Reservoir Risk Dispatching Combining Forecasting Error

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Abstract

Based on statistic forecasting error of different flood discharge magnitude, this paper considers the forecasting errors have relationship with flood discharge magnitude. Using interval estimation principle, a probable error magnitude bound on different risk level α *is estimated. To consider safety preference, the upper limit of the probable error magnitude bound is called maximal probable error. On the same risk level, the correlativity function between different flood discharge magnitude and its maximal probable error is called forecasting error risk function. Then the text establishes reservoir forecasting error risk function which puts scientific basis for rational making use of forecasting production. According to reservoir scheduling discipline, probing into Feng Shuba reservoir risk forecasting dispatching combining forecasting error risk, it puts application for real time forecasting and dispatching.*

Keywords: *Reservoir, flood, dispatching, risk*

1. Introduction

Flood forecasting technique is an important non-structure measure for flood hazard mitigation. But errors always exist in the result of the flood forecasting for the influence of various sources of uncertainties. And the errors will decrease the efficiency of the forecasting result in the application of the flood control. So while aiming to improve the veracity of the flood forecasting, we should analyze the uncertainties sources and estimate the probability of the error range.

2. Risk Function of Flood Forecasting Errors

2.1. Analysis on Flood Forecasting Errors

Although the result of the inflow forecasting with real-time adjustment is acceptable, the error is avoidless. And the stability of the model needs to be tested. So the error must be taken into account in the application of the forecasting result.

The errors include: (1) input data errors from the measure errors and computing errors of the precipitation, the evaporation and the flow. (2) model frame errors from the hypothesis of Xin'anjiang linear time invariable lumped model; (3) parameter errors from the model calibration for the effect of local optimization.

2.2. The Error Risk Function

All the error components can not be specified. But the combined error of flood forecasting result reflects the integrative effects of all various uncertainties. And the error sequence presents a stochastic series. In this application case, we consider there is a correlation between the forecasting errors and the forecasting discharge magnitude. By principle of the confidence intervals estimate, the probable error range of some magnitude discharge is estimated under a certain confidence level. To consider towards security, the maximum probable error is adopted. On the same confidence level, the correlativity function between different discharge magnitude and the maximal probable error is called forecasting error risk function. The calculation step is as follows:

(1) Calculate the errors $DQ_{(t)}$ between the forecasting discharge $Q_{F(t)}$ and the theoretically true discharge $Q_{T(t)}$:

$$DQ_{(t)} = Q_{T(t)} - Q_{F(t)} \tag{1}$$

Here the sign "t" expresses the time variable.

(2) According to the magnitude of forecasting discharge, the error sequence is partitioned into ten samples for the limited data. And the sign "$\overline{Q}_F$" expresses the average value of the error sequence of forecasting discharge of a certain magnitude.

(3) Some research articles mention that the forecasting error sequence generally presents normal distribution or normal logarithm distribution. In this paper we consider that the forecasting error sequence presents normal distribution. By principle of the confidence intervals estimate, the maximum probable error is estimated under a certain risk. Here we adopt 4 risk percents of 20%, 15%, 10% and 5%. And the corresponding maximum probable errors are $DQ_{20\%}$, $DQ_{15\%}$, $DQ_{10\%}$ and $DQ_{5\%}$.

(4) The error risk function is attained through formulating the recursive correlation of the maximum probable error series and the average value series under various risk percents. The forecasting error risk function of Feng Shuba reservoir presents rectilinear correlation. The correlation equation is expressed as follows:

$$DQ_{\alpha} = b\overline{Q}_F + a \tag{2}$$

Here the coefficient "a" and "b" can be calculated by recursive least mean square algorithm.

2.3. Feng Shuba Reservoir Error Risk Function

Feng Shuba reservoir error risk functions are presented in formula 3 to formula 6, Figure 1 to Figure 4. The regression coefficients of the maximum probable error series and the average value series under a certain risk percent are beyond 0.95. So we consider it is reasonable that the error risk functions present rectilinear correlation.

$$DQ_{20\%} = 0.1833Q_F + 48.404 \tag{3}$$

$$DQ_{15\%} = 0.2605Q_F + 40.319 \tag{4}$$

$$DQ_{10\%} = 0.3033Q_F + 59.371 \tag{5}$$

$$DQ_{5\%} = 0.3921Q_F + 77.201 \tag{6}$$

where, $DQ_{20\%}$, $DQ_{15\%}$, $DQ_{10\%}$ and $DQ_{5\%}$ is maximum probable errors of 20％, 15％, 10％, 5％ risk, Q_F is forecasting reservoir flow after real time adjustment.

