Chapter 4
Research Design and Method

The Nam Ngum river originates on the Tran Ninh plateau (Xieng Khuang province, Lao.PDR), 1,000 m to 1,500 m above mean sea level (m.a.s.l). The river flows through the mountainous area for about 120 km, and then through a wide open valley for about 120 km before reaching the Nam Ngum-1 dam site (at an elevation of about 160 m.a.s.l). The catchment area is 8,460 km^2 at the dam site. Most of the rainfall in the Nam Ngum river basin, as in the whole of the Mekong river basin, is caused by the inflow of warm moist air during the southwest monsoon. The characteristic of Nam Ngum basin is illustrated in Figure 4.1[22].

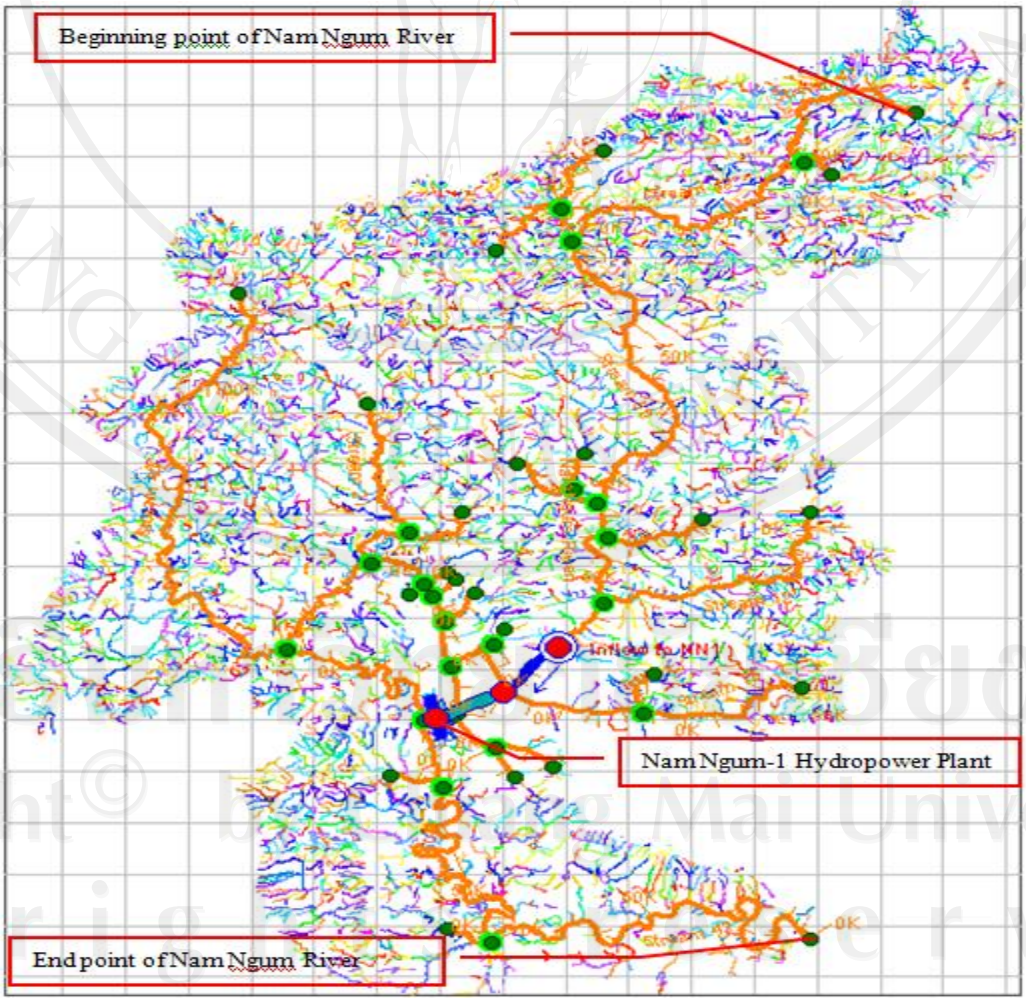

Figure 4.1 Shape of Nam Ngum basin and reservoir' Nam Ngum-1 HPP

4.1 Methodology

The main purpose of this study was to find out reservoir management of Nam Ngum-1 hydropower plant for optimum electricity production by HEC-ResSim3.0 software. Reservoir operation has been carried out using data of 10 years. There are average monthly water inflow, water outflow, water elevation and energy production data during year 2003 to 2012 from Nam Ngum-1 hydropower plant. The data are considered in the three cases such as: wet case, drought case and normal case. Furthermore, the data in the each case are consider on three steps such as : step one, step two and step three for find out optimum electricity production and reservoir operation in the each case.

4.2 General framework of the study

Framework is a skeleton of any work which shows clear steps of the work. In order to achieve the objectives of the study, different types of data have been collected from respective organizations and master plan prepared for the study area. Data obtained from these sources are analyzed and configured for the model. After all data are configured, simulation is performed and results are discussed. Based on the simulation results and objectives of the study, different conclusions and recommendations are drawn.

Nam Ngum-1 hydropower plant reservoir modeling for optimum electricity production and consists on the flow chart the details are following steps:

