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Integrating a Typhoon Event Database with an Optimal Flood Operation Model on the Real-Time Flood Control of the Tseng-Wen Reservoir

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Typhoons which normally bring a great amount of precipitation are the primary natural hazard in Taiwan during flooding season. Because the plentiful rainfall quantities brought by typhoons are normally stored for the usage of the next draught period, the determination of release strategies for flood operation of reservoirs which is required to simultaneously consider not only the impact of reservoir safety and the flooding damage in plain area but also for the water resource stored in the reservoir after typhoon becomes important.

This study proposes a two-steps study process. First, this study develop an optimal flood operation model (OFOM) for the planning of flood control and also applies the OFOM on Tseng-wun reservoir and the downstream plain related to the reservoir. Second, integrating a typhoon event database with the OFOM mentioned above makes the proposed planning model have ability to deal with a real-time flood control problem and names as real-time flood operation model (RTFOM). Three conditions are considered in the proposed models, OFOM and RTFOM, include the safety of the reservoir itself, the reservoir storage after typhoons and the impact of flooding in the plain area. Besides, the flood operation guideline announced by government is also considered in the proposed models. The these conditions and the guideline can be formed as an optimization problem which is solved by the genetic algorithm (GA) in this study. Furthermore, a distributed runoff model, kinematic-wave geomorphic instantaneous unit hydrograph (KW-GIUH), and a river flow simulation model, HEC-RAS, are used to simulate the river water level of Tseng-wun basin in the plain area and the simulated level is shown as an index of the impact of flooding. Because the simulated levels are required to re-calculate iteratively in the optimization model, applying a recursive artificial neural network (recursive ANN) instead of the HEC-RAS model can significantly reduce the computational burden of the entire optimization problem.

This study applies the developed methodology to Tseng-wun Reservoir. Forty typhoon events are collected as the historical database and six typhoon events are used to verify the proposed model. These typhoons include Typhoon Sepat and Typhoon Korsa in 2007 and Typhoon Kalmaegi, Typhoon Fung-Wong, Typhoon Sinlaku and Typhoon Jangmi in 2008. The results show that the proposed model can reduce the flood duration at the downstream area. For example, the real-time flood control model can reduce the flood duration by four and three hours for Typhoon Korsa and Typhoon Sinlaku respectively. This results indicate that the developed model can be a very useful tool for real-time flood control operation of reservoirs.