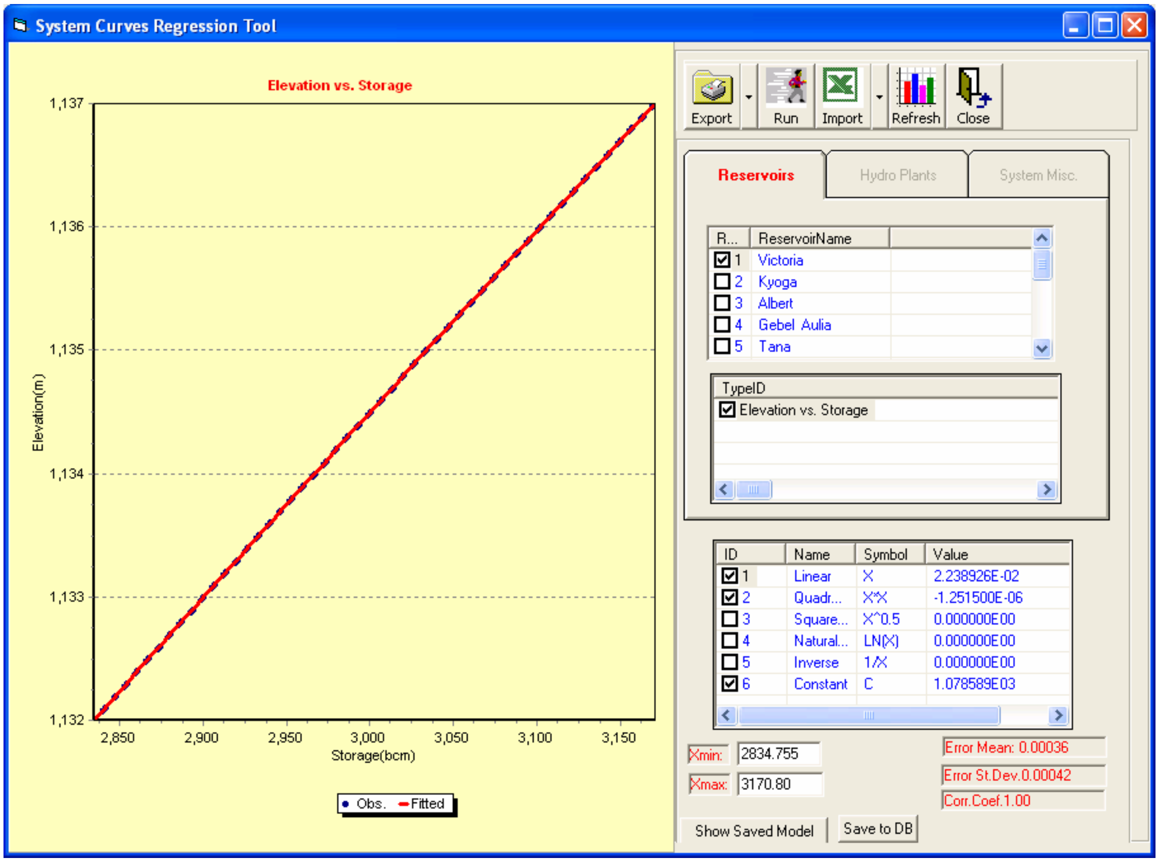
4. Tools

NileDST-RBM provides a set of utility tools to process and prepare data required by its applications. The tools are accessed through menu **Tools,** which includes the following items:

- **Regression**
- **Hydro Power Functions**
    - **Generation**
    - **Processing**
- **Hydro Energy Functions**
    - **Generation**
    - **Processing**
- **Database Compact**

4.1. Regression

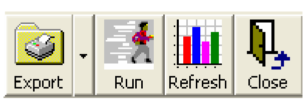
Interface Functionality: Provide customized regression tools for reservoir curves.



Data Items:

- Reservoir Storage vs. Elevation;

Toolbar Buttons and Other Screen Options:



Show Saved Model: Retrieve saved regression coefficients from database.

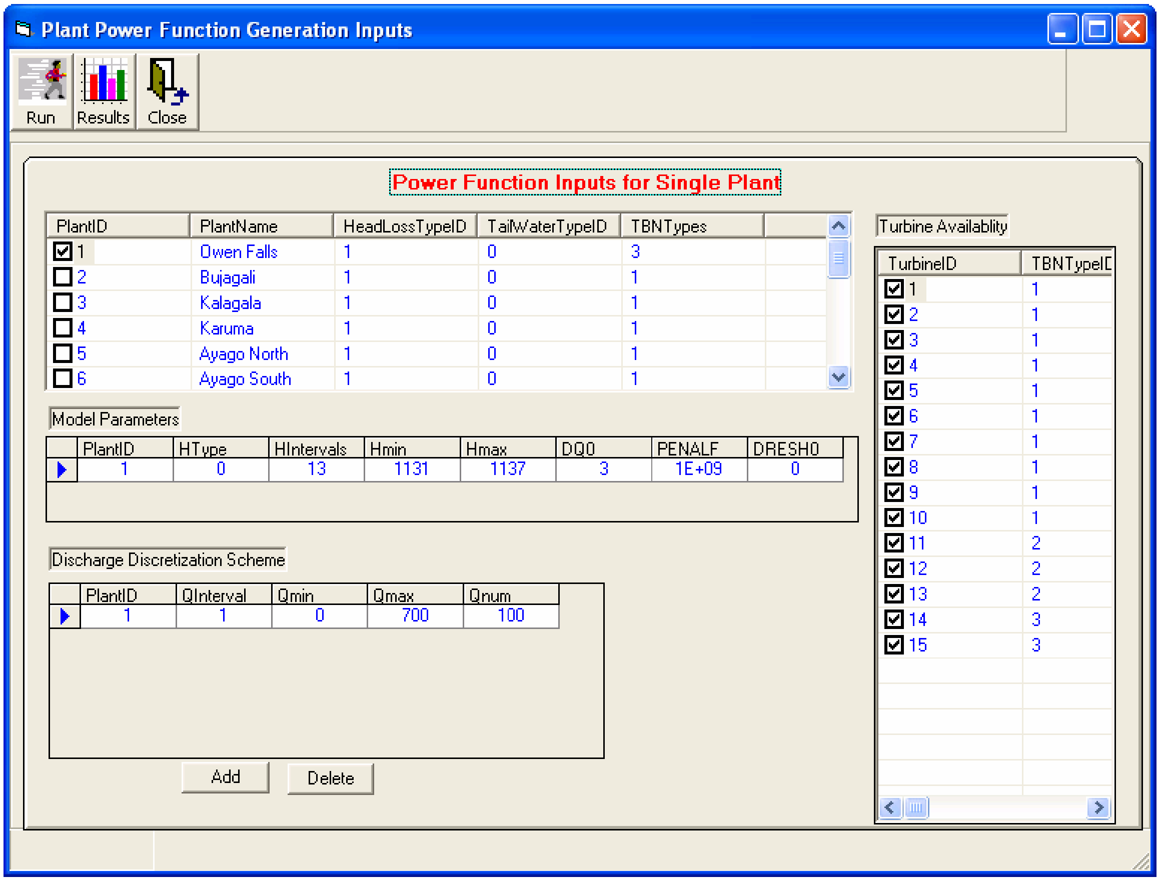
Save to DB: Save regression coefficients to database.

