FinalAssignment

Option (C)

Daily water Level Forecasting for Nyaung Oo Station using Stage to Stage Correlation Method

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1. Introduction

Flood is a climate caused natural disaster describe as the excess of river flow that exceeds the channel that has been specified for it. It may also be described as the very high flow of water overtopping the artificial or natural bank inundating the entire surrounding area. Flood is considered as the most disastrous and damaging and causes more economic loss than other natural or technological disasters (Hung et al, 2008). In the last decade, over 90% of those died in natural disasters were affected by hydro-meteorological events. Of the annual average of about 211 million people who are affected by natural disasters every year, flood contributed more than third of this total (International Federation of Red Cross and Red Crescent Society).

Flood mitigation system is required to reduce the impact of flood hazard. The term flood mitigation refers to long-term sustainable measures that can be implemented to reduce the impact of flood hazards. These measures can be structural and non-structural. The structural measures refer to construction and management of dykes, dams, reservoirs, irrigation system, raised settlements, housing design and other physical methods. The non-structural measures include training planning, awareness generation, change in agricultural production patterns, flood resistant cropping, flood forecasting and warning system, flood hazard map, etc.

As early-warning system is very important for flood mitigation system, flood forecasting action assists and provides to achieve the early warning system.In addition, flood/river forecasting provides an alternative means of reducing flood damage and loss of life. At the national level, the main responsibility of flood monitoring, forecasting and issuance of early warning falls on the Department of Meteorology and Hydrology (DMH). River forecasting section of DMH is using both simple and advanced techniques for issuing flood warning and bulletin to the users and public, and is also applying empirical models based on single and multiple regression analysis for forecasting peak flood level along Ayeyarwady and Chindwin rivers. The lead time for issuing flood warning is about one to two days for short range forecast and about seven to ten days for long range forecast, especially for deltaic area of Ayeyarwady. In this study, stage to stage correlation method is used for river stage forecasting of Nyaung Oo gauging station.

2. Objective

The daily water level forecasts for Nyaung Oo station by using the daily water level (06:30hr MST :) of Pakokku station has been carried out with the following objectives.

(1) To develop the formulation of daily water level forecast for Nyaung Oo station by using Multi Linear Regression Method (with rainfall and without rainfall).

(2) To estimate the daily water level forecast for Nyaung Oo station (2015) by using the above two formulae equations.

(3) To compare the model efficiencies of the two forecasts for Nyaung Oo Station.

3. Study Area

Nyaung Oo city is situated between Latitude 20°51' to 25° 18' North and Longitude 94°39' to 95°13' East. Nyaung Oo city is 60.69 m above mean sea level. The area of Nyaung Oo city is 8.78 square miles. The population of Nyaung Oo city is about 239,947 people in 2014 Myanmar Population and Housing Census. Nyaung Oo City is popular tourist attraction of Myanmar and it is situated in Eastern bank of the Ayeyarwady River (see Fig-1).

Nyaung Oo is in tropical climate region and it is under the influence of monsoon rain Storms. The City has a hot and dry climate with and annual rainfall is 618.9 mm(22.37"). Recorded highest water level of the Nyaung Oo is 2263cm (29.7.2004) and that of lowest is 1003 cm (20.3.2003). The danger level of the Ayeyarwady River at Nyaung Oo is 2120 cm above zero of the gauge.

