M.Sc. Thesis

FORECASTING OF HYDRO-METEROLOGICAL TIME-SERIES USING ARIMA MODEL FOR RESERVOIR OPERATION

Advisor

Dr. Ijaz Ahmad

Submitted By:

HAMMAD UR REHMAN
2016-MS-WRE-13

CENTRE OF EXCELLENCE IN WATER RESOURCES ENGINEERING
University of Engineering and Technology, Lahore, Pakistan

2019

ABSTRACT

Pakistan is an agricultural country and about 70% of its populations is directly linked with agriculture sector. This sector is also considered one of the biggest contributors in the country's Gross Domestic Product (GDP). The water storage reservoirs are considered essential for improving the production of agricultural sector to meet the ever-increasing food and fibre requirements. Traditionally, historical hydro-meteorological timeseries data generally used in conducting the reservoir operation studies in Pakistan to estimate the future water availability for various purposes such as irrigation, industry, domestic and hydropower etc. which leads to many issues such as inaccurate estimation of water availability, water shortage and excess periods. Therefore, this study aims to use the forecasted hydro-meteorological timeseries data for conducting the reservoir operation study at Mangla reservoir.

Many statistical models such as auto regressive (AR), auto regressive integrated moving average (ARIMA), artificial neural networks (ANN), etc. are being used in many studies round the world to forecast the hydrometeorological timeseries data. ARIMA model is considered one of the most suitable models for linear and seasonal forecasting of timeseries because it uses the simple linear regression model for forecasting. Hence, ARIMA model was used in this study to forecast the hydrometeorological timeseries data, i.e., inflows, precipitation and evaporation to estimate the future water shortage and excess periods. Before applying the ARIMA model, stationarity of hydrometeorological timeseries data was checked. After this, ACF and PACF of timeseries were determined to determine the "p" and "q" parameters of the ARIMA model. The best fitted structure of ARIMA model was used to forecast the hydrometeorological timeseries. The calibration and validation of

ARIMA model were performed by evaluating the R^2, MAE and RMSE. Finally, the future predicted hydrometeorological timeseries data were used in the reservoir operation to determine the water shortage and excess periods.

The seasonal ARIMA structure of $(1,0,0)(2,1,2)_{12}$ was found best fitted for the inflow timeseries during model calibration and validation. Whereas, ARIMA structures of (14,1,15) and (9,1,19) were considered for forecasting the precipitation and evaporation timeseries. These forecasted hydrometeorological timeseries were used in the reservoir operation for the period of 2016-2030. The R^2 values of inflows, precipitation and evaporation timeseries were found 0.85, 0.88 and 0.83 respectively. The inflows of Mangla reservoir have seasonal effect more prominent compared to climatic time-series of evaporation and precipitation, whereas precipitation timeseries of Mangla reservoir has many steep peaks. The variations in the precipitation timeseries was found less smooth than the inflows timeseries. These forecasted hydrometeorological timeseries data were used in conducting the reservoir operation and found an average water shortage of 14% during 2016-2030. It is believed that the results of present study may guide the reservoir operators and managers to predict the future uncertainties in hydrometeorological timeseries data.