1. Preparation of the time series stream flow data and storing the data set into the Hydrologic Engineering Center's Data Storage System Visual Utility Engine (HEC-DSSVue2.0) software.

2. From watershed module of HEC-ResSim3.0, drawing of the river network, Nam Ngum-1reservoir, river junctions, diversion outlet, computational points and nodes are arranged. (i.e., Watershed setup)

3. From the reservoir network module, draw reaches, diverted outlet, computational points and defining physical data such as reservoir data (elevation, storage, area curve), dam data (spill way capacity curve, power plant data, turbine outflow, tail water rating curve)

4. From the reservoir network module, fixing the operational data which are reservoir elevation for the inactive, conservation and the flood storage zones constant top elevation zone is assumed in this study.

5. Adding the diverted outlet for power intake, additional zones (if necessary) and adding the parameter for controlled outlet, power plant efficiency, station use, hydraulic loss and tail water elevation.

6. At the operation window of reservoir network module, set the operational rules at each zone of reservoir.

7. Assigning the required information or data for each zone and rule, that specifying the constraints of each zone.

8. After correctly defining the reservoir network, creating an alternative to locate the time series data from the HEC-DSSVue2.0 in the appropriate place.

9. Conduct the simulation or run the model and repeating step 8 until you get the best alternative which can give the optimal result for maximum power generation, at the same time able to satisfy the demand at the downstream site and also the one which have minimum spillage loss, minimum operating storage level and will not have risk of flooding is selected.

10. Finally analyzing the optimal result and determining the final selected alternative based on all gate setting patterns and detail discussion of the result is done.

The following flow chart is designed to show all these steps clearly as shown in Figure 4.2.