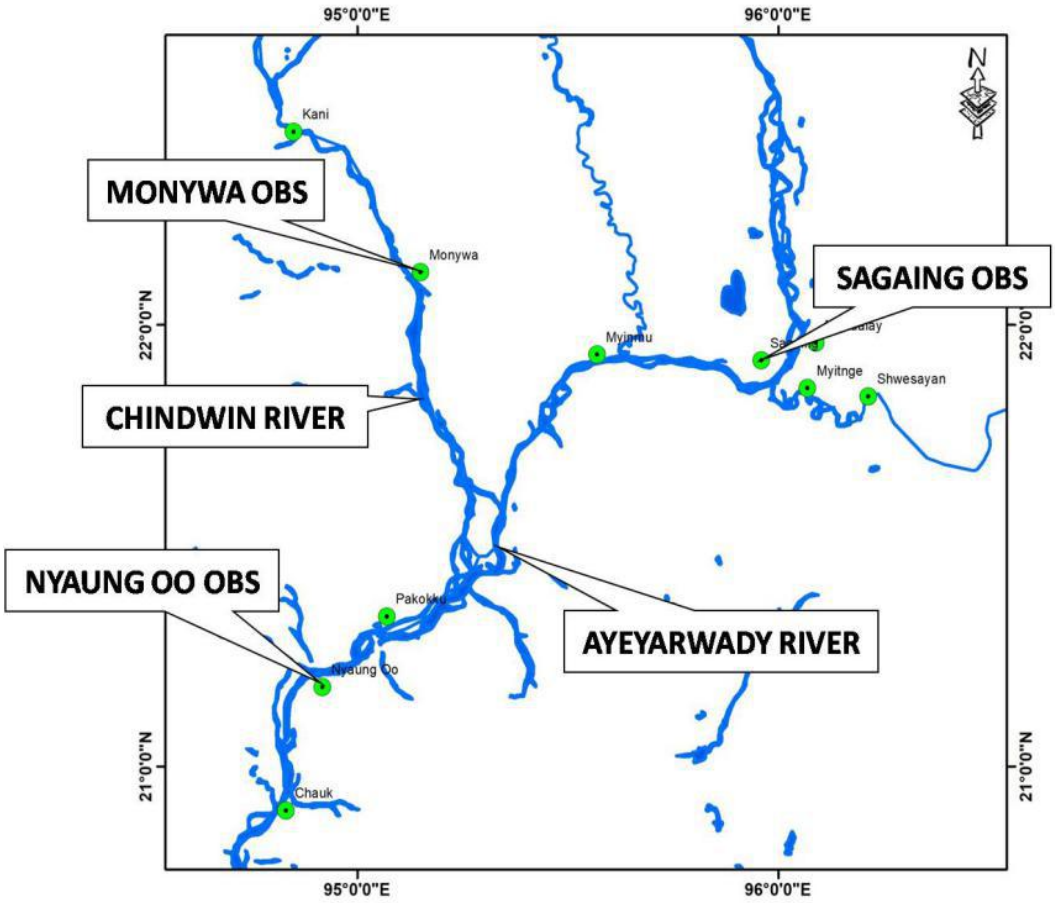


Figure 1. Location of study area (Nyaung Oo City) and Water Level observation stations.

4. Data Used

Daily Water Level, Daily Rainfall, Lag time (upstream to downstream stations)dataof (3) hydrological stations, Sagaing and Nyaung Oo Stations along Ayeyarwady River and Monywa station of Chindwin river have been collected.

5. Methodology

6.1 Stage to Stage Correlation Method

Method based on statistical Approach makes use of the statistical techniques to analysis the historical data with an objective of develop methods for the formulation of flood forecasts. The forecasting methods which are generally or in the form of mathematical relationship are developed with the help of historical data, using the statistical analysis.

Method based on statistical approach are commonly used in most countries of the world for formulation of forecast. These method can be presented either in the form of graphical relations or mathematical equations.

Various types of graphs which are used in formulation can be classified as below:

(1) Direct correlation between gauges or discharges of upstream and downstream station.

(2) Correlation between gauges or discharges of upstream and downstream stations with additional parameter.