Remarks: Six mathematical terms are predefined for the regression function. Based on extensive experimentation, these terms can provide a good approximation of reservoir curves.

4.2. Hydro Power Functions

4.2.1. Input Screen

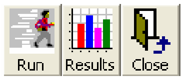
Interface Functionality: Prepare input data for optimal power function model.



Data Items:

- HType: 0 for elevation, 1 for head;
- HIntervals: Number of contour points for elevation or head;.
- Hmin: Lower bound for H range;
- Hmax: Upper bound for H range;
- DQ0: Discrete step size in Dynamic Programming solution;
- PENALF: DP penalty coefficients for infeasible solution;
- Qmin: Lower bound for discharge range;
- Qmax: Upper bound for discharge range;
- Qnum: Data points for selected discharge range;
- TurbineID in Turbine Availability Table: Turbine status.

Toolbar Buttons and Other Screen Options:

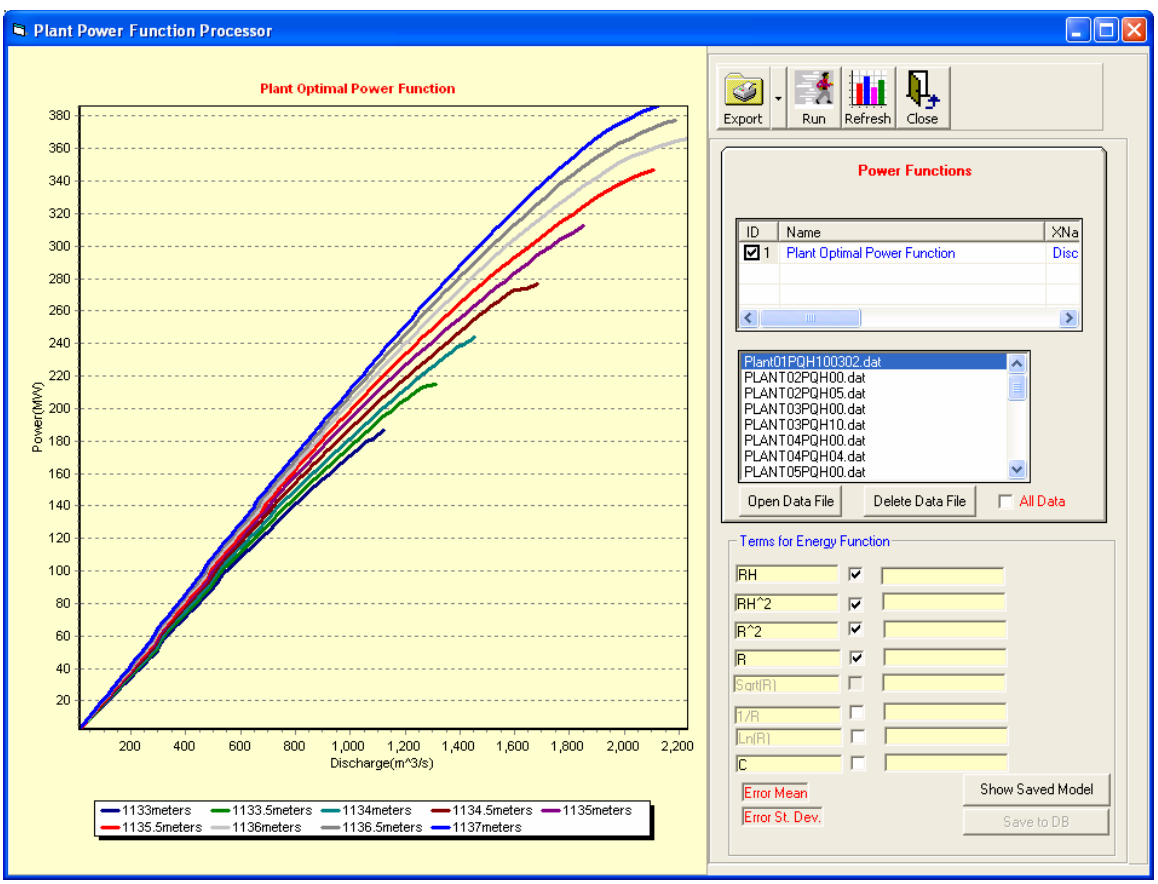


Remarks: The hydro power function is the power generation function for the entire plant. It gives the relationship among the reservoir elevation or gross head, plant discharge, and plant power generation. This function indicates the most efficient plant generation under various discharge and reservoir levels (or gross head) combinations. The hydro power function is generated off-line through Dynamic Programming and is used by other applications. Plant power functions are provided for all possible combinations of turbine types and configurations.

The results are saved in sub-directory **\bin\QtoPSim\Output** with one ASCII file per run.

4.2.2. Output Screen

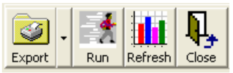
Interface Functionality: Display and process optimal plant power functions.



Data Items:

- ➢ Optimal plant power functions for single plant;

Toolbar Buttons and Other Screen Options:



Open Data File: View the selected file in Notepad;

All Data: Show both feasible and infeasible data points;

Show Saved Model: Retrieve saved regression coefficients from database;

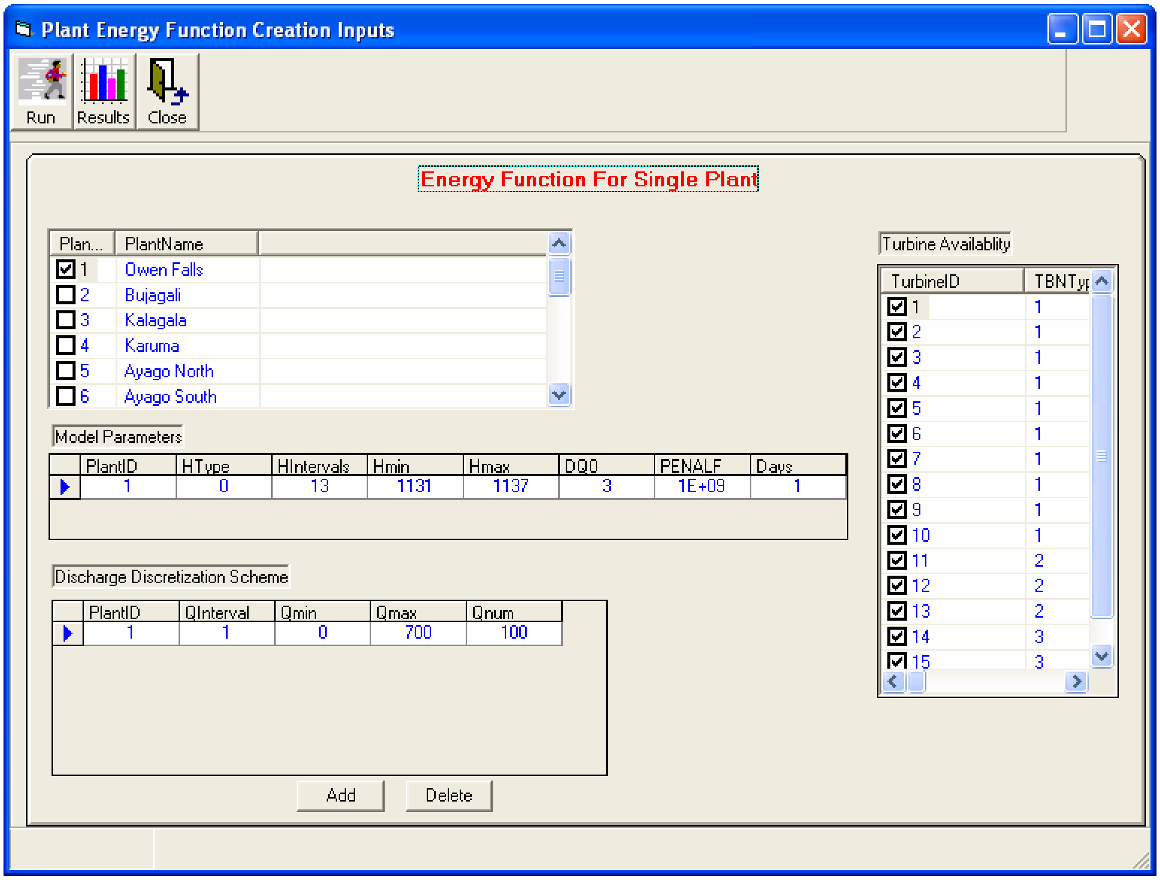
Save to DB: Save regression coefficients to database.