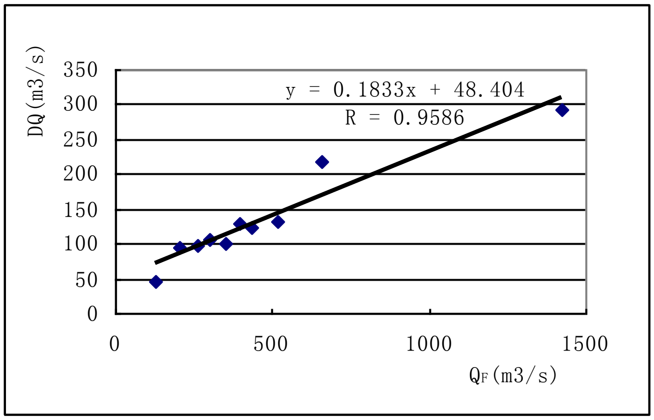

Figure 1. The Correlation between Discharge and Errors when Risk is 20%

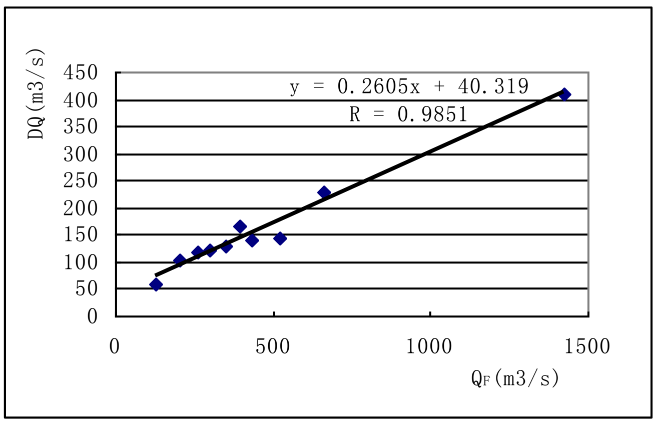

Figure 2. The Correlation between Discharge and Errors when Risk is 15%

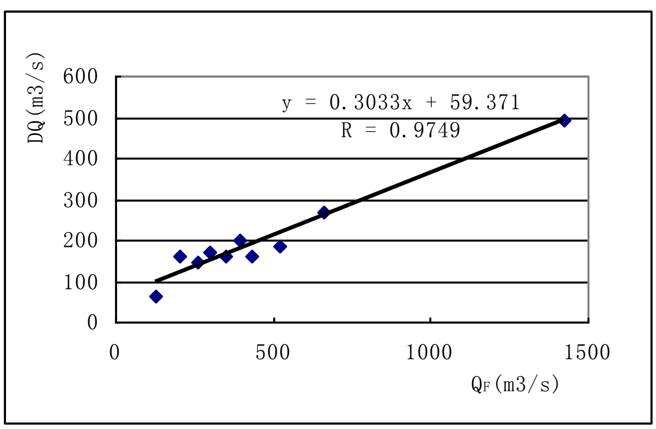

Figure 3. The correlation between Discharge and Errors when Risk is 10%

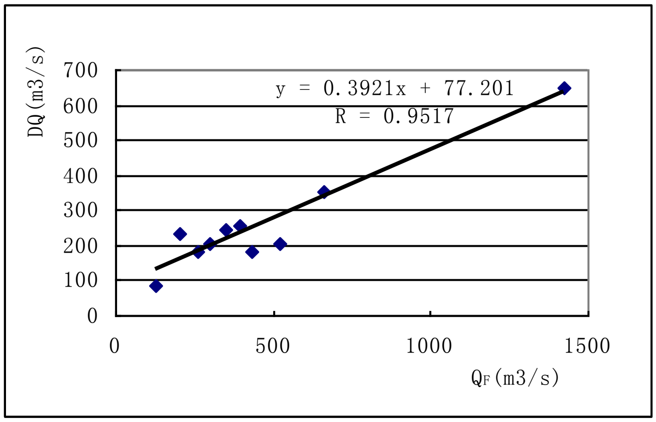

Figure 4. The Correlation between Discharge and Errors when Risk is 5%

3. Risk Regulation of Flood Control

The main idea of the risk regulation of flood control is that: the forecasting error may not be taken into account when the water level of the reservoir is much lower than the flood control level. But when the water level of the reservoir is higher than the flood control level of the reservoir, the flood forecasting error must not be ignored in respect of the safety of the reservoir. The risk of flood control is higher when the water level of the reservoir is higher. For example, when the water level of the reservoir is near flood control level, the hazard level of 20 percent may be adopted to calculate $DQ_{20\%}$; when the water level of the reservoir is near the design flood level, the hazard level of 10 percent may be adopted to calculate $DQ_{10\%}$, and when the water level of the reservoir is near spillway design flood level, the hazard level of 5 percent may be adopted to calculate $DQ_{5\%}$.