6.2 Direct Correlation between Gauges or Discharges of Upstream and Downstream

In the present study, the direct correlation between t^{th} day stage of base station and $(t+T)^{th}$ day stage of forecasting station has been used. T is the travel time of flood wave between the base station and forecasting station. In this study, between Sagaing and Nyaung Oo stations are used travel time of (2)days and during the peak monsoon period. In this paper, and also multiple correlation between t^{th} day stage of base station and forecasting station and $(t+T)^{th}$ day stage of forecasting have been used. Formula in State Correlation Method-

$$H_{t+\tau} = A + \sum_{j=1}^{m_1} a_j H_{t-j+1} + \sum_{j=1}^{m_2} b_j U_{t-j+1} + \sum_{j=1}^{m_3} c_j RF_{t-j+1} + \cdots$$

H	: water level at the station under consideration
U	: water level at the upstream station(s)
RF	: rainfall
A, a_j, b_j, c_j	: regression coefficient
	: forecast lead time

6. Calculation

The daily value of Hydrological and Meteorological data will used to calculate the state to state correlation method for daily water level forecast of Nyaung Oo station.State correlation method for daily water level forecastwithout rainfall data as shown in Fig-2 and with rainfall data as shown in Fig-3.

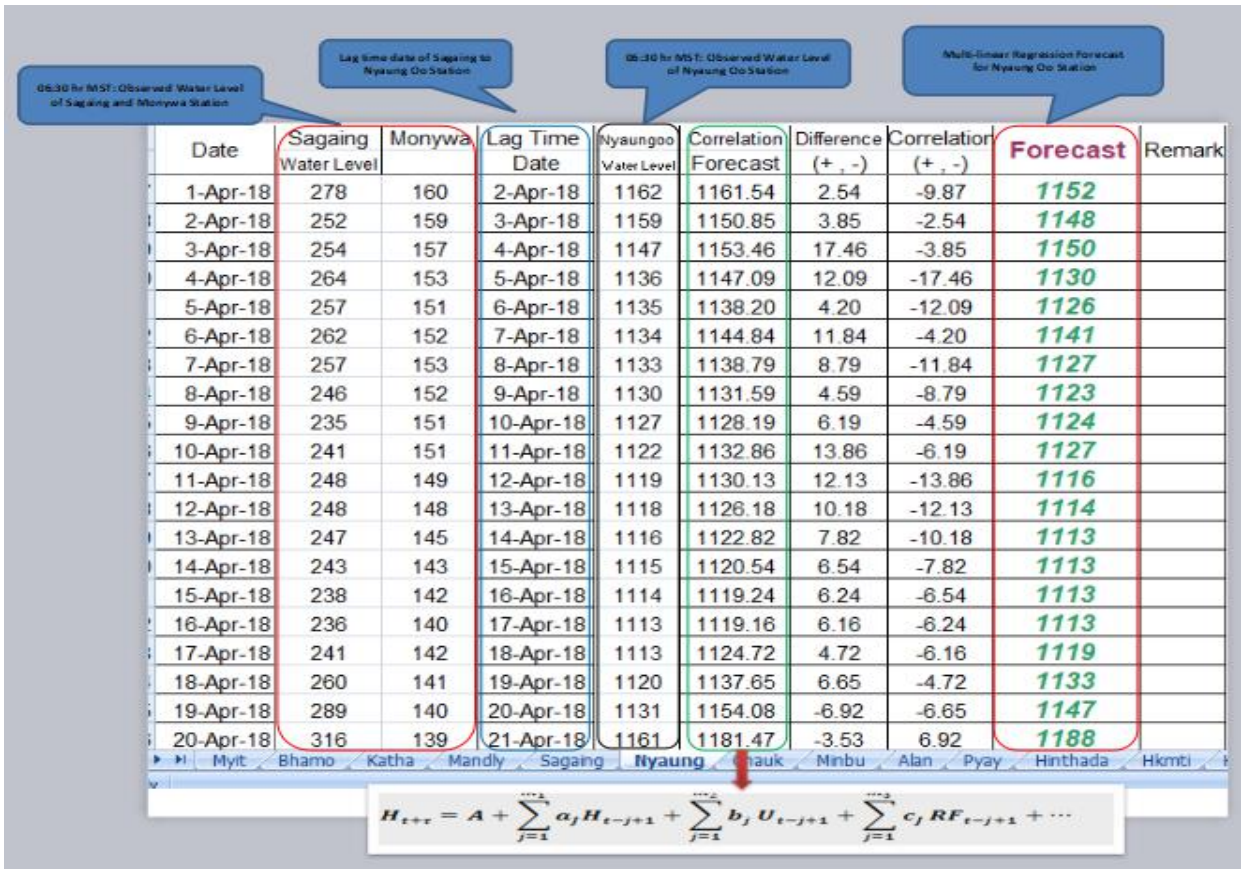
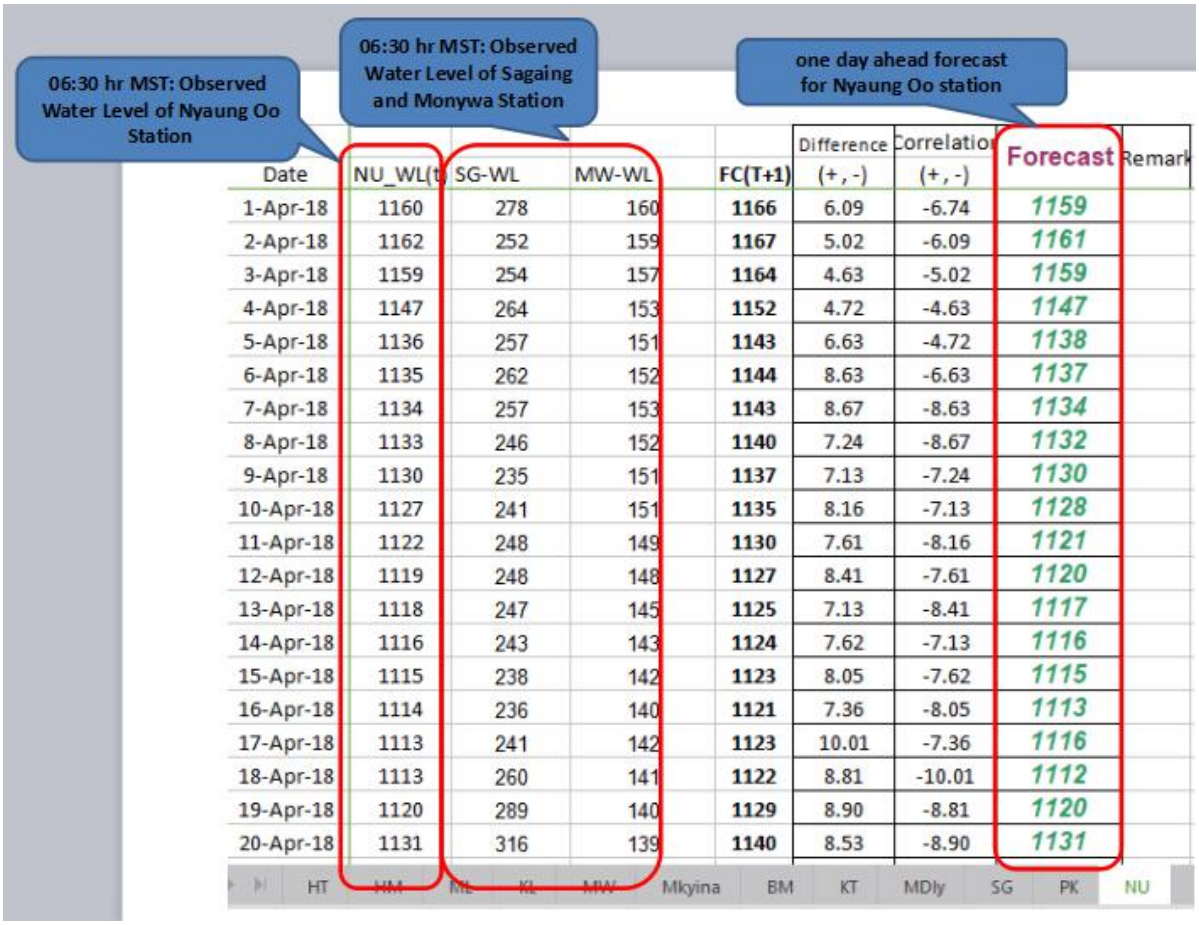