Remarks: Each file name consists of three parts. The first part is “PlantID,” the second part is “PQH,” and the third is the turbine availability combination code generated by the DST system. Processing a power function means to generate an analytic approximation of the power function using nonlinear regression analysis. The analytic approximations are used in the short range control model.

4.3. Hydro Energy Functions

4.3.1. Input Screen

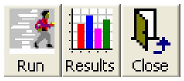
Interface Functionality: Prepare input data for the optimal energy function model.



Data Items:

- HType: 0 for elevation, 1 for head;
- HIntervals: Number of contour points for elevation of head;
- Hmin: Lower bound for H range;
- Hmax: Upper bound for H range;
- DQ0: Discrete step size in Dynamic Programming solution;
- PENALF: DP penalty coefficients for infeasible solution;
- Days: Time resolution in days;
- Qmin: Lower bound for discharge range;
- Qmax: Upper bound for discharge range;
- Qnum: Data points for selected discharge range;
- TurbineID in Turbine Availability Table: Turbine status.

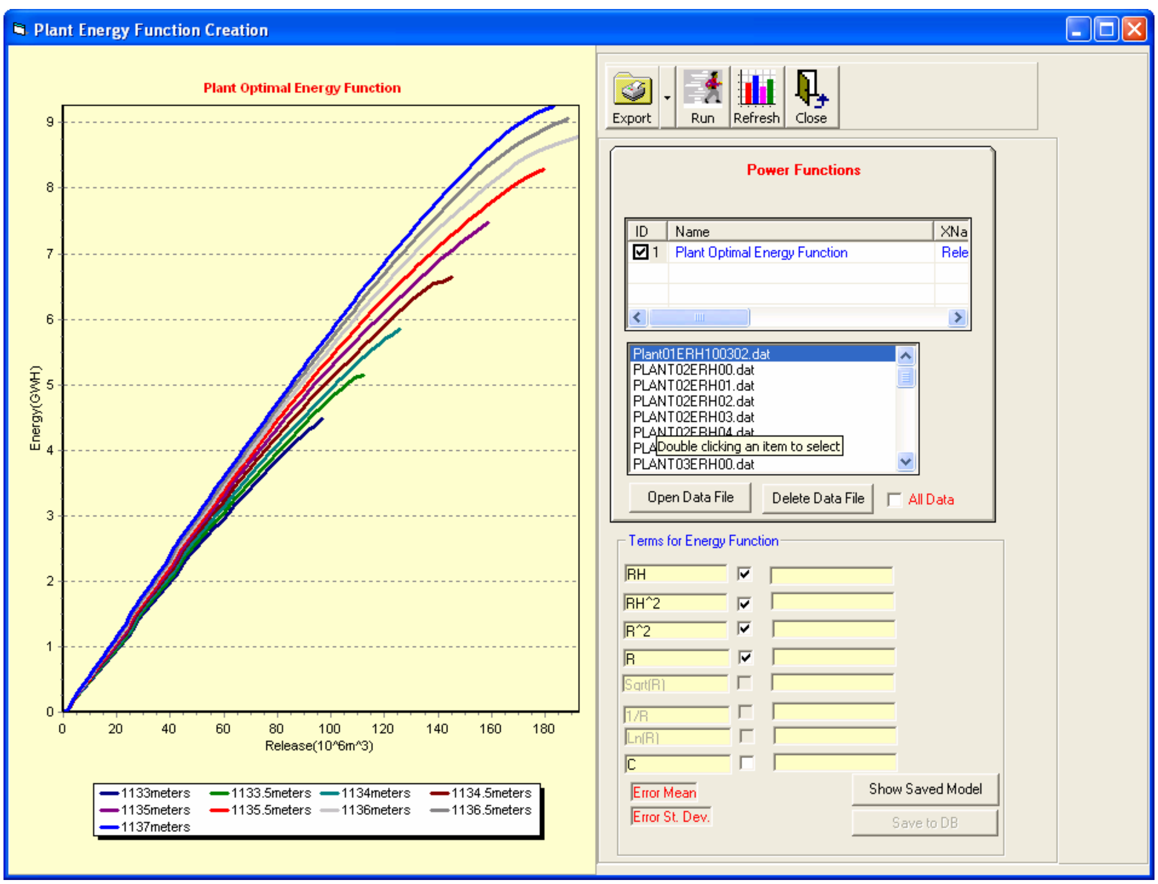
Toolbar Buttons and Other Screen Options:



Remarks: The hydro plant optimal energy function is an optimal generation function for the entire plant. It provides the energy generation as a function of the reservoir elevation/gross head and release volume for the selected time. This function is derived using Dynamic Programming that maximizes energy generation over a selected period in hourly time steps. The optimization is run for various weekly plant releases and reservoir elevations or gross heads. This optimization model uses the optimal plant power function obtained earlier as input. The results are saved in sub directory **\bin\EnSim\Output** in ASCII format.

4.3.2. Output Screen

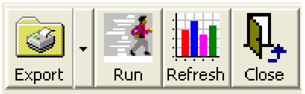
Interface Functionality: Display and process optimal plant energy generation functions.



Data Items:

- Optimal plant energy functions for single plant;

Toolbar Buttons and Other Screen Options:



Remarks: Each file name consists of three parts. The first part is "PlantID," the second part is "ERH," and the third part is the turbine availability combination code generated internally by the DST system. Processing an energy function means to generate an analytic approximation of the energy function using nonlinear regression analysis. The analytic functions are used by the long range control model.

4.4. Database Compact

The database files in **NileDST-RBM b**ecome fragmented as model runs create more data sets. This fragmentation eventually results in larger files than necessary. The database files should be compacted periodically using the **Database Compact** menu item.

