TRAINING MANUAL

For

NIH_ReSyP – 2022

(NIH_Reservoir Systems Package)

Brief Description of *NIH_ReSyP* – 2022: A Reservoir Systems Package Developed at NIH

Because of the high time and space variability of rainfall and uncertain nature of monsoon in India, reservoirs play an important role in the efficient utilization of water resources. More than 5300 major and medium dams with a storage capacity of around 258 Billion Cubic Meter (BCM) have already been constructed in India. The basic aim of a reservoir is to match the temporal and spatial availability of water in accordance with demands. However, efficient use of water resources requires not only judicious design but also proper management of hydraulic structures. Reservoir management involves allocating available water among multiple uses and users, minimizing the risks of water shortages and flooding, and optimizing the beneficial use of water. The management of reservoirs is a challenging problem because it deals with a natural system with all the associated uncertainties and a tailor-made solution methodology is not available. Further, integrated operation of a complex system is necessary for efficient management of the limited resources to meet various target demands.

The system engineering techniques like simulation and optimization are extensively used in the reservoir operation problem. A large number of models, generalized as well as system specific, have been developed, some of which include HEC-3 and HEC-5 of Hydrologic Engineering Centre (now HEC-ResSim), SIMYLD-II of Texas Water Development Board, the ACRES (Sigvaldason 1976), the RESER (Simonovic 1992) and the IRIS (Iris 1990). Recently, Nesa Ilich (2022) reported the WEB.BM model for multipurpose multi-reservoir river basin management that uses Mixed Integer Linear Programming to optimize basin operation over single or multiple time steps and optional use of both reservoir and hydrological channel routing.

In view of the importance of reservoir operation problem in Indian context and non-availability of a generalized indigenous software for reservoir analysis, NIH developed a generalized software named "*SRA – Software for Reservoir Analysis*" for reservoir analysis [Jain et. al (1996)]. Subsequently, a WINDOWS based software named *"NIH_ReSyP – Reservoir Systems Package"* was developed [Goel and Chalisgaonkar (2011)] in Visual BASIC platform to provide a user-friendly environment for carrying out various hydrological analyses related to reservoirs such as capacity computation, storage yield analysis, hydropower simulation, reservoir routing, interpolation of Elevation-Area-Capacity (EAC) table, inflow estimation using rate of rise in reservoir level, initial rule curve derivation, and operation of a system of multiple reservoirs for conservation and flood control purposes.

Some training courses on the software were organized for its wide-spread use and some suggestions from field engineers for modifications were received. Further, in view of the apprehensions that the future versions of Windows may provide limited support to VB6 applications, it was decided to develop the *NIH_ReSyP* on VB.NET platform which offers more features for development and user-friendliness.