Figure 2.State correlation method (Multi-linear regression)

for daily water level forecast



Date	NU_WL(t)	SG-WL	MW-WL	FC(T+1)	Difference (+, -)	Correlation (+, -)	Forecast	Remark
1-Apr-18	1160	278	160	1166	6.09	-6.74	1159	
2-Apr-18	1162	252	159	1167	5.02	-6.09	1161	
3-Apr-18	1159	254	157	1164	4.63	-5.02	1159	
4-Apr-18	1147	264	153	1152	4.72	-4.63	1147	
5-Apr-18	1136	257	151	1143	6.63	-4.72	1138	
6-Apr-18	1135	262	152	1144	8.63	-6.63	1137	
7-Apr-18	1134	257	153	1143	8.67	-8.63	1134	
8-Apr-18	1133	246	152	1140	7.24	-8.67	1132	
9-Apr-18	1130	235	151	1137	7.13	-7.24	1130	
10-Apr-18	1127	241	151	1135	8.16	-7.13	1128	
11-Apr-18	1122	248	149	1130	7.61	-8.16	1121	
12-Apr-18	1119	248	148	1127	8.41	-7.61	1120	
13-Apr-18	1118	247	145	1125	7.13	-8.41	1117	
14-Apr-18	1116	243	143	1124	7.62	-7.13	1116	
15-Apr-18	1115	238	142	1123	8.05	-7.62	1115	
16-Apr-18	1114	236	140	1121	7.36	-8.05	1113	
17-Apr-18	1113	241	142	1123	10.01	-7.36	1116	
18-Apr-18	1113	260	141	1122	8.81	-10.01	1112	
19-Apr-18	1120	289	140	1129	8.90	-8.81	1120	
20-Apr-18	1131	316	139	1140	8.53	-8.90	1131	

Figure3.State correlation method (one day ahead forecast)

for daily water level forecast

8. Analysis and Result

8.1 Statistical Approach

After formulation, daily water level of Nyaung Oo station is forecasted using these corresponding two equations. And then computed and observed water level of Nyaung Oo station in high flow season are compared in Fig-4. Computed and observed water level of Nyaung Oo station in low flow season are compared in Fig-5.

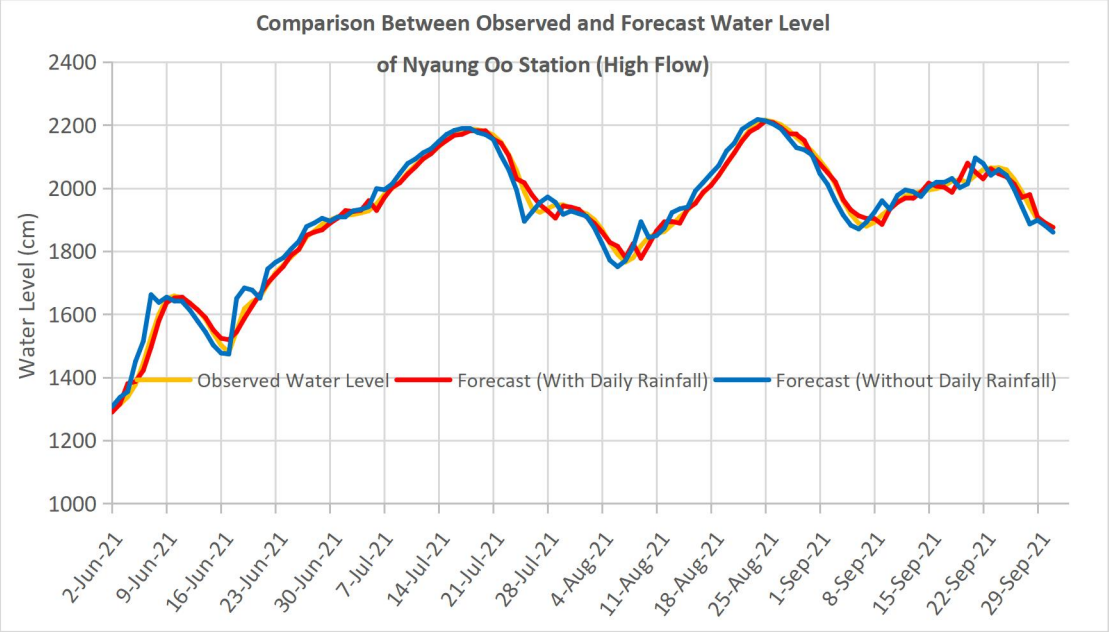


Figure 4.Comparison of Observed and Forecast water level at Nyaung Oo Station in high flow season

