INTEGRATED OPERATION OF RESERVOIRS FOR MAXIMIZING HYDROPOWER AND REDUCING FLOOD RISK.

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SUMMARY

Water is associated with development in all countries. However, the unsustainable exploitation of water is putting pressure on the community. Accordingly, around four billion people face severe physical water scarcity for over one month per year (The United Nations World Water Development Report 2020 'Water and Climate Change'). The increased climate variability will aggravate the situation with the increasing frequency and severity of water-related disasters. While sustainable water management is an essential part of adapting to climate change (The United Nations World Water Development Report 2020 'Water and Climate change'), water can also play a very important role in collaboration and coordination among the main targets for sustainable development (SDGs), climate change (Paris Agreement), and disaster risk reduction (Sendai Framework).

Water resources provide a potential energy value for electricity generation. As an important renewable energy resource, hydropower is expected to contribute to cutting down carbon emissions and mitigating global warming. Therefore, if properly planned and implemented, hydropower generation could be an affordable, reliable, sustainable, modern technology and will help mitigate the impact of climate change (Sustainable Development Goals -SDGs, which include a dedicated, stand-alone goal on energy, SDG 7).

For these reasons, significant public interest has been drawn in the use of hydropower generation in a concerted approach, which aims to improve the operational efficiency of existing reservoir systems as a preferred solution not only for mitigating flood damage but also for the effective use of water resources. In order to introduce the concerted approach successfully, an integrated system is needed to demonstrate the effectiveness of dam operations by combining a rainfall forecasting model and the distributed hydrological model capable of analyzing reservoir operations and simulating downstream flooding.

Two additional research novelties are considered in the present thesis while investigating strategies for flood damage reduction. Firstly, the study proposes an integrated method for quantitative evaluation of contributions of current hydropower generation dams to flood risk reduction. Second, an integrated approach was developed for investigating the effectiveness of reservoir operation strategies by conducting the analysis, evaluation, and proposal of the reservoir operation scenarios corresponding to the uncertainty scenarios of the forecasts. In this study, downstream flood simulations were conducted using a distributed hydrological model (WEB-RRI), and the simulation results were verified based on information from ground surveys (observed data) and aerial observations (SAR data). A well-calibrated and validated model was employed to quantify the contributions of hydropower generation dams to flood risk reduction.

The system was evaluated on the Vu Gia Thu Bon (VGTB) river basin, one of the major river basins in central Vietnam, by further applying the methodology to the hypothetical pre-release of dam water. The results showed that the methodology could reduce the magnitude of inundation while maintaining the water level of the dam after the flooding. By adopting the ensemble rainfall forecast information while considering the current state of the reservoir, the system can provide timely recommendations for the operator to take the initiative in pre-release, including determining the starting time of water release and flow rates, as well as no water release in advance in some cases. This integrated system consists of the ensemble rainfall prediction system and the WEB-RRI model. They can be operated worldwide if river discharge data is available at least. Therefore, the system can be widely applied to other regions.

This research evaluates the contributions of the current dam operation to the flood risk reduction in the downstream and demonstrates a more effective way without any loss of power generation. By applying the new system, there are not only contributes to reducing the level of downstream flooding but also increases the efficiency of electricity generation as well as the economic efficiency of hydropower reservoir operation. Considering flood risk management issues that have emerged after the rapid socioeconomic expansion in central Vietnam, the region is urgently in need of improved capability of flood risk management. The present study suggests how the basin without flood control dams could improve resilience against flood hazards by effectively utilizing currently available infrastructure. The reference information presented in this study can provide a harmonious solution to promote the integrated management of a river basin among relevant parties.