Evaluation of dam flood control using rainfall prediction

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1. Introduction

Dam flood control operation using rainfall predictions has been suggested as one way to improve the flood control functions of existing dams. It can optimally and efficiently use the flood control capacities of dams. However, the result of flood control operation based on rainfall predictions may be even worse than that by conventional regular flood control operation which does not use rainfall prediction when the actual rainfall greatly exceeds the prediction. Therefore, rainfall prediction has not been quantitatively utilized in practical dam flood control operation . This report aims to describe the method which evaluates merits and demerits of dam flood control operation based on rainfall prediction by considering rainfall prediction errors.

2. Evaluation by anticipating the inundation damage

Fig.1 shows a comparison of the inundation damages for several floods with different scales. Each flood was controlled by the two types of flood control operation. The one operation (hereinafter operation A) is the conventional regular flood control operation and the other (hereinafter operation B) is the operation which sets the outflow discharge smaller than that of operation A by 100 m^3/s. Those experimental floods were obtained by multiplying several scale factors to a certain hyetgraph. In a case where the scale factor is small, the inundation damage with operation B a which stores large volume of flood water is smaller than that of operation A. On the contrary, the inundation damage by operation B becomes larger than that of operation A in the case where the scale factor is large because operation B causes the flood control capacity of the dam to be full earlier than operation A. As a whole, operation B is superior to operation A on the condition that the scale factor is smaller than 1.7 and operation A is conversely superior to operation B on the condition that the scale factor is larger than 1.7. This relationship appears when a rainfall prediction is referred to. In particular, if the scale factor is replaced with the error of the rainfall prediction,, operation B is superior on the condition that the actual rainfall is smaller than 1.7 times the rainfall prediction and vice versa. This relation is one of the reasons that rainfall predictions cannot be practically applied to dam flood control operation. The expectation of inundation damage is proposed in this research to comprehensively evaluate dam flood control effect while considering the error of rainfall prediction. It is expressed as the integral of the multiplication of the probability on the error of rainfall prediction and inundation damage (Eq.1).

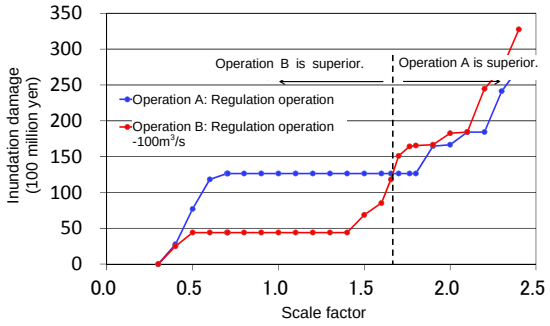

Fig.1 Scale factor change on inundation damage

$$E = \int P(r) \cdot C(r) dr \qquad \text{Eq.1}$$

Here, r is the error rate of rainfall prediction defined by actual rainfall/rainfall prediction, $P(r)$ is the probability density function on r and $C(r)$ is the function of the inundation damage on r.

The expected inundation damage is estimated by introducing the probability of error rate on rainfall prediction to the result of Fig.1 and those values are 1.26 and 4.6 billion yen for operation A and B respectively. This means that operation B is superior to operation A as the expectation of inundation damage. However, it is essential to be aware that there is little possibility that flood control by operation B might result in higher inundation damage than that by operation A.

3. Conclusion

The practical application of the proposed method will be studied by analyzing the rational method of setting the probability density function $P(r)$ based on accurate evaluation of a rainfall prediction and the impact of $P(r)$ and $C(r)$ on the estimated expectation of inundation damage.