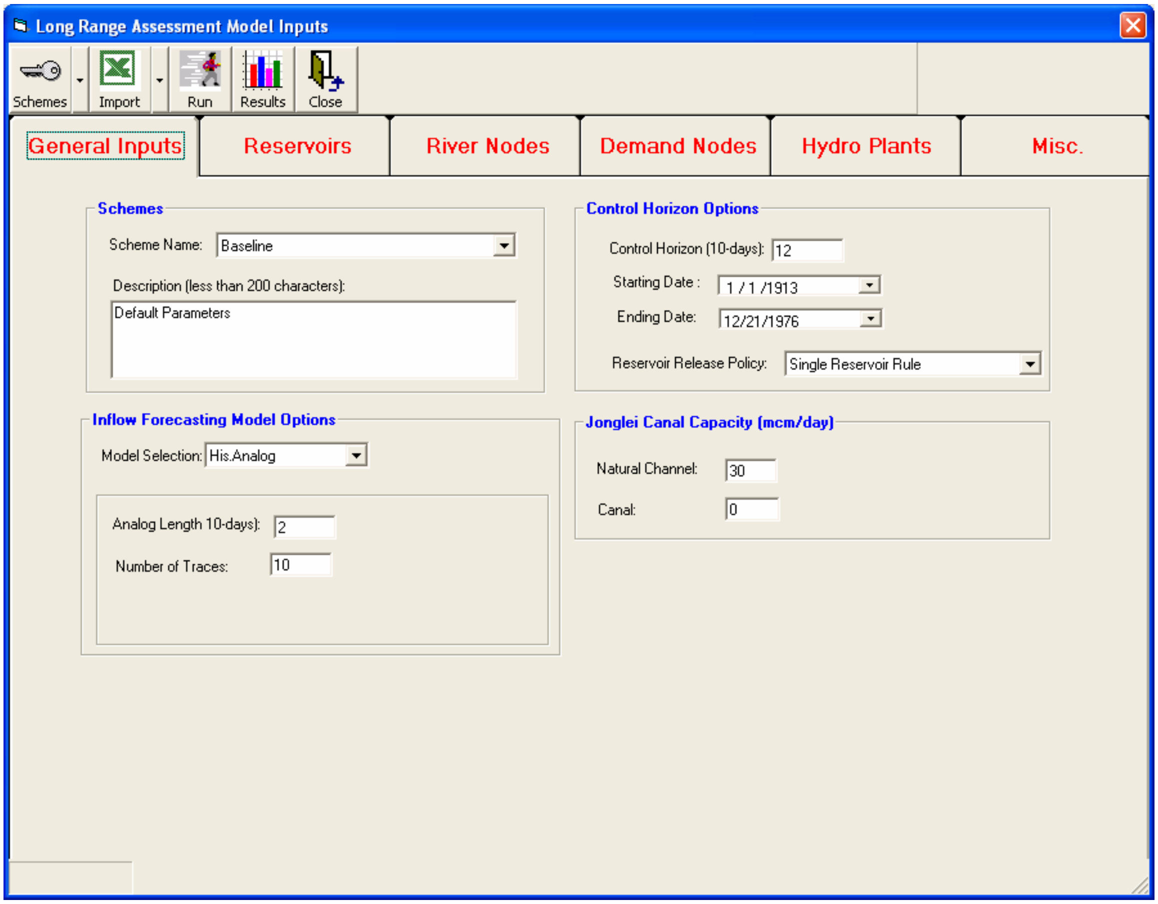
5. Applications

A complete decision support system usually includes inflow forecasting models and a suite of control models used for different time resolutions. However, the NileDST-RBM currently includes only one model: the Scenario Assessment Model. The purpose of this model is to assess the system impacts of various system constraints and operation policies, using a selected historical hydrological period. At beginning of each 10 day period, the model determines the releases for all reservoirs using the selected operation rules, then, it simulates the system evolution for one time step using the determined released and the actual observed inflows, and records the interested system quantities such as reservoir elevation, release, power generation, withdrawal requirement and deficit, among other quantities. At the end of the simulation, the simulated sequences of all quantities are saved. The user may compute the statistics, analyze the results, or make comparisons of different system constraints or policies. The long range assessment model is useful in assessing the implications of various system configurations, irrigation withdrawals, control policies, and other operational constraints.

5.1. Scenario Assessment Model

5.1.1. Input Screen

Interface Functionality: Prepare input data for the long range planning model.



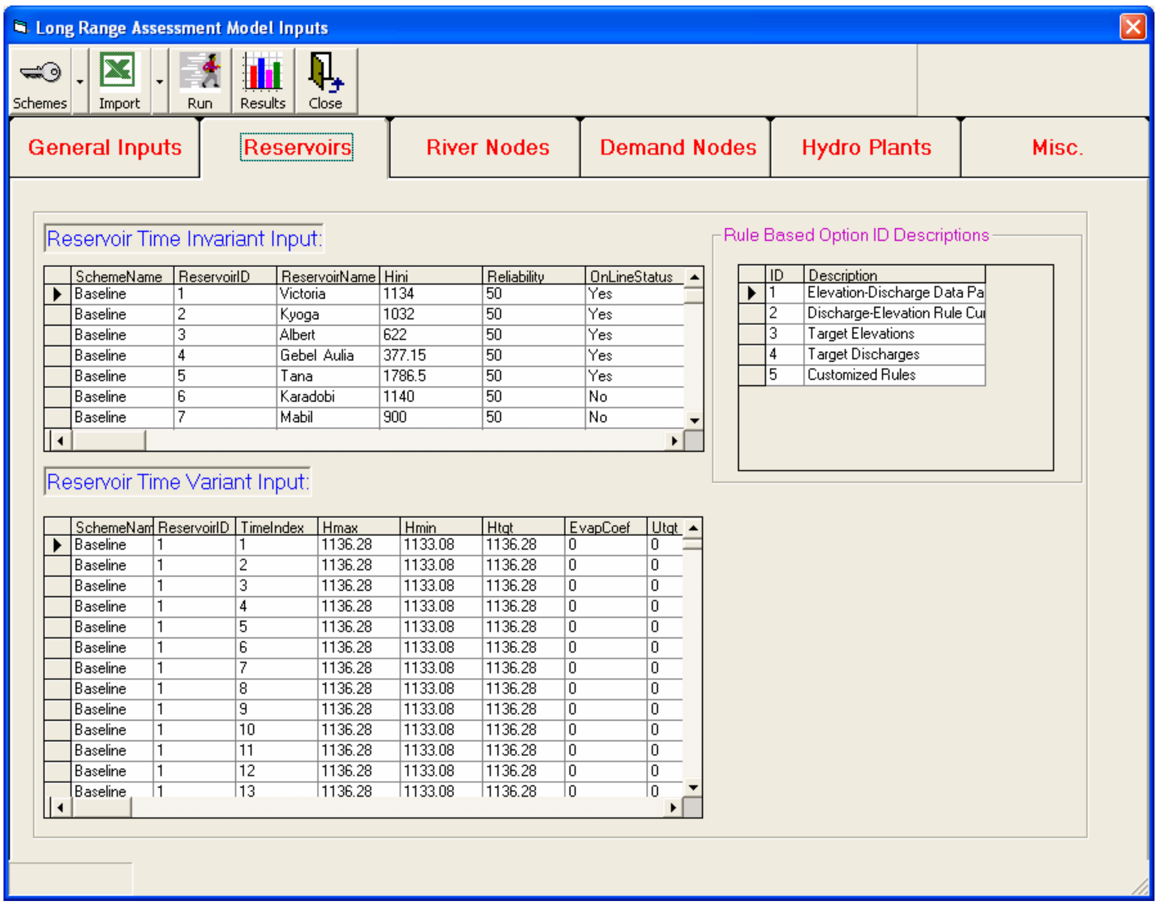
General Inputs:

- Scheme Name: A unique name assigned to the current run;
- Control Horizon Options:
  - Control Horizon: number of 10-days in the future;
  - Starting Date: Starting date for the simulation run (must be the 1^{st},11^{th}, 21^{st} day of a month);
  - Ending Date: Ending date for the simulation run (both starting and ending dates should be within the date range of the historical inflow record).
- Reservoir Release Policy:
  - Single Reservoir Rule
  - Coordination Rule
- Inflow Forecasting Model Options:
  - Model Selection: Historical Analog;

- Historical Analog Length: Length of historical matching in 10-day increments;
- Number of Traces: 15

➢ Jonglei Discharge:
  - Natural Channel;
  - Jonglei Canal.

Reservoir Inputs:



➢ Hini: Initial reservoir elevation;

➢ Reliability: Probability that lake elevation traces will be constrained to be within the min and max bounds at any time in the control horizon;

➢ OnLineStatus: Valid for planned reservoirs only;

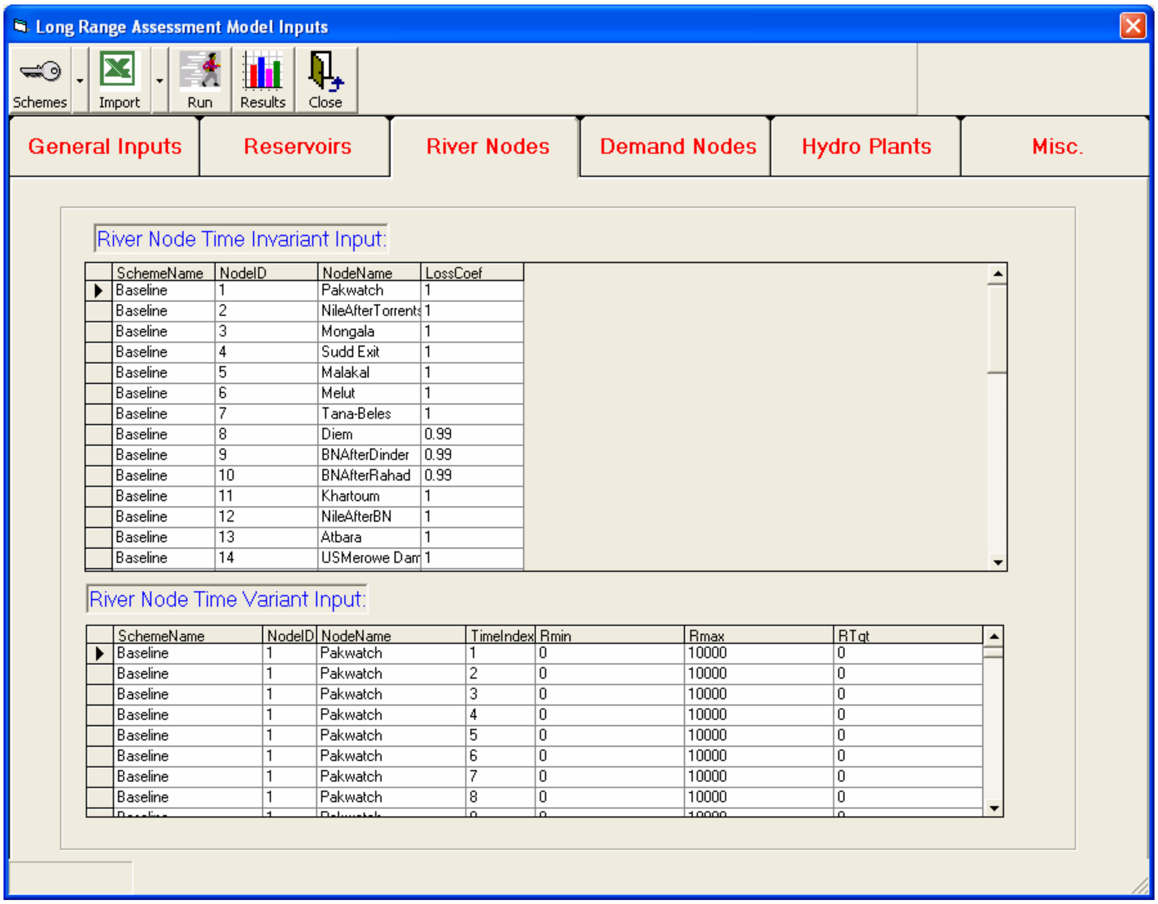
➢ Hmin: Minimum reservoir elevation;

➢ Hmax: Maximum reservoir elevation;

➢ Htgt: Target elevation (not active);

- ➢ EvapCoef: Net Evaportranspiration Rate;
- ➢ Utgt: Target release constraints (not active);
- ➢ Umin: Minimum release constraint;
- ➢ Umax: Maximum release constraints;

River Node Inputs:

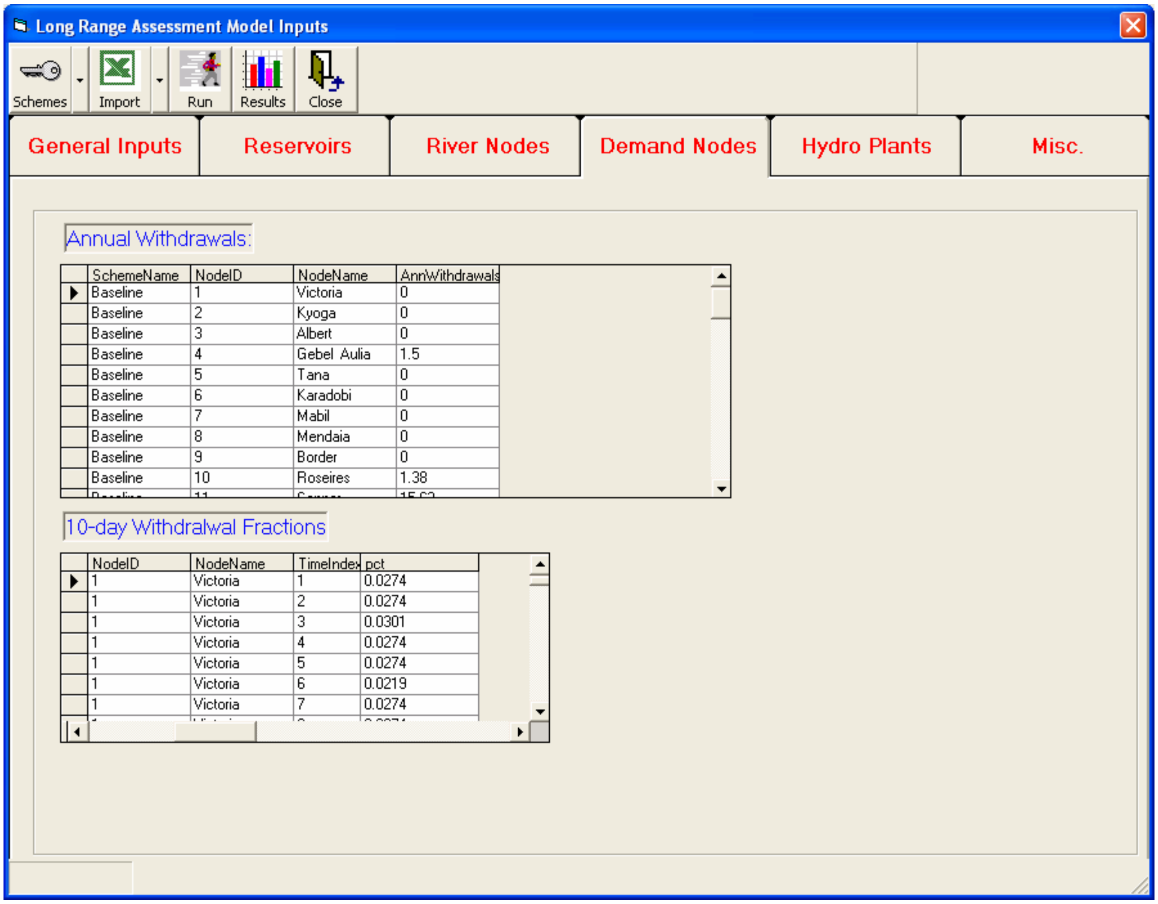


SchemeName	NodeID	NodeName	LossCoef
Baseline	1	Pakwatch	1
Baseline	2	NileAfterTorrents	1
Baseline	3	Mongala	1
Baseline	4	Sudd Exit	1
Baseline	5	Malakal	1
Baseline	6	Melut	1
Baseline	7	Tana-Beles	1
Baseline	8	Diem	0.99
Baseline	9	BNAfterDinder	0.99
Baseline	10	BNAfterRahad	0.99
Baseline	11	Khartoum	1
Baseline	12	NileAfterBN	1
Baseline	13	Atbara	1
Baseline	14	USMerowe Dam	1

SchemeName	NodeID	NodeName	TimeIndex	Rmin	Rmax	RTgt
Baseline	1	Pakwatch	1	0	10000	0
Baseline	1	Pakwatch	2	0	10000	0
Baseline	1	Pakwatch	3	0	10000	0
Baseline	1	Pakwatch	4	0	10000	0
Baseline	1	Pakwatch	5	0	10000	0
Baseline	1	Pakwatch	6	0	10000	0
Baseline	1	Pakwatch	7	0	10000	0
Baseline	1	Pakwatch	8	0	10000	0

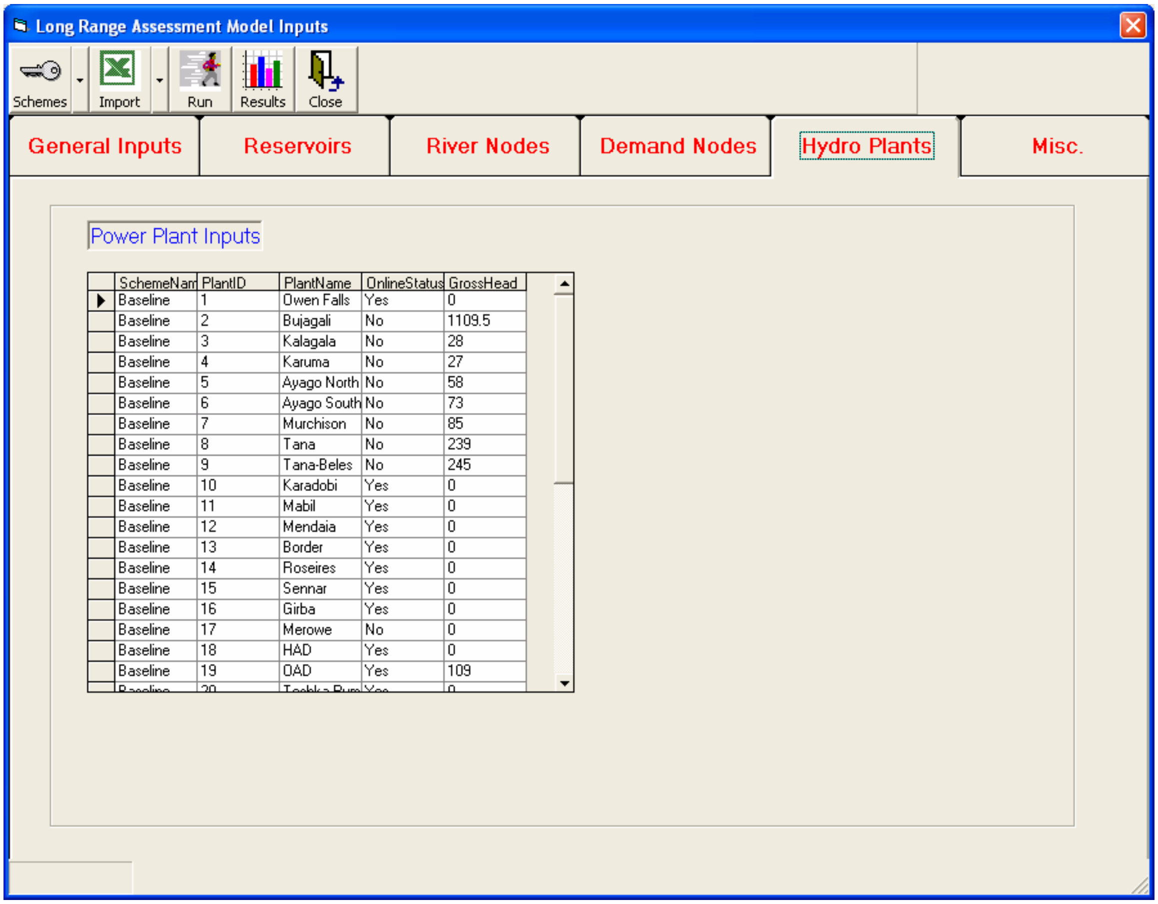
- ➢ LossCoef: Conveyance rate (active only for reaches without routing models);
- ➢ Rtgt: Target flow (not active);
- ➢ Rmin: Minimum flow constraint (not active);
- ➢ Rmax: Maximum flow constraints (not active);

Demand Node Inputs:



- AnnWithdrawals: Annual water demand (bcm);
- PCT: 10-day demand distribution fraction.