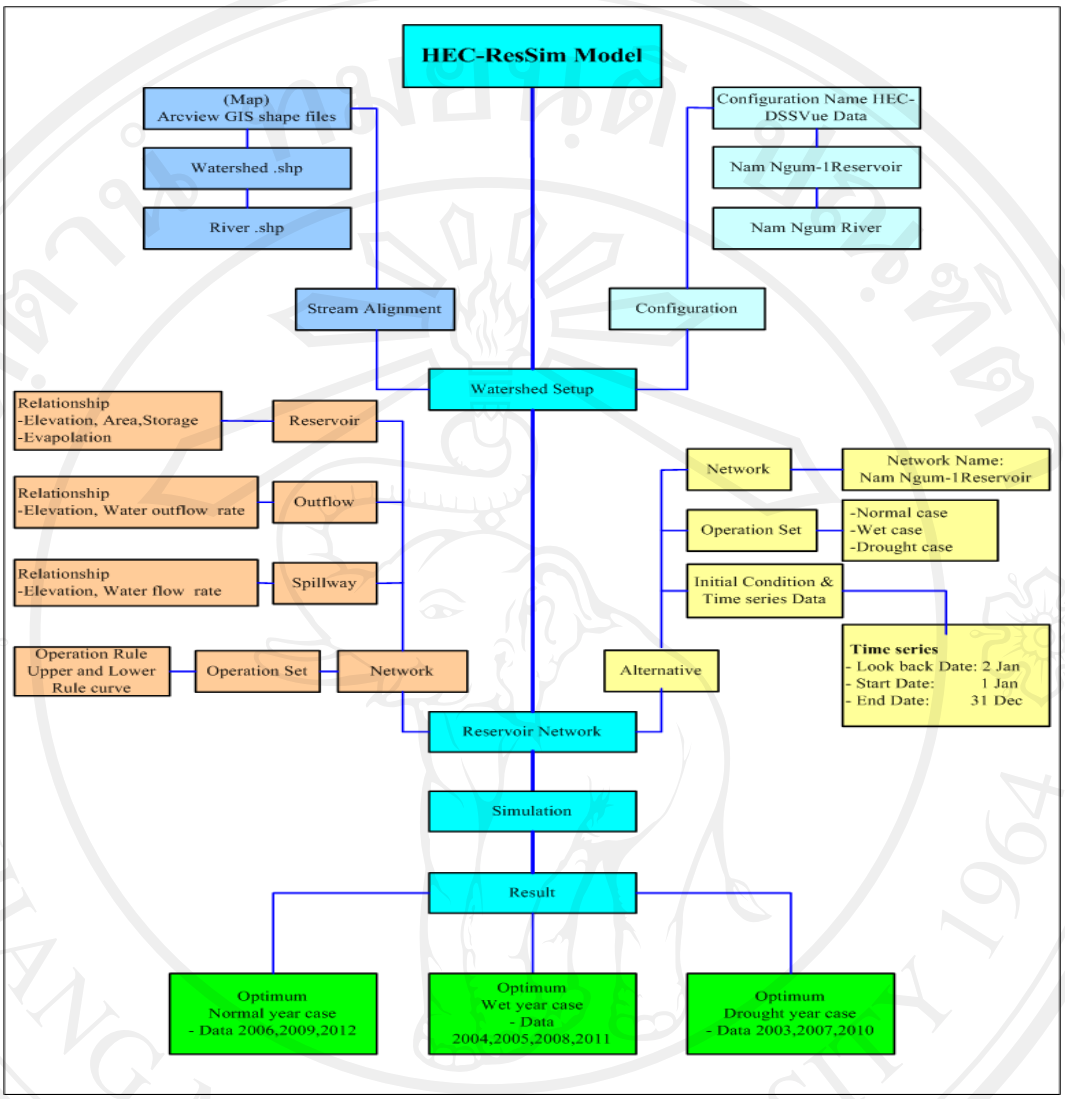

Figure 4.2 Flow chart designed model for reservoir operation of Nam Ngum-1 HPP

4.3 HEC-ResSim3.0 model setup

In this presentation, the Corps of Engineers software, HEC-ResSim3.0 model is used to perform the operational modeling or simulation analysis for reservoir management of Nam Ngum-1 hydropower plant. The HEC-ResSim3.0 is the reservoir simulation software developed by the Hydrologic engineering center of the corps of engineers.

HEC-ResSim3.0 is graphical user interface (GUI) software. Its hydropower simulation capabilities include analysis of runoff river generation, peak power generation, and pumped storage and system power operation. To simulate hydropower

operation, the reservoir releases are determined to meet power production goals which may vary on a monthly, daily or hourly basis. Additionally, the hydropower component takes into account the penstock capacity and losses, as well as leakage parameters.

The model allows the user to define alternatives and run simulations simultaneously to compare results. Schematic elements in HEC-ResSim3.0 allow the representation of watershed, reservoir network and simulation data visually in a geo-referenced context that interacts with associated data. In addition to that, HEC-ResSim3.0 is compatible with Arc-GIS shape files, which can be used as a background layer and facilitate the better representation of the physical system. Watershed boundaries, reservoirs, channel networks, diversions, etc. can be superimposed over the shape file.