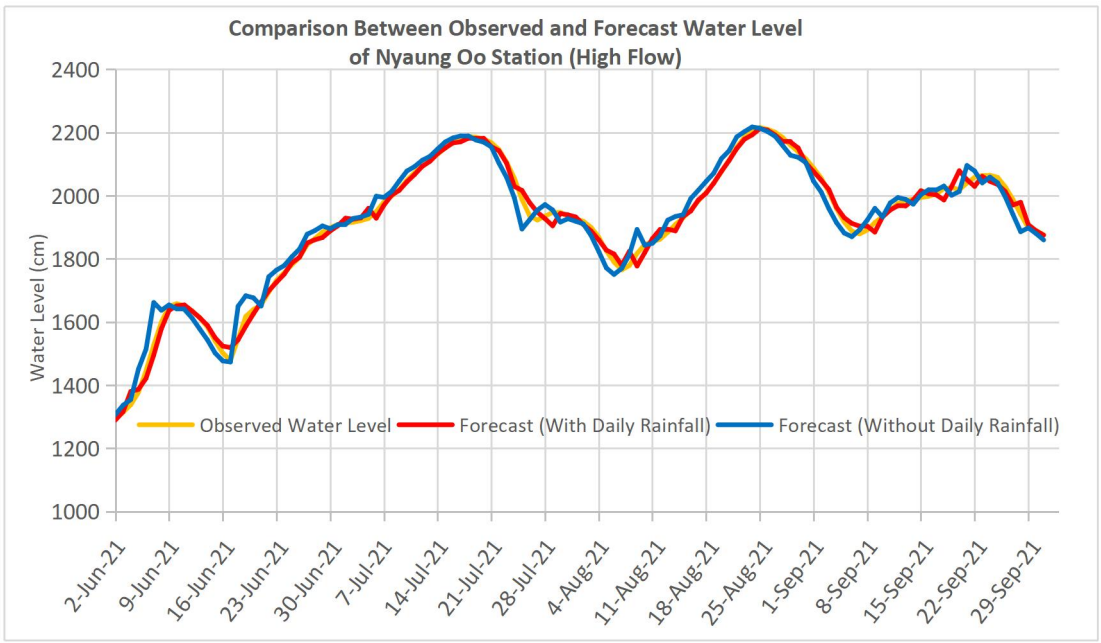


Figure 5.Comparison of Observed and Forecast water level at Nyaung Oo Station in low flow season

9. Conclusion and Recommendation

The two method obtained in the Microsoft Excel tool can be used as multiple linear regression equation for river stage calculation at high flow and low flow season. The main result of this paper is that water level at Nyaung Oo can be estimted through two upstream monitoring stations by using multiple regression

approaches i.e. multi linear regression and one day ahead. Both simulation methods are feasible to apply the operational flood forecasting system. But, we found that the accuracy of the water level at Nyaung Oo with rainfall is better than the forecast without rainfall during two flow season (high flow and low flow season). These results are seen in figure (4) for high flow season and figure (5) for low flow season.

Finally, the comparison of actual and forecast water level at Nyaung Oo station with rainfall and without rainfall are summarized as follws.

Multi linear Regression Method is one of the suitable method but others such as ANN, Matlab, Mike 11 software should be used in the future water level forecasting. More improved method of correlation is expected to carry out for flood forecasting.

Many physiographic and hydrographic characteristics exist at Nyaung Oo station. Therefore, future simulation should be considered physiographic parameters for estimation of lead time from the base station to forecasting station. And also, catchment rainfall input data set should be used in future flood forecasting model development.