Hydro Power Inputs:

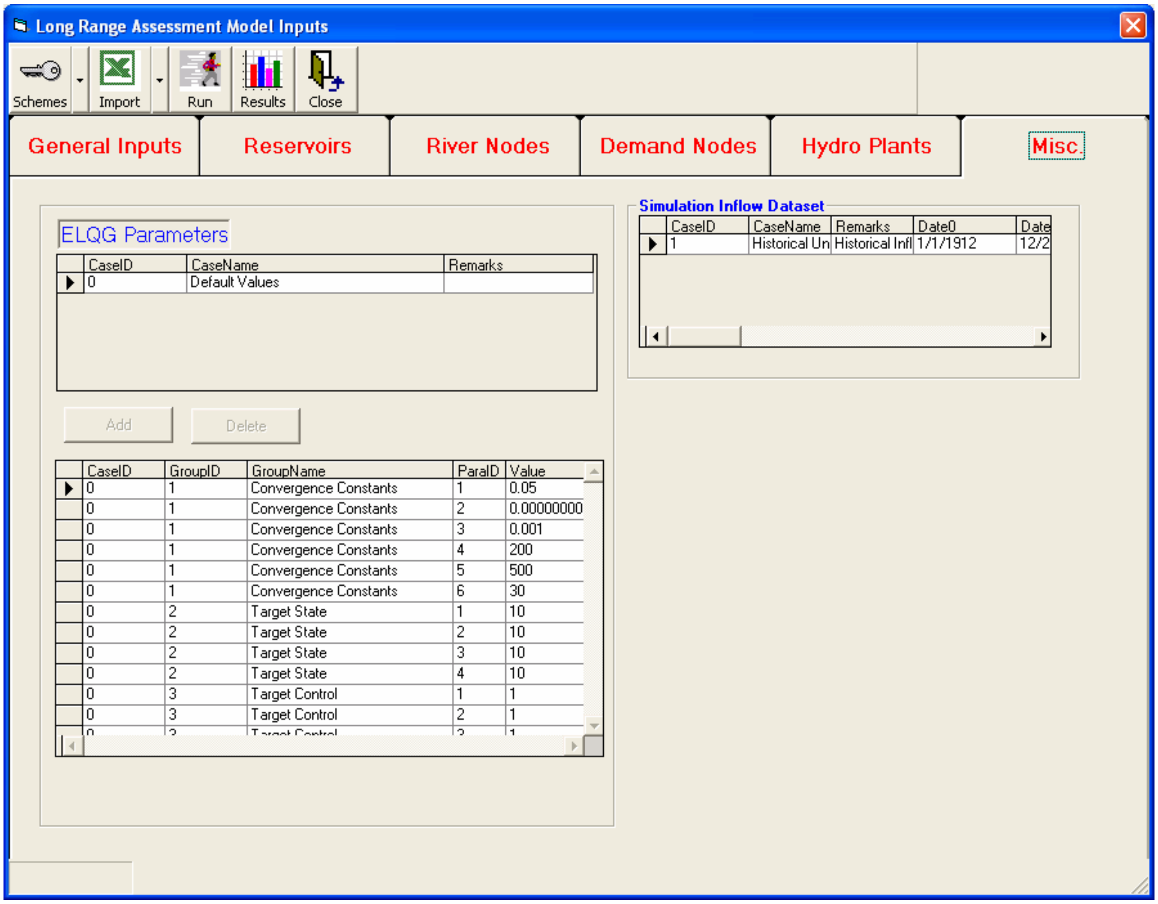


SchemeNam	PlantID	PlantName	OnlineStatus	GrossHead
Baseline	1	Owen Falls	Yes	0
Baseline	2	Bujagali	No	1109.5
Baseline	3	Kalagala	No	28
Baseline	4	Karuma	No	27
Baseline	5	Ayago North	No	58
Baseline	6	Ayago South	No	73
Baseline	7	Murchison	No	85
Baseline	8	Tana	No	239
Baseline	9	Tana-Beles	No	245
Baseline	10	Karadobi	Yes	0
Baseline	11	Mabil	Yes	0
Baseline	12	Mendaia	Yes	0
Baseline	13	Border	Yes	0
Baseline	14	Roseires	Yes	0
Baseline	15	Sennar	Yes	0
Baseline	16	Girba	Yes	0
Baseline	17	Merowe	No	0
Baseline	18	HAD	Yes	0
Baseline	19	OAD	Yes	109

- Power Plant Inputs
  - GrossHead: This parameter is used in computing power generation; Default values are normally provided by the program; This parameter represents average gross head if the tail water curve is not available; Otherwise, the model uses reservoir elevation to proceed with the computations; For Nalubaale and Kiira, the value of this parameter is ignored. For Bujagali, an average elevation of 1109.5 meters is used; For all other plants, this parameter represents designed turbine heads;

OnlineStatus: Whether the plant is online or offline.

Misc. Data:

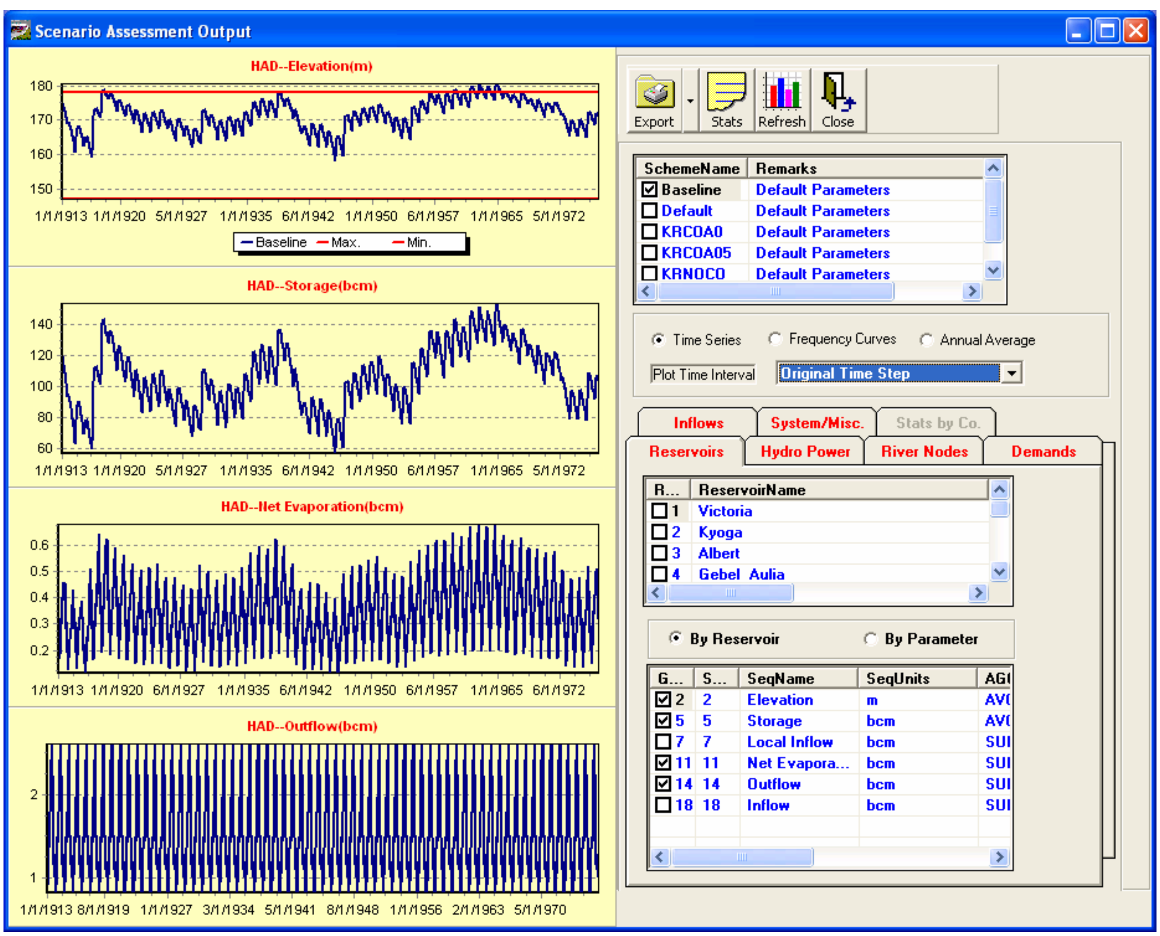


- ELQG Parameters (used by optimal control model, not active)
    - CaseID: ID for different data set;
    - CaseName: Name for different data set;
    - Remarks: Text to describe the case name and purpose for easy retrieval;
- Penalty Coefficients (used by optimal control model, not active): Coefficient used by the ELQG algorithm to achieve various objectives. Refer to the **NileDST-RBM** technical report for details.
- Inflows: Inflow scenarios defined in the data base that can be used by the historical analog forecasting model. Select one by clicking the row heading;

Remarks: The Scenario Assessment model is used to assess the system performance under various combinations of constraints and operational policies. It runs the long range planning model using the selected hydrological inflow sequences, a system load pattern, and a control policy. For each assessment run, the model assumes no knowledge of the upcoming inflow and uses the imbedded inflow forecasting model to generate inflow forecasts over the control horizon (usually a year or several months). The long range planning model is activated next to determine release and energy generation sequences over the same time frame. Then, the assessment model simulates the system response for one ten-day period using the identified release policies and the actual observed inflows. Important system quantities such as reservoir elevations, releases, power generation, water supply deficits, and wetland areas, are recorded. This process is repeated at the nest and all future time steps sequentially. At the end of the assessment, the simulated sequences for all quantities are saved in the database. The long range assessment model is useful in assessing the implications of various system configurations; power and water demand scenarios; inflow scenarios under historical and climate change conditions; management policies, and other operational requirements.

5.2. Scenario Assessment Model Output Screen

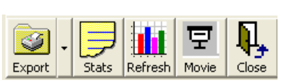
Interface Functionality: Display detailed results generated by the assessment model.



Data Items: The model outputs are organized by groups in different tabs.

- Reservoirs:
  - Elevation;
  - Storage;
  - Local inflows;
  - Evaporation;
  - Outflow;
  - Inflow.
- Plants:
  - Elevation/Gross Head;
  - Release;
  - Energy;
  - Spillage.
- River Nodes
  - Required Minimum;
  - Simulated Flow;
  - Deficit.
- Demand Nodes
  - Target;
  - Simulated;
  - Deficit.
- Inflows
- System:
  - Energy generation;
  - Toshka Spillage

Toolbar Buttons and Other Screen Options:



Additional Plot Options:

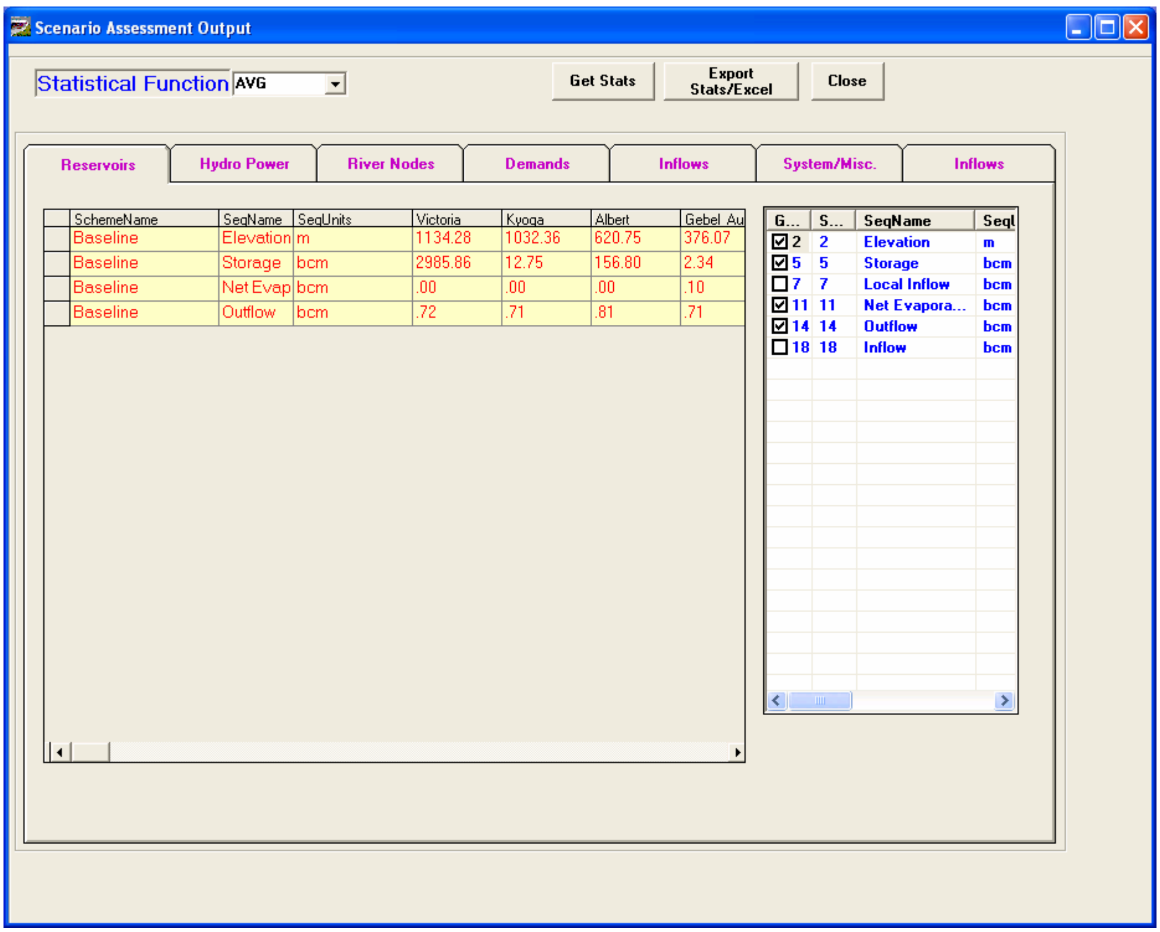
- Time Series
- Frequency Curve

- Annual Average

Aggregation Time Step:

- Original (10-day);
- Monthly;
- Yearly;
- All Data.

Simulation Statistics



Statistical Function Options:

- AVG
- MAX
- MIN
- STDEV
- SUM

6. Conclusion

This user manual describes the usage of the Nile Decision Support Tool – River Basin Management Module (NileDST-RBM). NileDST-RBM is an advanced decision support software developed for use by trained engineering staff. Novice users should first familiarize themselves with the NileDST-RBM design concept, methodologies, and capabilities described in the associated Technical Report. Furthermore, they should also receive sufficient training by qualified professional staff.