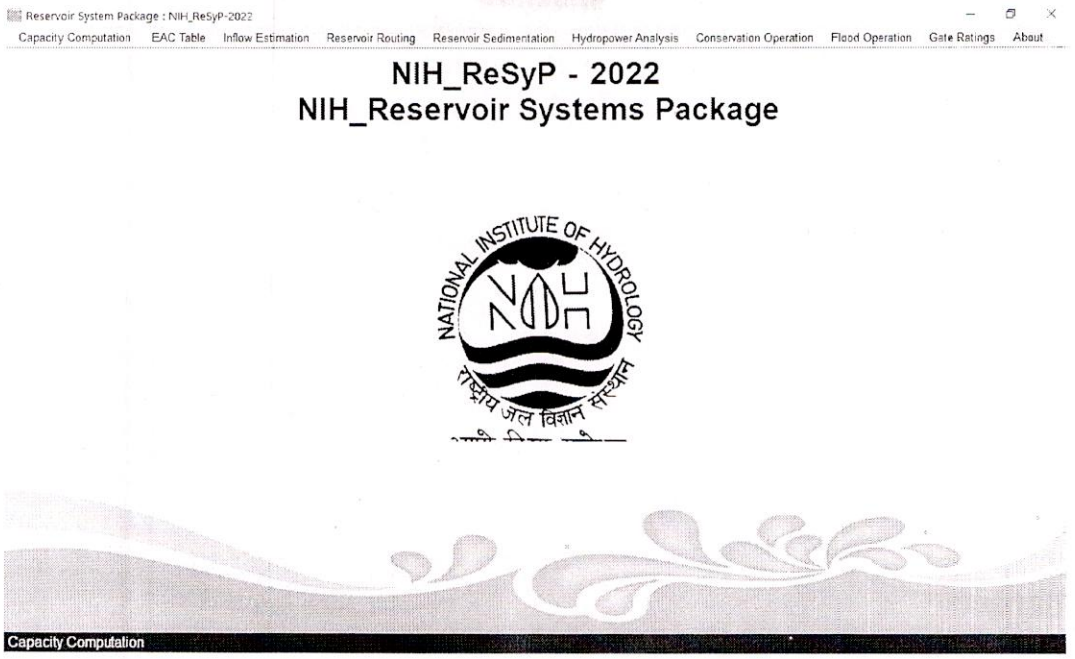
The NIH_ReSyP – 2022 software is a WINDOWS based comprehensive and easy-to-use menu-driven interactive package with on-line help to guide the user for various analytical modules. In contrast to the 10 modules in the earlier version, a total of 20 modules have been provided and their data forms in .NET framework have been developed. Based on the inputs from the field engineers and users, significant improvements in the previous modeling system have been made. Some checks have been introduced in various modules, especially with regard to the errors in the EAC table, others checks are specific to the modules.

By clicking on a particular analytical option, various modules related with the selected option appear on the screen. A data form has been designed for each module depending on its data requirement. Clicking on a module directly opens the data preparation form for the module. Various options such as retrieving an existing file, generating a new file, making changes in the retrieved file and saving it with a new name are provided. Each analytical module is given specific and related input and output file extensions so that one only sees the module-related files in the browser.

NIH_ReSyP Modules

There are 9 main modules in NIH_ReSyP-2022 package. Main modules are generalized terms and most of them consist of submodules which are used to perform different analysis.

1. Capacity Computation
2. EAC Table
3. Inflow Estimation
4. Reservoir Routing
5. Reservoir Sedimentation
6. Hydropower Analysis
7. Conservation Operation
8. Flood Operation
9. Gate Ratings



Current version of the software is capable of performing the following types of analyses related to reservoirs under each module:

1 Reservoir capacity computation
- using Sequent-Peak analysis
- Reservoir capacity computation using Storage-Yield-Reliability analysis
  - Development of working table
  - Development of Storage-Yield-Reliability relationship

2 Elevation-Area-Capacity table
- EAC Interpolation
- EAC Approximation

3 Inflow estimation
- Table for different Rate-of-Rise
- Instantaneous estimation for any specific rate of rise and reservoir level
- From reservoir working table including correction for negative flows

4 Reservoir routing

5 Reservoir sedimentation

6 Hydropower analysis
- Firm power determination
- Hydropower simulation

7 Conservation operation of a multi-reservoir system

- Probable flow estimation for initial rule curve derivation
- Initial rule curve derivation
- Instant release estimation for conservation demands

8 Flood control operation of a multi-reservoir system

- Instant flood release estimation

9 Spillway/Sluice gate ratings

- Rating tables
- Instantaneous estimations for any specific gate opening at any reservoir level

The software in FORTRAN for some of these modules have been taken from NIH reports. Program for power transformation technique for probable flow analysis has been developed by Seth and Perumal (1982). The program for sequent-peak analysis has been taken from Jain (1985). For storage yield analysis, the computer program developed by Jain (1986) has been utilized. Reservoir routing analysis software has been adopted from Jain and Gupta (1989). Software for simulation of a multi-reservoir system for conservation has been developed by Jain and Goel (1994) while such program for flood control has been taken from Jain and Goel (1999). Computer program for spillway gate regulation and sluice gates has been taken from Senthil Kumar et al. (1994). All these programs have been suitably modified as per the module options and software requirements. In addition, a number of programs for other modules have been developed independently so as to help the field engineers in their day-to-day analysis.

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