HEC-ResSim3.0 offer s three separate sets of functions called Module that provides access to specific types of data within a watershed. These modules are **Watershed Setup**, **Reservoir Network**, and **Simulation.** Each module has unique purpose and an associated set of functions accessible through menu, toolbar, and schematic elements. Figure 4.3 illustrates the basic modeling features available in each module [23].

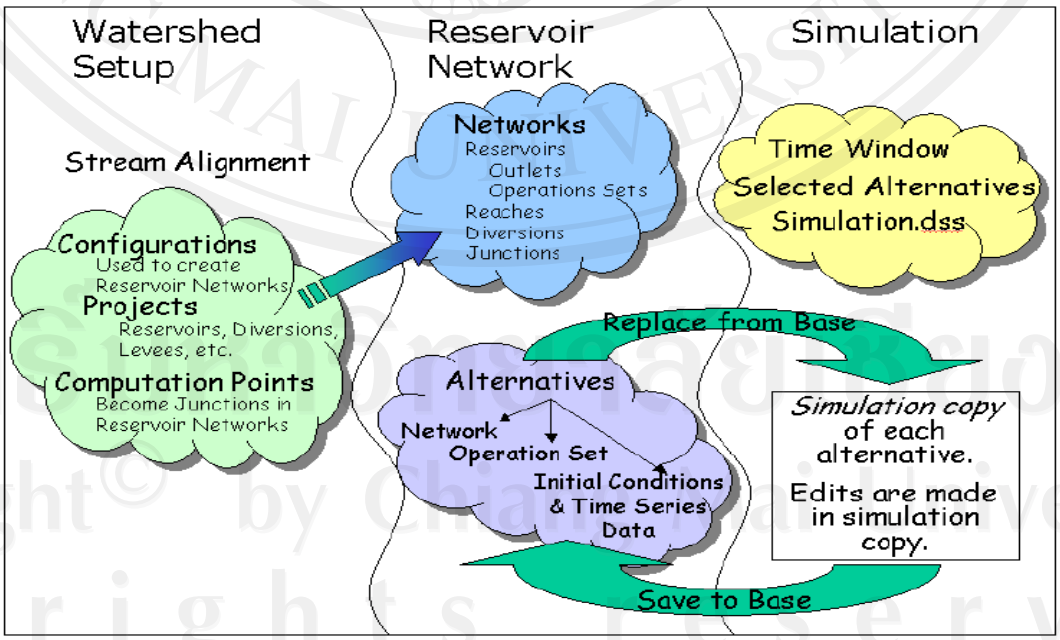

Figure 4.3 Modeling module concepts

4.3.1 Watershed setup module

The purpose of the Watershed Setup module is to provide a common framework for watershed creation and definition among different modeling applications. This module is currently common to HECResSim3.0, a watershed is associated with a geographic region for which multiple models and area coverage can be configured. A watershed may include all of the streams, projects e.g., reservoirs, levees, gage locations, impact areas, time-series locations and hydrologic and hydraulic data for a specific area. All of these details together, once configured, form a watershed framework. In the Watershed Setup module, items that describe a watershed's physical arrangement are assembled. Once a new watershed, has been created, it will able to import maps from external sources, specify the units of measure for viewing the watershed, add layers containing additional information about the watershed, create a common stream alignment and configure elements. Projects can also be added and create time-series icons within the Watershed Setup module. The window of module is illustrates in Figure 4.4 and the detail is shown in the Appendix E.

