Hydrological Analysis for Inflow Forecasting into Temengor Dam

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Abstract. These days, natural disaster such as flood is the main concern for hydrologists. One of solutions in understanding the reason of flood is by prediction of the event sooner than normal occurrence. One of the criteria is lead time or travel time that is important in the study of fresh waters and flood events. Therefore, estimation of lead or travel time for flood event can be beneficial primary information. The objective of this study is to estimate the lead time or travel time for outlet of Temengor dam in Malaysia. Tenaga Nasional Berhad (TNB) Sungai Perak dam operation has the main contribution on decision support for early water released and flood warning to authorities and locals resident for in the down streams area. For this study, hydrological analysis carried out will help to determine which years that give more rainfall contribution into the reservoir. Rainfall contribution of reservoir help to understanding rainfall distribution and peak discharge on that period. It also help for calibration of forecasting model system for better accuracy of flood hydrograph. There may be various methods to determine the rainfall contribution of catchment. The result has shown that, the rainfall contribution for Temengor catchment, is more on November in each year which is the monsoon season in Malaysia. TNB dam operational decision support systems can prepare and be more aware at this time for flood control and flood mitigation.

1. Introduction

Hydrological phenomena such as flood become regular as it happened almost every year in different states in Malaysia [1]. However, rainfall forecasting is one of the key that plays important role in regard with water resources. These days, one of the concerns for hydrologists is natural inflows to reservoirs. For flood mitigation, engineers estimate flood discharge and volume to assess of flood storage dam in order to determine channel capacity. Moreover, there is a need to understand the rainfall pattern and attributed temporal variation, evaporation and infiltration for estimation of irrigation storage and requirement. In addition, estimation of flow from the catchment, losses due to evaporation and seepage are necessary. Mentioned issues are related with hydrological analysis. Indeed, hydrological analysis is involved with flood forecasting, water resources modelling, real-time monitoring and management of water resources system and flood risk mapping. Inflow forecasting is a commonly used technique in hydrology to predict inflow based on forecasted weather and real-time data. It is currently used for flood prediction and hydropower reservoirs. The advantages of inflow forecasting systems are related with flood management, efficient water allocation. Inflow forecasts are one of the key inputs in the short-term scheduling of hydroelectric generation, and therefore, an inflow forecast module is an essential part of an operational Decision Support System (DSS) for hydro
scheduling. In this study, inflows forecasting is one of the key inputs in the short-term scheduling of hydroelectric generation, and therefore an inflow forecast module is an essential part of an operational Decision Support System (DSS) for hydro scheduling. The objective of the study is to ensure that the longest possible forecast time is achieved for developing a flood forecasting system that will be characterized by reflecting and addressing the needs of TNB.

2. Study Area
The Perak Hydroelectric Scheme consists of four dams on Sungai Perak (Figure 1). Hydroelectric starts with the Temengor Dam at the upstream and continues by Bersia Dam, Kenering Dam and Chenderoh Dam toward the downstream.

![Figure 1: Sungai Perak Hydroelectric Scheme](image)

3. Methodology
In this study, rainfall analysis has been implemented due to transformation of precipitation into channel flow. Usually, a favourable practice is to use hydrological model to represent watershed processes. Rainfall time series analysis will give some figure on rainfall contribution on reservoir, while double mass curve analysis is to verify the time series consistency. Therefore, it is considered to calculate the 7 Tenaga Nasional Berhad (TNB) rainfall stations and 1 Department of Irrigation and Drainage (DID, Malaysia) rainfall station at Temengor catchment area. One hour data of rainfall from the total of 8 stations is used to define the annual average of rainfall.

3.1. Double Mass Curve
The double-mass curve is used to find the harmony and consistency of hydrologic data with comparison of a reference station with selected stations in the catchment [4]. In this study, the cumulative rainfall and the average cumulative rainfall of considered stations are plotted. To give more definite results, the accumulations of rainfall data can be plotted against the accumulations of the average of many records of other nearby stations which are influenced by the same meteorological condition is less affected by an inconsistency in the record of any one station. Figure 2.a and 2.b shows the double mass curve analysis for TNB station 9061 and average accumulative rainfall at other six stations at Temengor catchment.
3.2. Rainfall Trend Analysis

The hourly recorded rainfall data is collected in time series for all DID and TNB stations. Figures 3.a and 3.b present 1 hour time series for Empangan Temengor (Station No: 9061) and Kg. Sg. Tiang (Station No: 9120)

4. Results and Discussion

Due to recognition of rainfall into the reservoir, monthly average rainfall is calculated from each station to monitor high precipitation months. Table 1 shows the example of rainfall contribution data into reservoir for station 9119 Sg. Tan. Hain. From the data, November 2009 has contributed the most rainfall with average 435.5 mm which has a relative contribution roughly 22.7%. In January 2010, the
lowest rainfall contribution were recorded with the average of 2.8 mm per month which has a relative contribution roughly 1.5%.

Table 1: Percentage of rainfall contribution into reservoir

| Date   | Rainfall (mm) | Percentage of Rainfall Contribution (%) |
|--------|---------------|-----------------------------------------|
| July 2009 | 170           | 8.85                                    |
| Aug 2009  | 192           | 9.99                                    |
| Sept 2009 | 201.5         | 10.49                                   |
| Oct 2009  | 194.5         | 10.12                                   |
| Nov 2009  | 435.5         | 22.66                                   |
| Dec 2009  | 142           | 7.39                                    |
| Jan 2010  | 28            | 1.46                                    |
| Feb 2010  | 37.5          | 1.95                                    |
| Mar 2010  | 28.5          | 1.48                                    |
| Apr 2010  | 73            | 3.80                                    |
| May 2010  | 208.5         | 10.85                                   |
| Jun 2010  | 210.5         | 10.95                                   |

5. Conclusion

From the rainfall data analysis, the estimation of rainfall contribution for Temengor catchment is possible. Double mass curve can help to check the consistency of hydrologic data at the upstream stations. Rainfall contribution time forecast can be estimated at that rainfall stations by statistical rainfall analysis. The rainfall contribution for Temengor catchment is more on November each year which is the monsoon season in Malaysia.

6. References

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