2.0 Introduction

The ESPADP Users Manual is designed to describe the basic use and functionality of the program. This introduction includes background information about the ESPADP program environment, outlines the goals and objectives of the program and describes the specific capabilities included in the program.

2.1 Program Environment

The NWS forecasting activities are supported through a complex set of models and techniques combined into one system, the National Weather Service River Forecast System (NWSRFS). NWSRFS is a continuous forecasting system which provides real-time predictions of river flows and other variables used in producing river and flood forecasts. The system includes a Calibration System (CS), an Operational Forecast System (OFS) and an Extended Streamflow Prediction (ESP) System.

NWSRFS is a modular system that allows hydrologists to select from a variety of models and configure them in a manner that is descriptive of the basin. All of the hydrologic and hydraulic models are common to CS, OFS and ESP.

CS performs the tasks needed to process historical hydrometeorological data and estimate model parameters for a specific basin. The models simulate snow accumulation and ablation, calculate runoff, time the distribution of runoff from the basin to the basin outlet and perform channel routing. As part of the calibration procedure, the simulated streamflow is statistically and visually compared to the observed streamflow to determine the necessary model parameter adjustments.

After the models have been calibrated for a specific basin, the optimal set of parameters can be combined with real-time hydrometeorological data to operationally forecast streamflow. OFS contains three major components that are needed for operational river forecasting: data entry, preprocessing and forecasting. The data entry component is a set of programs that transfer hydrometeorological data from a variety of sources to the observed data base. The preprocessing component reads raw station data, estimates missing data as required and then uses these data to calculate mean areal time series of precipitation, temperature and potential evapotranspiration for a particular basin. The processed time series are used by the forecasting component to perform requested hydrologic and hydraulic simulations. The forecasting component maintains an account of the current model states that describe the hydrologic condition of the basin, including snow cover, soil moisture and channel storage. The states are needed as starting points for subsequent forecasts.

ESP produces probabilistic forecasts of streamflow and other hydrological variables. ESP assumes that historical meteorological data are representative of possible future conditions and uses these as input data to hydrologic models along with the current states of the models obtained from the forecasting component. A separate streamflow trace is simulated for each year of historical data using the current conditions as the starting point for each simulation. The streamflow traces can be analyzed for peak flows, minimum flows, flow volumes, etc., for any period in the future. A statistical analysis is performed using the values obtained from each year's simulation to produce a probabilistic forecast for the streamflow variable. This analysis can be repeated for different forecast periods and additional streamflow variables of interest. Short-term quantitative forecasts of precipitation and temperature can be blended with the historical time series to take advantage of any skill in short-term meteorological forecasting. In addition, knowledge of the current climatology can be used to weight the years of simulated streamflow based on

the similarity between the climatological conditions of each historical year and the current year.

ESP allows flexibility in selecting streamflow variables which can be analyzed, the capability to make forecasts over both short- and long-term periods and the ability to incorporate forecast meteorological data into the procedure. Because of ESP's flexibility and conceptual basis, it has many applications, including water supply forecasts, flood control planning, drought analysis, hydropower planning and navigation forecasts. The probabilistic forecasts provide uncertainty information needed by water managers for risk-based decisions. The streamflow time series generated by ESP can be output as products so that they can be used in reservoir simulation/optimization models to investigate how operations might be improved. The ESP forecast information is based on the best estimate of current hydrometeorological conditions, as well as an analysis of the local historical climatological variability.

2.2 The Current Operational ESP System

ESP has been designed as an integrated part of NWSRFS. It is completely compatible with OFS and can take advantage of the changing parameters defined for each forecast point. Parameters, rating curve information and simulated carryover (model states) information are obtained directly from the OFS forecast parameter and carryover files. Information needed for ESP that is not available from the OFS files is defined with the ESP Initialization Program (ESPINIT). ESPINIT is used to define ESP segment information including the location of time series (i.e., temperature, precipitation) on the historical data files and the types of analyses to be performed. ESP segment information is stored in the ESP parameter file. The ESPINIT program is used to redefine, delete and display this information.

ESP accesses the OFS Carryover, OFS Parameter and ESP Parameter files to obtain the necessary run information. Historical data is obtained from the ESP Historical Data files and shorter term meteorological forecast information is accessed from the OFS Processed Data files.

Historically, ESP has been run on the NWS mainframe computer system in Suitland, Maryland. Submission and output of ESP jobs have been restricted to slow communication transmissions. Typical ESP results are presented in a large number of printed pages. Improved graphical output would greatly assist the user in interpreting ESP results. ESP must be rerun to reflect changes in year weights or the ESP analysis window. Changes to output variables or frequency analysis options can only be made by redefining the segment with ESPINIT. Procedures for aiding the user in adjusting the simulated conditional output for model errors do not exist, so users must manually estimate these adjustments.

More recently, ESP has been ported to the workstation, but it still only exists in a batch form that does not allow user interaction or graphical displays. ESPADP provides the necessary linkage and user interface.

2.3 Project Goal and Objectives

The goal in developing ESPADP is to provide a tool that will enhance the capability of River Forecast Centers (RFCs) to produce accurate extended water resources forecasts and increase user confidence and understanding of the ESP process. This goal will be met by accomplishing the following specific objectives within the framework of an interactive system in a workstation environment:

1.   Produce additional tools for analysis, display and adjustment of ESP outputs, including interactive graphics

2.   Incorporate procedures to adjust forecasts for model bias, as well as procedures for coupling short-

and long-term meteorological forecasts with ESP

3.   Provide automatic generation of outputs and products that satisfy forecaster and user needs

4.   Provide a facility for preparing ESP segment definitions and running ESPINIT

5.   Provide an interface for submitting ESP runs