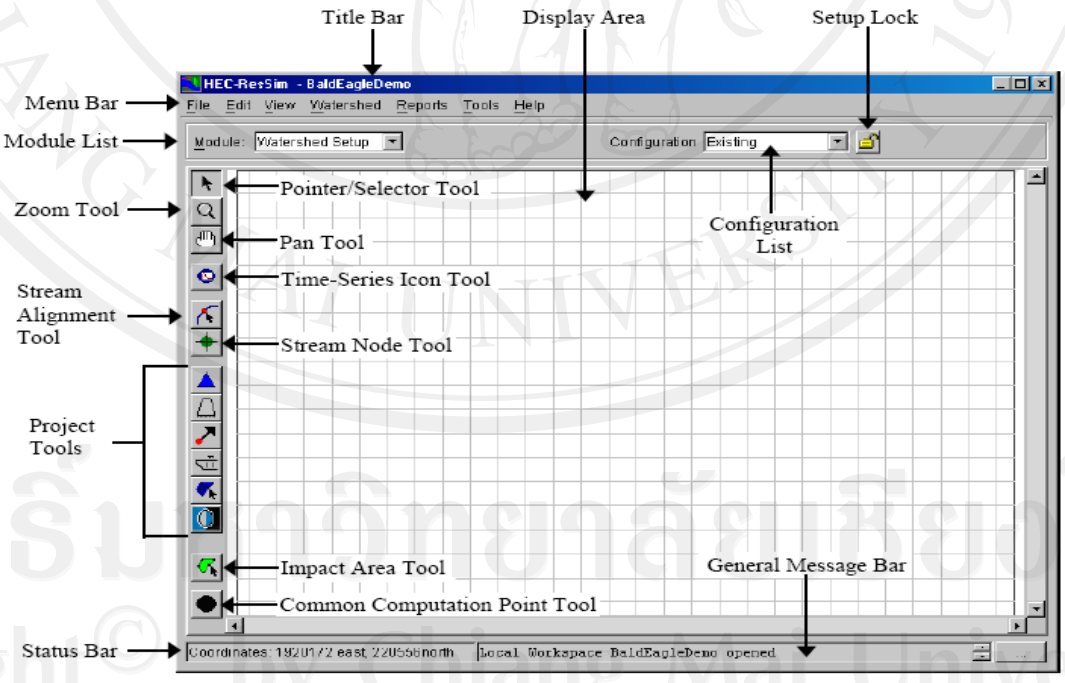

Figure 4.4 Main windows of watershed setup modules

4.3.2 Reservoir network module

The reservoir network module is used for editing element data and placing additional elements onto the stream alignment. From the module list, select reservoir network. The main window and the different components for the reservoir network module are illustrated in Figure 4.5 and the detail is shown in the Appendix E.