The hazard level of 10 percent and 5 percent are adopted to calculate $DQ_{10\%}$ and $DQ_{5\%}$ when the water level of the reservoir is near spillway design flood level. Comparing with normal dispatching, the results are as Figure 5, Figure 6 and Figure 7.

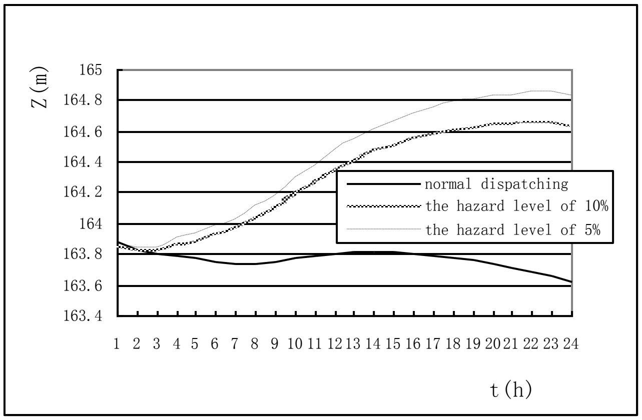

Figure 5. Feng Shuba Reservoir Water Level in 24 hours

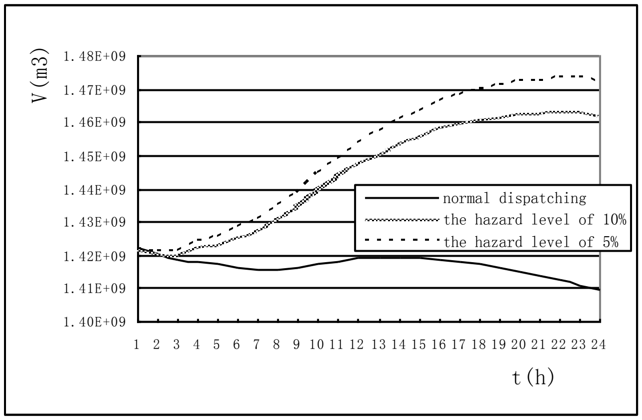

Figure 6. Feng Shuba Reservoir Capacity in 24 hours

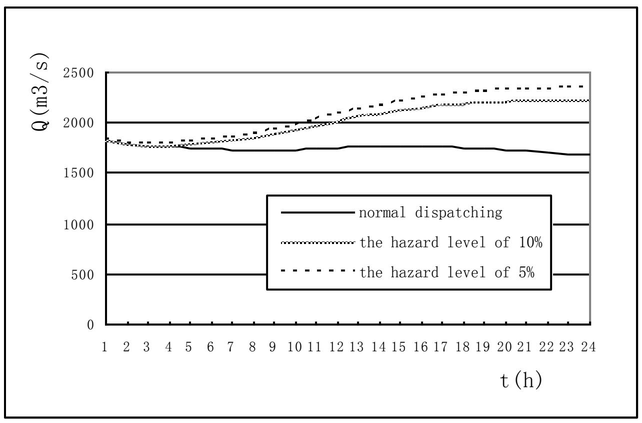

Figure 7. Feng Shuba Reservoir Flux in 24 hours

Comparing with Figure 5 to Figure 7:

1. Because of considering risk regulation of flood control, the water level, the capacity and the flux of Feng Shuba reservoir are higher than normal dispatching.

2. Comparing with the hazard level of 5 percent and the hazard level of 10 percent, for the water level, the capacity and the flux of Feng Shuba reservoir, the former is higher than the latter, so the former is safer for Feng Shuba reservoir.

3. But because the reservoir flux is more, dispatching will more conservative and waste some water resources.

4. Conclusion

The inflow forecasting error risk functions of Feng Shuba reservoir are formulated for the application of the flood risk control. The flood forecasting model and the flood forecasting error risk function are reasonable and acceptable, it puts application for real time forecasting and dispatching.

Acknowledgements

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