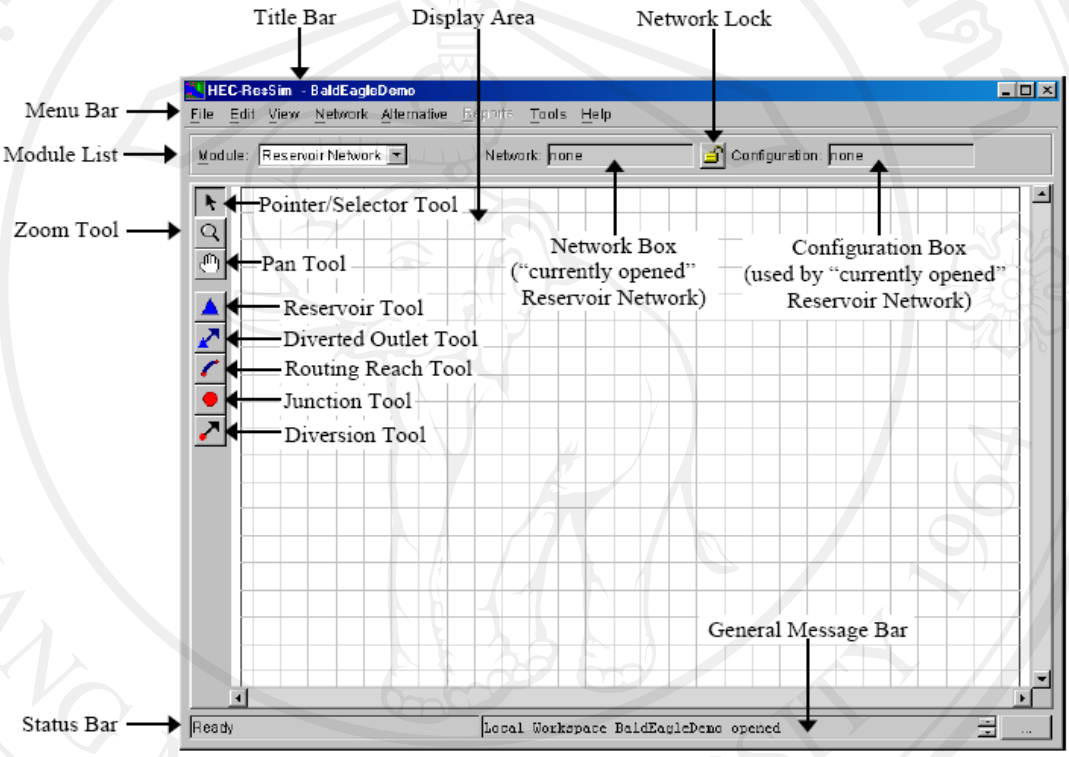

Figure 4.5 Main window of reservoir network module

4.3.3 Simulation module

The purpose of the Simulation Module is to isolate output analysis from the model development process. Once the reservoir model is completed and the alternatives have been defined, the simulation module is used to configure the simulation. The computations are performed and results are viewed within the Simulation Module.

When creating a simulation, a simulation time window must be specified, a computation interval and the alternatives to be analyzed. Then, HEC-ResSim3.0 creates a directory structure within the rss folder of the watershed that represents the

simulation. The main window of module is show in Figure 4.6 and the detail is shown in the Appendix E.

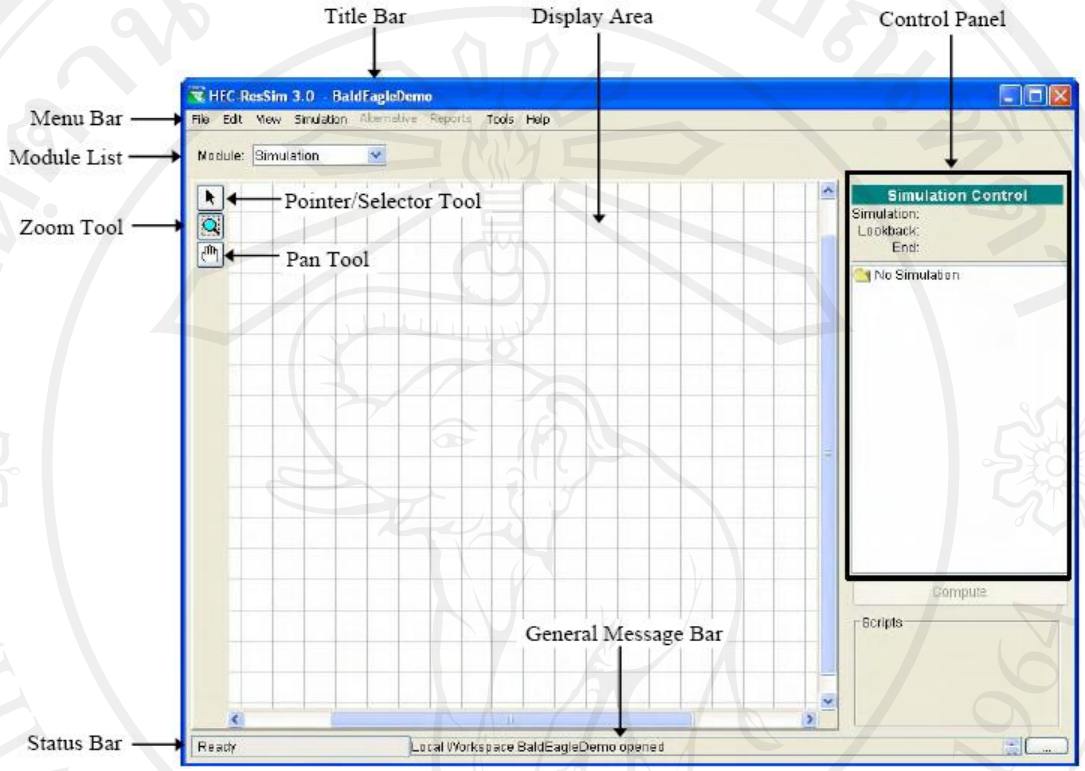

Figure 4.6 Main window of simulation module